Sabina
GOLD & SILVER CORP.

The BACK RIVER PROJECT

Human Environment

Volume 8



Prepared by:

Rescan™
an ERM company

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Back River Project Fact Sheet

December 2013

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

- Six mining areas within the Goose and George Properties. Three locations at the Goose Property (Goose, Umwelt, and Llama) and three locations at the George Property (Locale 1, Locale 2, and LCP North).

Site Preparation and Construction Phase

- Site preparation may begin in 2014 (winter roads, fuel depots, laydown areas)
- Full construction of the project could commence as early as 2016 – two years to complete construction
- Approximately $605 M initial capital investment

Operational Phase

- Goose Property: open pit at Llama, Umwelt and Goose deposits; underground at Umwelt deposit
- George Property: Open pits at Locale 1, Locale 2, LCP North

Production

- Production Rate (Ore): 15.0 million tonnes of mill feed for life of mine
- Projected annual 300,000 ounces of gold for about up to 10 years

Processing

- 5,000 tonnes per day
- Standard gravity separation and cyanide leaching circuit
- Tailings facility at Goose Property

Transport

- Gold doré bars shipped out by aircraft

Access Roads

- All-weather roads within George and Goose properties
- Winter road between George and Goose properties
- Winter road to link properties to the Marine Laydown Area at Bathurst Inlet
- Short term winter road link to Tibbett-Contwoyto Winter Road

Re-supply

- Marine supply via open water seasonal shipping (max of 10 ships, average of 3 to 5 per year)
- Year-round by aircraft
- Winter road to the Marine Laydown Area
- Winter road connection to Yellowknife (short term)

Environment

- Extensive baseline studies including terrestrial environment, wildlife (particularly caribou), marine environment, freshwater environment, air quality and resource utilization
- Traditional knowledge information collected and analyzed through an Inuit owned major study - Naonaiyaotit Traditional Knowledge Project
- 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 1200 person years over a two year period
- Direct operations employment up to 4442 person years for 10 years

Social and Economic Benefits

- Inuit Impact Benefits Agreement with the Kitikmeot Inuit Association
- 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 sufficient to verify that reclamation has successfully met closure and reclamation objectives

BACK RIVER PROJECT

DRAFT ENVIRONMENTAL IMPACT STATEMENT
Supporting Volume 8:
Human Environment

December 2013
Project #0194096-0040

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan Environmental Services Ltd., an ERM company
Vancouver, British Columbia

Executive Summary

Rescan™
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Executive Summary

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of Nunavut. The Project is composed of three main areas: the Goose Property, the George Property, and a Marine Laydown Area (MLA) situated along the western shore of southern Bathurst Inlet. Sabina has prepared an Environmental Impact Statement (EIS) to identify and assess potential environmental and social effects resulting from the Project, and is consistent with the requirements outlined in the Nunavut Land Claim Agreement (NCLA) and the Nunavut Impact Review Board (NIRB) Guidelines for the Preparation of an Environmental Impact Statement for the Back River Project (NIRB File No. 12MN036; NIRB 2013). This volume of the EIS presents the assessment of potential environmental effects to the human environment associated with proposed Project activities following the application of mitigation and management measures.

The scoping of potential 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 human environment components were selected as VSECs: archaeological sites, economic development, business opportunities, employment, education and training, health and community well-being, non-traditional land and resource use, subsistence economy and land use, and country foods. Paleontological sites, human health risk assessment, and environmental risk assessment were considered Subjects of Note and all required information noted in the EIS guidelines is included in this volume.

Potential effects on VSECs were evaluated spatially within a Local Study Area (LSA) and a larger Regional Study Area (RSA). LSAs and RSAs are separately defined for archaeology, socio-economics, land use, and country foods. For archeology, the LSA consisted of a 5 km buffer around all Project infrastructure, and the RSA was the same as the terrestrial RSA. For socio-economics, the LSA consisted of west Kitikmeot region communities, and the RSA was expanded to include eastern Kitikmeot communities and Yellowknife. For land use, the LSA consisted of a 5 km buffer around Project infrastructure and the RSA was the combined area of the terrestrial and marine RSAs. For country foods, the LSA was the maximum boundary of the atmospheric and terrestrial LSA, and the RSA was the combined boundary of the terrestrial and marine RSA. All potential Project effects were assessed during the Site Preparation, Construction, Operations, Reclamation and Closure, and Post-closure Project phases.

The following presents summaries of the existing environment, primary Project activities that are anticipated to interact with the human environment VSECs, mitigation measures, effects assessment, and if applicable, cumulative effects assessment for each VSEC.

<u>Paleontology</u>

The paleontological Regional Study Area (RSA) is predominantly underlain by folded turbiditic meta-sediments of the Archean (~1.8 Ga) Beechey Lake Group, cut by felsic and gabbroic dikes, sills, and small intrusions. Only the sedimentary rocks are of interest from a paleontological perspective, as intrusive igneous rocks have no potential to contain fossils and metamorphosed rocks would not preserve fossils of the size prevalent during this interval of geologic time.

No known paleontological studies have been carried out in the RSA, and as a result records are lacking on the presence of fossil species in the Beechey Lake and Goulburn Groups, though biological structures have been identified in the form of stromatolites (Cecile and Campbell 1977). The dominant sediments in the RSA are Late Archean to Proterozoic in age (~2.6-1.8 Ga). The fossil record during this interval is dominated by the occurrence of stromatolites. These layered, mound-like structures are produced by communities of photosynthetic bacteria. In exceptional circumstances, cells of bacteria can be preserved (Schopf 2006). Stromatolites have been encountered at the boundary between felsic rocks from the Back River volcanic complex and the Beechey Lake turbidites (Lambert 1998). They have also been found in the Kilohigok Basin around Bathurst Inlet (Pelechaty and Grotzinger 1988), and in the Goulburn Group sediments. Given the clastic nature of these sediments, the fine-scale preservation necessary for the preservation of cellular detail is improbable.

Archaeological Sites

Recent site-specific baseline studies have been conducted within the Project Potential Development Areas (PDAs), and the archaeological LSA and RSA in 2001, 2002, 2004, 2007, 2010 to 2013. Some historical information within the RSA is available from the 1970s and 1990s.

Potential Project-related effects on the VSEC archaeological sites included the disturbance of archaeological sites. During construction, Project activities that could have potential effects on archaeological sites include: clearing and grading for roads and pipeline rights-of-way; clearing, grading, and excavation for foundations and building footings; earth moving and blasting for mine construction; and tailing and waste rock deposition. Residual effects are anticipated to sites located within 50 m of the PDAs and the road rights-of-way. These sites have a high probability of being directly affected from disturbance due to ground altering activity by construction. Archaeological sites between 50 m and 1,000 m from Project developments have the potential to be indirectly affected during construction and operations through increased human presence in the area.

There are 305 known archaeological sites within the archaeology RSA and the Tibbitt to Contwoyto Winter Road Connector Assessment Area. There are 132 known archaeological sites within 1,000 m of the PDAs that may be impacted either directly or indirectly by the Project. Of the 132 sites within 1,000 m, 84 are between 150 m and 1,000 m and are considered to be at low risk of indirect impacts during construction and operations. There are 14 sites between 50 and 150 m from the PDAs that are considered to be at moderate risk of indirect impact through increase human presence during construction and operations. The 34 archaeological sites within 50 m of the PDAs are considered to be at high risk of direct impact during construction.

Typically, site avoidance through Project redesign is the recommended management option and the Project has been designed to minimize effects on archaeological sites. Archaeological site locations were considered during Project design and where possible were avoided. The use of temporary winter roads further limits potential effects to archaeological sites by reducing overland traffic. However, where avoidance is not possible, mitigation of archaeological sites will be conducted prior to construction activities. Any archaeological sites not previously recorded that are discovered during construction, operations, and closure will be inspected by the Project archaeologist, documented, and reported to the Government of Nunavut, Department of Culture and Heritage using the 'Chance Find Procedure'. These sites will be subject to the same level of management and mitigation afforded to the currently known archaeological sites outlined above.

With avoidance and/or mitigation implemented, residual effects on known archaeological sites are anticipated to be **Not Significant**. Due to the spatially localized nature of archaeological sites there are no cumulative effects or transboundary effects from the Project on the VSEC archaeological sites.

Socio-economics

The assessment of potential effects of the Project on socio-economics considers five VSECS: 1) economic development; 2) business opportunities; 3) employment; 4) education and training; and 5) health and community well-being. A total of 10 potential effects were identified, resulting in seven positive residual effects, two negative residual effects, and one effect with both positive and negative residual effects. Positive residual effects were described but were not evaluated for significance or carried in to potential cumulative or transboundary effects assessment. Negative residual effects were further evaluated for determination of significance, and were also included in potential cumulative and transboundary effects assessments.

Economic Development

The Kitikmeot Region has a mixed economy, focusing on public sector services, private sector market economies, and traditional activities. Formal economic sectors of particular importance include: government administration, health care and social services, education, retail, construction, transportation, tourism services, arts and crafts, and mineral exploration and development (Statistics Canada 2007b). The service sector is the base of the Kitikmeot economy, providing employment to around 80% of the employed labour force. In contrast, primary and secondary industries—including resource-based industries and construction—account for about 20% of local employment (Statistics Canada 2007b). Nunavut's Gross Domestic Product (GDP) experienced an overall increase of approximately 26.5%, from $1,357 million to $1,716 million between 2007 and 2011. Opportunities to develop mineral-based deposits are expected over the next 25 years, leading to continued economic growth in the region and its communities.

Project activities have the potential to result in positive changes to economic growth, diversity, and performance. The economic impacts of the Project are a result of direct procurement and workforce employment, which are expected to also have indirect and induced effects to employment, personal income, GDP, and government revenues. The Business Development Plan and Human Resources Plan detail enhancement measures that together aim to increase the benefits of the Project on local and regional development (see Volume 10, Chapters 24 and 28). Benefits will be enhanced through experience with the Project, support for local Inuit and northern businesses, capacity building, and community investment.

Overall, increases to economic diversity are anticipated as a result of the Project and are characterized by: increased local employment, increased incomes, and spending; Project-related expenditures (locally, regionally) with existing businesses located in the Kitikmeot and across Nunavut, increasing the financial resources available to existing businesses; the addition of new businesses or expansion of existing businesses within the Kitikmeot Region that provide goods or services previously unavailable; and/or the development of, or additional investment in, Inuit-owned businesses. Increased economic growth, diversity, and performance are expected to have a positive residual effect on the VSEC economic development. As the residual effect was determined to be positive, the effect was not carried through for further cumulative or transboundary assessment.

Business Opportunities

The Government of Nunavut dominates the service sector and is the major economic driver of the Kitikmeot communities. Government employment and income support provides the main source of income for residents and this, in turn, supports the presence of the private sector in each community. Dependence on the public sector results from multiple conditions, such as the harsh climate, geographic remoteness, small population, and underdeveloped infrastructure systems, as these conditions have constrained private sector economic development. Private sector businesses prominently include accommodation and retail, as well as a range of smaller-scale goods and service

providers in each community. Cambridge Bay, and to a lesser extent Kugluktuk, stands out as a community where the private sector has a more important role in the economy. There are multiple investment support programs offered by the Government of Nunavut to encourage the development of local business. Funding to small businesses, individuals, organizations, and municipal governments is provided by the Nunavut Department of Economic Development and Transportation and is administered by the regional office based in Kugluktuk. The four main funding programs include: the Small Business Support Program, Arts and Crafts Program, Strategic Investment Program, and Policy on Program Partnership (NDEDT 2011).

The Project has the potential to result in changes in the growth and diversity of Inuit and northern businesses. This effect is defined as the potential for new businesses and the ability of existing businesses to expand or diversify and as a result of local Project procurement and the expenditure of Project-related income of workers. Measures to enhance business opportunities are detailed in the Business Development Plan (Volume 10, Chapter 24).

Project activities that are anticipated to promote growth and diversity among Inuit and northern businesses include: provision of contract and sub-contract opportunities, specifically the procurement of goods and services from local suppliers; and contribution to personal incomes, increasing the purchasing power of local residents. The expected increase in local business activity itself is expected to bring about an increase in capital investment (e.g., investment in the expansion of businesses or the creation of new businesses) in anticipation of the Project. Local businesses will be presented with opportunities to bid on Project work, facilitated by the Project through mitigation and management measures established to maximize the benefits of contracting opportunities and the local sourcing of goods and services. Changes to the growth and diversity of Inuit and northern business are anticipated to have a positive residual effect on the VSEC business opportunities. As the residual effect was determined to be positive, the effect was not carried through for further cumulative or transboundary assessment.

Employment

The potential labour force within the Kitikmeot communities was approximately 3,475 in 2006. The active labour force among these same communities was approximately 2,185 individuals, indicating an average participation rate of 62.9%. Unemployment rates were considerably higher in Gjoa Haven and Taloyoak (31.9% and 31.4%, respectively) as compared to the rate for the Canadian Aboriginal population (14.8%). In terms of unemployment among the Aboriginal identity population in Nunavut, the Kitikmeot remains highest of the three regions (23.5%), but more closely reflects the territorial average (20.1%). All Kitikmeot communities exhibit high participation in the education, business, retail, and other services sectors. These labour trends are typical for small, relatively isolated northern communities (Statistics Canada 2007b). The Government of Nunavut is also a notable employer in the Kitikmeot Region. Cambridge Bay reported the highest median household income among the Kitikmeot communities ($71,936), which is approximately 22% more than the community with the second highest household income (Kugaaruk at $58,624) and almost 20% more than the Nunavut average. In general, all communities reported high proportions of part-time or seasonal work, ranging from approximately 58% in Cambridge Bay to 87% in Gjoa Haven.

The Project is expected to affect the VSEC employment through: 1) changes to employment and income levels; 2) changes to the capacity of the labour force; and 3) changes to competition for local labour. Mitigation and management measures that focus on training, recruitment, and retention have been developed to enhance the participation of local Inuit in Project employment and are detailed in the Human Resources Plan (Volume 10, Chapter 28). The strategies to enhance Project effects on employment include: a Labour Relations Strategy; a Preferential Recruitment Strategy; a Workforce

Training Strategy; and a Workforce Transition Strategy. The targeted recruiting of Inuit employees is expected to reduce the higher than average unemployment rates. The Project will also inform local businesses, organizations, and hamlets of their hiring requirements and procurement practices in advance of the implementation of Construction and Operation and will collaborate to reduce any adverse effects of increased competition for local labour.

Overall, the employment and income effects of the Project are highly beneficial and have the potential to enable increased standards of living for Kitikmeot families. Direct Project employment and procurement are expected to increase the capacity of the labour force, specifically the skills and experience of Kitikmeot workers. Increased capacity is predicted to lower unemployment rates, promote economic growth, and enhance ability of the regional workforce to support future projects. Changes in income and employment levels, as well as changes in the capacity of the labour force, are anticipated to have positive residual effects on the VSEC employment.

Direct Project employment and procurement may cause negative changes to local competition for labour. That is, the Project creates the potential for individuals currently employed in the Kitikmeot Region to leave their current employment for mine-related employment. However, most Kitikmeot residents employed elsewhere are not expected to leave their current employment to obtain work with the Project. The Project also serves to increase the skills and experience of the local labour force, over time increasing the availability for local employers. In sum, the residual effect of changes to competition for local labour is assessed as being of low magnitude and limited to the socio-economic LSA communities. The duration was determined as medium term (confined to the life of the Project), the equity neutral, and the frequency sporadic. Finally, the effect is determined to be reversible, and a moderate probability and medium confidence are provided. The residual effect is rated as **Not Significant**.

The predicted residual adverse effect was further assessed as part of the potential cumulative effects assessment (CEA). The geographic boundary for the CEA was expanded to include those projects and human activities in the Kitikmeot and NWT considered to have potential effects within the socio-economic RSA that are relevant to current residents. There was one past, four current, and five future projects that had the potential to result in cumulative changes to the VSEC employment related to competition to local labour for Kitikmeot residents. The CEA concluded that the development of the Project and one or more additional projects would result in residual negative 'changes to competition for local labour'. The cumulative residual effect is expected to be reversible, of low to moderate magnitude, and be of local geographic extent. The duration is determined as medium term (confined to the life of the Project) and the equity neutral, and frequency sporadic. The residual cumulative effect is determined as unlikely and **Not Significant** with a medium level of confidence. As this residual cumulative effect is unlikely, the potential transboundary implications are negligible.

Special consideration was given to potential transboundary effects to employment and businesses within the socio-economic RSA. The transboundary effects assessment concluded that competition for local labour is not expected to be substantial outside the Kitikmeot Region but is rather anticipated to provide desired employment. The transboundary effects of the Project were determined as positive and therefore not further characterized.

Education and Training

Each of the study communities, with the exception of Bathurst Inlet and Omingmaktok, is provided with kindergarten, elementary, and secondary schooling. Students are provided with the opportunity to obtain their high school certificate (or equivalent) within their home community. In general, high school completion rates remain low in all communities. Gjoa Haven residents exhibited the lowest level

of educational attainment in the region, with over 59% of the population aged 25 to 64 lacking high school or other certificates/diplomas. In contrast, Cambridge Bay residents had the highest level of educational attainment among the communities, with approximately 36% of residents aged 25 to 64 without high school or other certificates/diplomas. Among the Kitikmeot communities, Cambridge Bay had a relatively high proportion of the population with a university certificate/diploma (16%) or a college degree or diploma (24%) compared with the other communities. Attainment levels for apprenticeship and trade certifications ranged from almost one-quarter of the population in Kugaaruk (22%) to just over one-tenth (12%) of the population in Cambridge Bay. Post-secondary education is offered through the Nunavut Arctic College (NAC). The college serves Kitikmeot communities through its central campus in Cambridge Bay, which is responsible for all college programming in the region (NAC 2008). Programs offered through the NAC include trade programs, certificate and diploma programs, career development programs, academic studies programs, and continuing education programs. NAC also provides training programs to support employment in the mining sector.

The potential effects of the Project on education and training include changes to the demand for education and training, and changes to youth attitudes and behaviours toward education and training. Sabina expects to partner with local governments, educational institutions, Inuit organizations, and other mine proponents to contribute to the creation of a regional training facility or additional mine employment training programs at the NAC. Further discussion of community investment is provided in the Community Involvement Plan (Volume 10, Chapter 26). The Workforce Training Strategy, as defined in the Human Resources Plan (Volume 10, Chapter 28), specifies actions to enhance the benefits of Project employment within the local communities by developing strategic partnerships; contributing to local programs and training initiatives; providing in-house training and career development; employment of an Inuit Employment and Training Coordinator; and engaging youth through mentorship programs.

In sum, changes to the demand for education and training, as well as changes in youth attitudes toward education and training, are predicted to have positive residual effects on the VSEC education and training. The assessment concluded that the Project would have positive effects on the VSEC education and training. As a result, effects to education and training were not subject to cumulative or transboundary effects assessments.

Health and Community Well-being

Nunavummiut experience lower rates of arthritis, diabetes, asthma, and high blood pressure as compared to Canadians. However, more Nunavummiut are overweight and obese, and have a higher incidence of cancer (512.1 per 100,000) as compared to Canadians generally (404.9 per 100,000). The incidence of lung cancer (206.8 per 100,000) is particularly high for Nunavummiut, at approximately four times the rate in Canada (56.9 per 100,000). Residents of Nunavut can expect a much shorter lifespan than the average Canadian (DHSS 2004; NTI 2008). On average, Nunavut residents have a life expectancy of 71.6 years at birth and 15.2 years at age 65 (2007/2009 average). Despite the relatively small populations, there are a wide range of health services and programs available in Kitikmeot communities. Although Cambridge Bay is the only community that provides full-time physician services, visiting doctors see patients in the other communities on a rotational basis. With respect to community health within Kitikmeot communities, relatively high suicide rates are a concern.

General community well-being, as described by AANDC's community well-being indicator, was relatively low within Kitikmeot communities. Cambridge Bay and Kugluktuk scored somewhat higher, on or above the Nunavut average. Taloyoak, Kugaaruk, and Gjoa Haven scored exceptionally low (53, 55, and 56, respectively), particularly on the housing component of the index. Crime and housing contribute to community health and well-being. Crime rates among Kitikmeot communities are highest in Cambridge Bay, Kugluktuk, and Gjoa Haven. Kugaaruk typically has low crime rates in relation to

other Kitikmeot communities. Although housing challenges exist in all Kitikmeot communities, there are a notably high proportion of crowded homes in Gjoa Haven, Taloyoak, and Kugaaruk (57, 56, and 50%, respectively). Public housing is the most common type of tenure, and dependence on the public sector for housing is likely to continue given severe economic, climatic, and geographic constraints on private sector involvement.

The effects of the Project on Health and CWB are anticipated to be both positive and negative and include: changes to the life skills of those employed with the Project; changes to individual and family spending; and changes to family/household function. Engagement in economic productive work, the management of finances, and responsibility associated with employment are expected to assist with or support decision making and increase life skills. Enhancement measures have been developed to promote the retention of positive Project effects locally including those aimed to increase the number of Inuit employed (e.g., EFAP, financial management counselling) as detailed in the Human Resources Plan (Volume 10, Chapter 28).

The Project is anticipated to increase the life skills of individuals who obtain Project-related employment, resulting in a residual positive effect on the VSEC Health and CWB.

Both positive and negative residual effects are predicted on Health and CWB due to changes to individual and family spending. Should local residents that obtain employment with the Project choose to spend their increased incomes unproductively (e.g., on gambling, drugs, and alcohol) and engage in negative social behaviours, this will have a negative effect on CWB. However, income used to improve standards of living (e.g., improvements to housing, food security) coupled with the other numerous positive effects associated with Project employment have the potential to result in substantial increases to CWB. Changes to individual and family spending, whether negative or positive, were determined as moderate in magnitude, short to medium term in duration and neutral in equity. This residual effect was expected to occur mainly within the socio-economic LSA but may extend to the RSA. This residual effect is reversible and has a sporadic frequency. Overall, negative changes to individual and family spending are determined to be **Not Significant.** This finding is moderately probable and is supported by a medium level of confidence. Overall, changes to family and household structure are expected to result in a negative residual effect. The magnitude of this negative residual effect is considered low as it is estimated to affect a relatively small number of households. The residual effect is reversible, medium term in duration, continuous in frequency, and neutral in equity. The geographic extent of this residual effect is expected to remain within the LSA but may extend to the RSA. Overall, negatives changes to family and household structure are determined to be **Not Significant.** This finding is moderately probable and is supported by a high level of confidence.

The residual adverse effects of the Project on Heath and CWB were included in the assessment of potential cumulative effects. As noted earlier, the geographic boundary for the socio-economic CEA was expanded to include those projects and human activities in the Kitikmeot and NWT considered to have potential effects within the socio-economic RSA that are relevant to current residents. There was one past, four current, and five future projects that have the potential to result in cumulative changes to health and community well-being. The assessment determined that the development of the Project and one or more additional projects would result in both negative and positive residual effects to the VSEC health and community well-being. Specifically, changes to the individual and family spending that result from the development of multiple projects may result in both positive and negative outcomes. The residual cumulative effects is expected to be reversible, moderate in magnitude, continuous in frequency, short to medium term in duration and neutral in equity. This residual cumulative effect is expected to be relevant mainly within the LSA but may extend into the RSA. The employment and income associated with the Project and one or more future projects are expected to result in overall positive cumulative effects to Health and CWB; however, for some individuals there is also potential for negative cumulative

effects as a result of unproductive or negative spending. This cumulative residual negative effect is determined to be **Not Significant.** This finding is moderately probable and a medium confidence is provided.

Finally, the development of one or more additional projects is expected to increase the number of households that may experience a negative outcome as related to changes in family and household structure. This residual cumulative effect is negative, reversible, low in magnitude, medium term in duration, and neutral in equity. The frequency of this residual cumulative effect is continuous and expected to remain mainly within the LSA, although there is potential for the effect to expand to the RSA. The cumulative residual effect is similarly determined to be **Not Significant.** This conclusion is moderately probable and supported by a medium level of confidence.

The transboundary effects assessment reviewed the effects of the Project on the VSEC health and community well-being. The residual effects of the Project on health and community well-being are expected to be most relevant to small northern communities. Both residual effects are expected to be negligible outside the Kitikmeot Region.

Special consideration was given to potential transboundary effects to health systems in the NWT as a result of Project reliance on medical services. The Project is not expected to have transboundary effects on the health system in the NWT due to the fly-in/fly-out operation of the Project and the provision of required medical services at the Project site. Project employees are expected to continue to utilize health services in their home communities and will have access to health services at the Project site as required.

Land Use

The assessment of potential effects of the Project on land use considers two VSECS: 1) non-traditional land and resource use; and 2) subsistence economy and land use. A total of three potential effects were identified acting on each VSEC, resulting in a total of six potential effects. All of the potential effects were identified as negative residual effects. Negative residual effects were further evaluated for determination of significance.

Non-traditional Land and Resource Use

Commercial land use consists primarily of sport hunting, tourism, mineral exploration, and transportation and shipping. In 2012, there were 22 active exploration projects in the Kitikmeot Region. This is a reduction from 95 active exploration projects in the Kitikmeot in 2011, including 35 within the western Kitikmeot. Currently, there are no active mines in the Kitikmeot. There is one exploratory licence for an Arctic char fishery located within the land use RSA near the community of Bathurst Inlet; the fishery is not yet active primarily due to difficulties of transporting catch to a processing facility. Sport hunting in Nunavut is usually organized through the community HTO office. Species typically targeted for sport hunting include caribou, muskox, grizzly bear, polar bear, and wolf (Back River Project Research Program 2012; Nunavut Tourism 2012). Seasonal lodges and adventure tourism companies operate throughout the Kitikmeot Region. One is located near the community of Bathurst Inlet (the Bathurst Inlet Lodge). Operating from June to September of each year, the lodge can accommodate 30 people and occupies an old Hudson Bay Company post. Ecotourism activities include boating in Bathurst Inlet, hiking, sightseeing, and culture and nature interpretation (Back River Project Research Program 2012).

The only interaction between the Project and non-traditional land and resource use is predicted for ecotourism activities potentially affected by: changes in access to land and resources; changes to the experience of the natural environment; and changes to the abundance and distribution of resources.

More specifically, there is one operator, the Bathurst Inlet Lodge, known to sometimes use an area adjacent to the Marine Laydown Area (MLA) within the land use LSA, as well as other areas within the RSA, during the summer season. There are several best practice management and mitigation measures in place which serve to reduce potential adverse effects of the Project, while maximizing the potentially beneficial outcomes as they relate to non-traditional land and resource. The management and mitigation measures can be found in both built-in Project design components, as well as specific additional measures that were developed based upon identified needs. Mitigation has been identified as it specifically applies to noise and vibration, and air quality in the Noise Abatement Mitigation and Monitoring Program, within the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), as well as the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17).

The effects assessment identified one residual adverse effect of the Project on the VSEC non-traditional land and resource. This residual effect is predicted to be geographically limited to the land use LSA, primarily in the vicinity of the MLA, and be low in magnitude affecting a small number of users with currently very limited use. This residual effect is characterized as medium-term in duration (confined to the life of the Project), sporadic in frequency, and is reversible with effort. Finally, geographic extent is limited to Project footprint but extends to areas within the northern portion of the land use LSA. Overall, this residual effect is rated as **Not Significant** and likely to occur. A high level of confidence is provided.

A potential cumulative effects assessment (CEA) was conducted because a negative residual Project effect was predicted. The geographic boundary for the land use CEA was expanded to include those projects and human activities in the western Kitikmeot considered to have potential effects within the land use RSA that are relevant to current land use activities. The Project residual effects on non-traditional land use could interact with potential residual effects of two past projects, one current project and three future projects. The CEA determined the development of the Project and one or more additional projects may result in one adverse residual cumulative effect on non-traditional land use; specifically, changes to the experience of the natural environment. This cumulative residual effect is characterized as moderate in magnitude, medium term in duration, and reversible. The frequency of the residual effect is expected to be sporadic and the geographic extent is regional. Overall, this residual cumulative effect is rated as **Not Significant.** The residual cumulative effects of the Project on non-traditional land use do not extend beyond the boundaries of the Nunavut Settlement Area (NSA) and therefore, cannot result in transboundary effects.

Subsistence Economy and Land Use

The Inuit culture and way of life are intrinsically connected with the land. The Inuit people of the Kitikmeot have always depended on Inuit Qaujimajatuqangit, or knowledge of the land and environment. Subsistence land use such as hunting, fishing, trapping, and gathering, take place throughout the land use RSA. Approximately 10 to 20 active hunters continue to hunt in the Bathurst Inlet area (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Caribou, wolf, and wolverine were the most commonly hunted species; however, marine harvesting for seal and other species was also common. Beechey Lake is a preferred destination for hunters who are active in this area and is reported to have rich wildlife, scenic nature views, and availability of camps and cabins. While there are main travel routes within the area, land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables. Fishing also takes place throughout the land use RSA in Bathurst Inlet and various lakes and rivers. Species of focus include Arctic char, lake trout, whitefish, cod, wolffish, and Arctic grayling. Other species harvested from Bathurst Inlet include clams, mussels, sea urchin, starfish, and crab. Cloudberries, sweet leaves, bearberry, blueberries, mahok, bog cranberry, crowberry, and cloudberry are harvested throughout the RSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012; Cambridge Bay Hunter Focus Group 2012).

There are a number of cabins located in the region, including personally owned cabins, trapper cabins, and campsites with permanent poles or tent posts.

Subsistence economy and land use is potentially affected by: changes in access to land and resources; changes to the experience of the natural environment; and changes to the abundance and distribution of resources. There are several management and mitigation measures in place which serve to mitigate impacts to the subsistence economy, including mitigation by Project design, best practice management measures, and monitoring. Subsistence land use activities will also be facilitated through the provision of the worker rotation schedule, fly-in/fly-out Project operation, and support of land users and the development of land use knowledge. Mitigation has been identified as it specifically applies to noise and vibration, and air quality in the Noise Abatement Mitigation and Monitoring Program, within the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17). Ongoing communication with local individuals and communities will be facilitated by regular public meetings and meeting with the Cambridge Bay and Kugluktuk Community Advisory Groups (CAGs). Feedback will be obtained from mine employees, local land users, the community HTOs and hamlets, as well as from the CAGs themselves in order to provide ongoing updates and make adjustments to management practices as needed.

After the implementation of mitigation and management measures, three residual effects on the VSEC economy and land use were identified: changes in access to land and resources, changes to the experience of the natural environment, and changes to the abundance and distribution of resources. The residual effects are anticipated to be moderate in magnitude, and reversible. Each residual effect is expected to be of medium term (confined to the life of the Project) and will be confined to either the Project footprint or the LSA. Overall, the negative residual effects on the VSEC subsistence economy and land use are rated as **Not Significant**, likely to occur and a high level of confidence is provided. In addition, the benefits of the Project may serve to maintain traditional subsistence land use to a greater extent than would be possible without the economic growth and employment income associated with the Project.

A potential cumulative effects assessment was conducted because negative residual Project effects were predicted. As noted earlier, the geographic boundary for the land use CEA was expanded to include those projects and human activities in the western Kitikmeot considered to have potential effects within the land use RSA that are relevant to current land use activities. The Project residual effects on the Subsistence Economy and Land Use could interact with potential residual effects of two past projects, one current project and three future projects. The CEA reviewed the three residual effects of the Project: changes in access to land and resources, changes in the experience of the natural environment, and changes to the distribution and abundance of resources. The CEA determined the development of the Project and one or more additional projects would result in adverse residual cumulative effects on subsistence harvesters. Each residual cumulative effect is characterized as moderate in magnitude, medium term in duration, and reversible. The frequency of the residual cumulative effects is expected to be sporadic and the geographic extent is the RSA. Overall, the three residual cumulative effects are each rated as **Not Significant** and likely to occur. A medium level of confidence is provided to support this conclusion.

Kitikmeot region land users did not report travel outside the NSA for the purpose of subsistence harvesting. As a result, the Project is not expected to result in transboundary effects on subsistence land users.

Country Foods

Country foods are animals, plants, and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation (Health Canada 2010). These foods are an important part of a healthy diet, have medicinal qualities, and are of high cultural and traditional importance. People obtaining country foods by hunting, trapping, and collecting berries, mushrooms, and medicinal plants from the country foods LSA, and by fishing inside and downstream of the country foods LSA can be affected by the quality of the country foods they consume.

The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water, and vegetation). Chemicals accumulated from the environment may be present in the edible tissue portions of the country foods consumed by people. The potential for adverse effects in human consumers due to chemicals present in country foods depends on the concentration of the chemical, which type and portion of the country food is eaten (e.g., roots or leaves, muscle tissue or liver), life stage of the consumer (e.g., toddler or adult), quantity of food consumed, and frequency of consumption.

There are no permanent residents living in the country foods LSA; however, some seasonal and temporary use of the area does occur (see Land Use, Volume 8, Chapter 4). Inuit people whose main food source is from harvesting country foods are likely the most frequent users of the area (even though the area is infrequently used) and, therefore, are the focus of the assessment.

There are a number of Contaminants of Potential Concern (COPCs) that may be present in the country foods LSA during the life of the Project including compounds used in mineral processing, chemicals found in treated sewage effluent or blasting residues, and fuels. In addition, by-products of combustion such as PAHs, dioxins, and furans may also be present due to the operation of vehicles or incinerators. These potential contaminants were assessed and potential effects were characterized in a qualitative manner taking into consideration mitigation and management strategies, and using best professional judgement. Metals occur naturally in the country foods LSA, sometimes at concentrations exceeding guideline limits (particularly in soil), due to natural physical and geological processes. Because the proposed Project is a metal mine and metal concentrations in the environment are most likely to change as a result of Project development, metals were selected for quantitative evaluation of their potential to affect the quality of country foods. Extensive mitigation and management measures will be in place to minimize or eliminate potential effects on environmental media (air, water, sediment, soil, and vegetation) and country foods themselves (fish and wildlife). These are detailed in Volume 4 (Atmospheric Environment), Volume 5 (Terrestrial Environment), Volume 6 (Freshwater Environment), Volume 7 (Marine Environment), and Volume 10 (Management Plans).

Based on the country foods baseline screening level assessment results, consumption of country foods from the country foods LSA were shown to not present any health risks from the selected COPCs to local human consumers under baseline conditions. Based on the qualitative and quantitative results of the effects assessment, the quality of country foods is not expected to change substantially from baseline conditions. Therefore, human health due to the consumption of country foods from within the country foods LSA is not expected to change in comparison to the baseline levels. No residual effects were identified and no health effects to human consumers of country foods are expected as a result of the Project activities or infrastructure during any phase of the Project. As there are no anticipated Project residual effects, there are no potential cumulative effects or transboundary effects. The overall effect of the Project on the VEC country foods is **Not Significant**.

Human Health and Environmental Risk Assessment

Human health and environmental risk assessments involve comprehensive and systematic processes designed to identify, analyze, and evaluate the effects of the Project on environmental and human health. Baseline studies reviewed the existing levels of contaminants and noise in the local and regional study areas of the Project to establish a benchmark for evaluating the potential future effects of the Project and to characterize pre-disturbance conditions for the purpose of reclamation activities. As part of the human health and environmental risk assessment, data was reviewed for air quality; freshwater and sediment quality; marine water and sediment quality; freshwater aquatic resources and fish; marine aquatic resources, fish, and wildlife; soil and vegetation; terrestrial wildlife; country foods; and noise.

The environmental risk assessment identified 13 Valued Ecosystem Components (VECs) important to assessment of Project effects on environmental health associated with the freshwater environment, the marine environment, or the terrestrial environment. The human health risk assessment focused on four VECs to assess effects of the Project on human health: specifically air quality, water quality, country foods consumption, and noise. The environmental risk assessment for contaminants found no Project-related Contaminants of Potential Concern (COPCs). Thus, there is a negligible potential risk of the Project on health of fish and aquatic habitat, fish communities, wildlife, migratory birds, and raptor VECs. The human health risk assessment for contaminants indicated there was a low risk to humans at Project camps. Potential health effects may include irritation of the bronchial system and lungs. No COPCs were identified that would change the quality of either drinking water or country foods relative to baseline conditions. Finally, the human health and environmental risk assessment for noise concluded the Project was within a tolerable noise level range that is easily mitigated through building construction and design.

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ᓴᵒᓂᖏᓚᔪᓕᐅᑦ ᑯᖏᓚᓂ ᓴᓇᕕᐅᔪᒥ (ᓴᓇᕕᐅᔪᖅ) ᐅᔨᕆᵒᓂᐊᖏᒪᑕ ᖃᓂᖅᓭᑎᒃ ᓴᕕᕆᔨᖅᓴᓂᒃ ᔪᑐᖏᖅᑕᑐᖅᑕᓂᒃ ᓄᓇᖏᑎᑕᑦᑐᐅᔪᓂ ᓴᐱᓇᒃᑯᓚᐃᓄᑦ (ᓴᐱᓇᓗ) ᑕᒪᑐᒪᓂ ᖃᑎᖏᒥᐅᓂ ᓄᓇᕐᒥᐅᑦᑕ ᐅᐊᓕᓂᖏᓐᖏᓚᓂ. ᓴᓇᕕᑎᔨᖅᑕᑦ ᐱᖏᓕᓭᐅᓚᔪᓂᒃ ᓄᓇᓕᕆᓕᖅᑎᒪᑕ ᓄᓇᒥ: ᔪᓴᒥ ᓴᓇᕕᐅᔪᖅ, ᔪᐊᓕᒥ ᓴᓇᕕᐅᔪᖅ, ᐊᓚᒪᓗ ᓗᓴᒥ ᓂᐅᕆᐃᕐᕕᖏᓚᓂ (MLA) ᑲᵒᓇᓕ ᐅᐊᓕᓂᖏᓚᖏᓂᑦᑐᖅ ᖃᖏᓚᐅᖅᑎᐅᑦ ᑲᖏᕐᓂᓗᓂᒃ. ᓴᐱᓇᒃᑯᑦ ᐸᖅᓇᕐᓕᓗᔪᑦ ᐊᐅᑎᖏᓚᓂ ᐃᒃᐱᖏᓇᖅᑎᖅᑎᐊᖅᑐᓂᒃ ᐅᓂᒃᑲᓕᐊᖅᓗᒪᓕᖅᑐᑦ ᑕᒪᑐᒧᖏᓚ (EIS) ᓇᓗᓇᐃᓴᐃᓕᑐᐱᒃ ᖃᓇᖅᑲᖅ ᑕᒪᐅᖏᓚᐅᓴᐅᑎᑦᑎᓂᒃ ᐊᖏᓚᓗ ᐊᖅᑯᔨᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᐅᑎᖏᓕᑦ ᐊᑦᑕᖏᓇᖅᑎᖅᑐᑦ ᐊᖏᓚᓂ ᖃᓇᖅᑲᖅ ᑕᒪᒧᓗ ᐃᓕᓴᕐᕕᐅᑦ ᐃᓕᓴᕐᕕᐅᑦᑐᓂᒃ ᐃᓕᓴᕐᕕᐅᑎᖏᓚᓂᒃ ᑕᒪᒧᓗ ᖃᓇᖅᑲᖅ ᑕᒪᒧᓗ ᐃᓕᓴᕐᕕᐅᑎᖏᓚᓂᒃ ᐊᖏᓚᓂ ᐊᑦᑕᖏᓇᖅᑎᖅᑎᐊᖅᑐᑦ ᐊᖏᓚᓂ ᐃᓕᓴᕐᕕᐅᑎᖏᓚᓂᒃ ᐅᓂᒃᑲᓕᐅᖅᑎ

ᐊᑐᖅᑐᑦᓗ, ᑕᒪᓂᑐᐊᖅ LSA-Γ ᐃᓗᐊᓂᕐᑐᑦ ᐊᐳᓗᖏᓐᓄᑦ 5-ᑭᓯᒥᑐᒥᖅ ᐅᖏᓪᓗᓂᖏᓂᖅᑐᒥᖅ ᓴᓇᐃᐅᓂᐊᖅᑐᒥᑦ ᑎᑭᑦᓗᒍ ᐱᖁᑎᖅᐊᖅᖏᓂᐅᓂᖅᑐᑦᓗ ᐊᒪᓚ RSA-Γ ᐃᓕᓴᐅᑎᕐᐅᑦ ᓄᓇᖏᒐ ᐊᒪᓚ ᐃᒪᖏᓂ ᑕᒪᓂ RSA-Γ. ᓄᓇᒥᑦ ᓂᕆᑦᖏᐃᖏᑦᓕᓴ, LSA ᐃᓗᐊᓂᑐᐊᖅ ᑭᓴᓴᖏᖅᓂᓂ ᓂᓴᖏᓂᑦ ᐊᒪᓚ ᓄᓇᖏᓄᑦ ᖏᐅᐃᓵᑕᐅᐸᓂᓂ ᐊᒪᓚ RSA-Γᓴᓂᑦ ᑲᑎᓂᕆᑦ ᑭᓴᓴᖏᑦ ᓄᓇᖏᓂᓗ ᓂᐱᖏᖏᓂᓗ ᖏᐅᐃᓵᑕᐅᐸᓂᓂᑦ RSA-Γ. ᑕᒪᐃᑕ ᐃᑲᐱᖏᓪᓗᓂᖏᖅᑐᑦᓗᐊᖅᑐᑦ ᓴᓇᐃᖏᓂᑦ ᐊᓐᓇᐅᓂᖏᖅᑐᑦᓗᐊᖅᑐᑦ ᐅᓴᖏᓪᓗᐊᖅᑐᑦ ᐃᓕᓴᐅᑎᕐᐅᑦ ᐊᒪᓚ ᓄᓇᖏᓄᑦ ᖏᐅᐃᓵᑕᐅᐸᓂᓂᑦ ᐱᖁᑎᖅᐊᖅᑐᑦᓗᐊᖅᑐᑦ ᐅᓴᖏᓪᓗᐊᖅᑐᑦ ᐃᓕᓴᐅᑎᕐᐅᑦ ᐊᒪᓚ ᓄᓇᖏᓄᑦ ᖏᐅᐃᓵᑕᐅᐸᓂᓂᑦ ᐱᖁᑎᖅᐊᖅᑐᑦ

ᐃᒪᐃᓐᓇᑭᐅᑐᐃᓇᓐᓇᕆᔨᓕᕐᓂ ᑕᒪᓂ ᓴᓇᙵᐅᓂᔪᓄᑦ ᐅᓂᒃᑲᖅᓯᒪᔪᒡᒐ VSEC-ᓂ ᐃᑦᑕᓐᓂᑕᕆᔨᖅᑐᑦ ᓇᓂᖏᐅᓯᒪᔪᓕᕐᓂ ᐸᕐᓇᓴᕐᑕᐅᕆᔨᖅᑐᖅᓂᓐᓂᕐᓂ. ᑕᒪᑐᒪᓂ ᓴᓇᙵᒃᓴᒥ ᐃᒃᓗᓂᐅᕐᖅᑭᑦᓂᕆᔨᑦᓗᑎᒃ, ᓴᓇᙵᒃᓴᓂ ᐊᖏᕈᒃᓯᐃᑦᓗᑎᒃ ᐱᓕᓐᑦᓗᑎᓗ ᐃᒃᐱᓐᓇᖅᑎᑦᑕᑐᐃᓇᓐᓇᕆᔨᓕᕐᓗᒃᓂᒃ ᐃᑦᑕᓐᓂᑕᕆᔨᖅᑐᙵᐅᓂ ᒪᑯᐊ ᒪᓂᖅᑲᒃᓴᐃᑦᓗᑎᓕᕐᓂᒃ ᐃᒃᓗᓂᐅᕐᖅᑭᑦᓂᕆᔨᖅᑐᙵᐅᓂᒃ ᐊᖅᑐᓕᕐᓂᒃ, ᓴᓇᓪᓚᖅᓴᐃᑦᓗᑎᒃ, ᑐᐊᕐᓚᖅᑕᖅᑭᓐᓇᓗ ᐊᖏᓪᓗ ᐱᔪᐃᖅᑎᑦᓂᐊᖏᓚᑦ ᓄᓇᓂᒃ ᒪᓂᖅᑲᒃᓴᐃᑦᓗᑎᓕᕐᓗᒃᓂᒃ ᐃᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᒃ ᐊᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᓐᓂ ᐃᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᓐᓂ ᐊᖏᓪᓗ ᐊᖅᑐᓂᔨᓯᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᑐᐃᓇᓐᓇᕆᔨᓕᕐᓗᒃᓂᓐᓂ ᐅᓴᖅᓂᒡᓗᓂᑦ ᐊᖏᓪᓗ ᐊᖅᑐᓂᔨᓯᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᑐᐃᓇᓐᓇᕆᔨᓕᕐᓗᒃᓂᑐᐃᓇᓐᓇᕆᔨᓕᕐᓗᒃᓂᓐᓂ ᐅᓴᖅᓂᒡᓗᓂᑦ. ᐳᔪᐊᕋᔪᓂᑦ ᑕᒪᓐᓇ ᐊᐅᑐᐊᕆᐅᓂᐊᖏᓚᑦ ᐃᓗᐊᓂ 50-ᒥᑐᑐᒥ ᓴᓇᓕᐊᔪᓂ PDA-ᓂ ᐊᖏᓪᓗ ᐊᖅᑯᐃᓐᓇᐅᓴᓕᐅᕆᔨᖅᑐᙵᐅᓂ. ᑕᒪᕆᔨᐊ ᐊᖅᑯᐃᓴᖅᑕᖅᑎᑦᓂ ᐊᐅᑐᖅᑕᐅᕆᔨᖅᑐᙵᐅᓂᑦ ᐃᑦᑕᓐᓂᑕᕆᔨᖅᑐᖅᓂᓐᓂᕐᓂ ᓇᓂᖏᓂᓂ ᐊᔪᓴᓂᐊᖏᓚᑦ ᓴᓇᙵᓐᓂ ᐊᖅᑯᐃᓐᓇᖅᑐᙵᐅᓂ ᓴᓇᓕᐊᔪᓂᑦᑕᖅᑐᙵᐅᓂ ᐃᑦᑕᓐᓂᑕᕆᔨᖅᑐᖅᓂᓐᓂᕐᓂ ᓇᓂᖏᓂᓂ ᐊᖏᓪᓗ ᐊᖅᑯᐃᓐᓇᐅᓴᓕᐅᕆᔨᖅᑐᙵᐅᓂ ᐃᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᒃᑲᖅᓯᒪᔪᓕᕐᓗᒃᓂᓐᓂᕐᓂ ᓇᓂᖏᓂᓂ ᐊᖏᓪᓗ ᐊᖅᑯᐃᓐᓇᐅᓴᓕᐅᕆᔨᖅᑐᙵᐅᓂ ᐃᑦᑕᓐᓂᑕᕆᔨᖅᑐᖅ

ᐱᓕᒪᐅᕆᕐᓴᐅᑎᓄᑦᓗ; ᐊᒻᒪᓗ 5) ᐃᓐᓂᐊᖏᑐᓕᕐᓂᐊᑎᓄᑦ ᐊᒻᒪᓗ ᓄᓇᓕᖓᓂ ᖃᓄᐃᖅᑭᐅᐃᓕᓴᐅᓚᐅᑎᓄᑦ. ᑲᑎᑦᓗᓕᑦ ᖃᓄᑦᓂᓂᐅᓕ ᐃᓕᐊᖅᓴᖅᑭᖏᖅᑐᓂᐅᓕ ᑭᓴᓚᐃᓐᓇ ᓇᓗᓇᐃᔭᐃᓇᓕᐅᕆᕐᓂ, 7-ᐱᐅᔨᑦᓗᑎᒃ ᐱᔭᐅᔨᓐᓇᖅᑐᑦ, ᒪᖏᖅᑲ ᐊᐅᑦᑎᓐᓂᖅᑭᑦᑐᖅᑐᓂ, ᐊᒻᒪᓗ ᐊᑕᐅᓯᖅᑭᒃ ᑕᒪᐃᓐᓂᐅ ᐱᐅᔨᐅᓂ ᐱᐅᖏᑕᑐᓯᓐᓂᖅᑐᓂ ᖃᓄᐃᖅᑭᖏᖅᑐᓂᐅᓕ. ᐱᐅᓂᖅᓴᒍᑦ ᐊᖏᓂᓯᑕᐅᔨᓐᓇᓂᐊᖅᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᑕᐅᖏᑦᑐᔪᑦ ᑭᓯᐊᓂᓕ ᖃᓄᐃᑎᒃ ᑕᒪᐃᓐᓂᖅᑐᑦ ᐊᐅᓚᑦᑎᓂᐊᖏᓂᖅᑐᑦ. ᐅᓂᖅᑐᖃᓄᐃᓂᐊᖏᓂᖅᑐᑦ ᐃᓐᓇᐃᖅᑐᓂᐊᖏᓂᖅᑐᑦ ᐃᓕᓴᐅᔪᓐᓇᖅᑐᑦ ᐅᖃᓕᓂᐊᖅᑐᓂᐅᓚᐅᑎᓄᑦ ᐅᓐᖓᑕᐅᔪᓐᓇᖅᑐᑦ ᐊᐅᓚᑦᑎᓂᐊᖏᓂᖅᑐᑦ ᐊᑭᐊᓄᑦ ᐊᑐᐊᓄᑦ ᐊᑐᓂᖃᓄᐃᓂᐊᖏᓂᖅᑐᑦ ᐊᑭᓚᐅᔪᓐᓇᖅᑐᑦ. ᐱᐅᖏᑦᑐᓂᐅᓕ ᐊᓯᖏᓐᓂᐊᖏᓂᖅᑐᑦ ᐊᑭᓚᐅᔪᓐᓇᖅᑐᑦ ᐊᒻᒪᓗ ᓄᓇᓕᖓᓂ ᐊᑭᓚᐅᔪᓐᓇᖅᑐᑦ ᐊᑭᓚᐅᔪᓐᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓐᓇᐃᖅᑐᓂᐊᖏᓂ

ᐱᑭᖅᑕᑦᑐᐊᑕᖅᑕᑕ ᑭᓇᐅᔨᖅᓴᐅᑕᐅᔪᓇᓇᖅᑐᑦ, ᐅᓄᖅᓯᓀᑦᑕᔪᓂᒃ ᐊᓯᖏᑦᓗ ᐱᑎᐊᖅᑎᑕᐅᓗᓂᒃ ᐊᑲᐅᓯᓀᑦᓂᔪᓂᐊᖅᑐᖅ ᑕᐃᓂᕆᑎᐅᓄ VSEC-ᓄᑦ ᑭᓇᐅᔨᖅᓴᐅᑎᖏᓐᓄᓄᑦ ᐱᓀᑦᑕᐅᑕᐅᓗᓂᒃ. ᓄᓇᕐᓄᑦ ᑎᑭᓐᓂᐊᕐᕆᓕᑕ ᒥᑭᔪᑕᐅᓂᖅᓴᓄᑦ ᐱᓇᓯᐊᖅᓵᓄᑦ ᐊᑲᐅᓂᖅᓴᐅᑕᕆᓂᐅᖅᑐᖅ ᓇᓗᓇᖏᑦᑐᖅ ᑭᓯᐅᓂᒃ ᕿᓂᐊᑎ ᐊᑐᖅᓯᓂᖅᑐᖅ ᐅᑎᕐᓂᖅᓴᐅᑕᐅᓗᓂᒃ ᐅᖃᓕᓂᖅᑐᖅ ᐊᓯᖏᑦᓗ ᐊᑲᐅᓂᖅᓴᐅᑕᐅᓗᓂᒃ ᓇᐅᑦᓂᖅᓴᓂᐊᖅᑐᖅ ᐊᑲᐅᓂᖅᓴᐅᑕᐅᓗᓂᒃ ᓇᐅᑦᓂᖅᓴᓂᐊᖅᑐᖅ ᐊᑲᐅᓂᖅᓴᐅᑕᐅᓗᓂᒃ ᐊᑲᐅᓂᖅᓴᐅᑕᐅᓗᓂᒃ ᓇᐅᑦᓂᖅᓴᓂᐊᖅᑐᖅ ᐊᑲᐅᓂᖅᓴᐅᑕᐅᓗᓂᒃ

ᐱᓇᓴᐊᔪᖅᑐᑐᓄᑦ ᐱᐅᓂᖅᓴᒍᑦ ᐱᓯᒪᓕᐅᑕᐅᓂᐊᕆᓴᐅᑎᔾᔪᑦ ᑕᐅᓄᖓ ᓄᓇᒥᖅᓂ ᓇᖕᒥᓂᖅᑐᑐᓄᑦ VSEC-ᓂ ᑕᐃᒪᓐᓇ ᒥᑭᓂᖅᓴᓄᑦ ᐊᑐᕐᓂᖅᓴᓂᐊᖏᓪᓕ ᐃᓕᐊᕐᓂᔪᖅᒍᑦ ᐱᓯᒪᓕᐅᑕᐅᓕᖅᑐᑦ ᐅᖃᓕᒫᖅᑐᑦ ᑲᑎᒪᔨᖅᑕᐅᔾᔨᒪᓕᒃᑐᑦ ᑕᐅᓄᖓ ᓄᓇᒥᒥᐅᓄᑦ ᑎᑭᓪᓕᐊᔪ ᐊᒻᒪᓗ ᐊᓯᖏᓐᓂ ᓄᓇᖕᓂᖅᑐᑐᓄᑦ ᐅᖃᓕᒫᖅᑐᑦ.

ᐃᓅᖅᑲᐃᔾᔦᖅᑕᕐᓂᐅᔪᓂᑦ

ᐱᔪᓐᓇᓂᐊᕐᒥᓪᓕᒃᑕ ᓴᓇᔨᓂᒃ ᐊᑐᕐᓗᑎᒃ ᑕᓪᓕᖏᓪᑕ ᑭᑎᕐᒥᐅᑦ ᓄᓇᒥᖅᑎᓂᑦ ᐃᓗᓕᖅ 3,475-ᓂᒃ 2006-Γ ᐊᑐᓕᐅᖅᓪᓕᑕ. ᓴᓇᔨᖅᑭᓐᓇᖅᓪᓕᑕ ᑕᒃᑯᓂᖅᓱᐃᓐᓇᖅᓄᖅ ᓄᓇᒥᖅᓂ ᐱᑕᖅᖅᑕᑦ ᑎᑭᓪᓕᑐᒍ 2,185-ᓂᒃ, ᐃᓕᐅᕆᐊᔪᓐᓇᖅᓪᓕᑕ ᐃᓗᓕᖅ 62.9->ᓴᖅᑭᓐᓂᒃ. ᐃᓅᖅᓇᐃᔾᔦᖅᑕᕐᑐᓕᒥᓕᐅᖅᑐᑦ ᐅᔾᓂᓅᖅᓴᐅᓕᐅᖅᑐᑦ ᐅᔨᓂᖅᑐᐃᒥ ᑕᓗᔨᐊᒥᓗ (31.9->ᓴᖅᑭᓐᓂᑦ ᓄᓇᒥᖅᒥᐅᑦ 31.4->ᓴᖅᑭᓐᓂᒡᓗ ᑕᓗᔨᐊᓂ) ᐃᓚᓗᐊᓂᐱᓴᖅ ᑕᑯᓐᓗᑎᑦ ᓄᓇᖕᓂᖅᖃᖅᑕᑦ ᖃᓇᑕᒥ (14.8->ᓴᖅᑭᓐᓂᑦ). ᐃᓂᒪᓐᓗᑎᒡᓗ ᓄᓇᒥᖅᓂ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ ᓄᓇᖕᓂᖅᖃᖅᖃᖅᑕᑦ ᓄᓇᕐᒥ, ᖃᐅᑎᖅᒥᐅᓂ ᐊᒥᓂᔨᓂᖅᓴᐅᓕᖅᑐᑦ ᑕᑯᓂᐊᓂ ᐱᖓᓱᓂ ᓄᓇᓕᓂ ᐊᐃᔭᑐᖅᑕᐃᓐᓇᖅᑐᑦ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ (23.5->ᓴᖅᑭᓐᓂᑦ), ᐳᓂᐊᓂᓕ ᓄᓇᕐᒥᒥᐅᓂᒡᓂ ᓄᓇᒥᖅᒥᐅᑦ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ ᐃᓄᐃᐊᕐᓂᖅᓂᕐᓂᐅᓂ (201->ᓴᖅᑭᓐᓂᑦ). ᑕᒪᐃᓐᓂ ᖃᐅᑎᖅᒥᐅᑦ ᓄᓇᒥᖅᓂᐅᓂ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᐅᓕᖅᓴᖅᑐᑦ ᐃᓕᓴᖅᑐᑕᓗᓂᔅᓴᓂ, ᓇᖕᒥᓂᖅ ᐱᓇᓴᐊᔪᖅᑐᖅᑐᓂ, ᓂᐅᕐᓂᖅ ᐊᒻᒪᓗ ᐊᓯᖏᓐᓂᒃ ᐱᓕᓯᕋᕈᑐᓂ. ᑕᒃᑯᓇ ᑕᑯᓂᒃᑐᑦ ᓴᓇᔨᖅᑎᖓᔪᓐᓇᖅᑐᑦ ᑕᐃᒪᐃᑦᓴᖅᓗᒃ ᐅᓇᓱᐊᓂᒃ, ᓄᓇᕐᒥᒥᐅᓂᒡᓂ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ ᐅᓇᓱᐊᓂᒃ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ (ᐃᓚᖅᑲᓐᓂᑦ 10, ᐃᓕᓴᐅ 28-Γ. ᐸᖅᓇᐃᔪᑕᐅᓯᒪᔪᓂ ᓯᕐᓂᓴᖅᑎᓐᓄᑦ ᐱᓯᒪᓕᐅᑕᐅᓕᖅᓴᖅᑐᑦ ᐃᓅᖅᓇᐃᔾᔦᓄᑦ ᒪᑯᐊ: ᓴᓇᔨᖅᑭᖅᑕᑦ ᐸᖅᓇᖅᑕᐅᓕᐅᖅᑐᑦ; ᐱᑯᑎᑎᕆᐊᔪᓐᓇᖅᓪᓕᑕ ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ ᐅᓇᓱᐊᓂᒃ ᓄᓇᒥᖅᒥᐅᑦ ᐸᖅᓇᐃᔪᑕᐅᓕᐅᖅᑐᑦ, ᐃᓅᖅᓇᐃᔾᔦᖅᑭᖅᑕᑦ ᐊᑐᕐᓂᖅᓴᓂᐊᖏᓪᓕᑕ

ᐅᓄᖑᑉᓂᵃᵇᓴᐅᓕᕐᓗᑎᵇ, ᐱᵇᔪᒥᐊᓚᓗᑎᵇ ᐱᖃᑦᓕᐅᑕᐅᔨᑉᓇᓴᖅᑐᓂᒃ ᓴᓇᔭᓄᑦ, ᖃᑭᓚᖏᒪᑕ ᐃᓗᐊᖏᓂᵃᵇᓴᒧᒍᑦ ᐃᓄᖑᑉᓄᓄᑦ ᐱᖃᑦᓕᐅᑕᐅᓂᑉᓇᓂᓂᒃᓱᓂᒃ VSEC-ᓂ ᐃᵃᵇᑲᓇᐃᔨᵃᵇᑲᓕᕐᓗᓄᑦ.

ᑐᑭᒧᐊᵃᵇᑐᒥᓂ ᓴᓇᘐᐅᔨᒥ ᐃᵃᵇᑲᓇᐃᔨᵃᵇᑕᐸᑉᓇᓚᖅᑕᓂ ᑕᒪᓂᖏᑎᐅᑦ ᐃᓚᖑᑉᓄᓄᑦ ᐊᓐᓂᐸᓚᐅᑎᔨᓄᑦ ᐱᓇᖑᐊᵃᵇᑐᓄᑦ ᐃᵃᵇᑲᓇᐃᔨᓂᒃ ᐊᑭᑦᵃᵇᑐᑕᐅᐃᓐᓇᖑᐊᵃᵇᓴᓂ ᐊᑐᓂᖏᑎᐅᓂ ᖃᑎᖑᑎᐅᓂ ᐃᵃᵇᑲᓇᐃᔨᓂᒃ ᖃᑕᐃᓐᓴᑐᓂᒃ ᑕᐱᔪᓐᓴᒪᓐᓴᵃᵇ ᐃᵃᵇᑲᓇᐃᔨᵃᵇᑎᓄᑦ ᖃᑎᖑᑎᐅᓂ ᐅᔨᑦᓐᓂᐊᖑᑉᓇᓂᑦᓴᒪᓐᓴᑦᑕᒪᓕᒃ ᐃᵃᵇᑲᓇᐃᔨᓂᒃ ᐱᓕᐹᓐᓂᵃᵇᑲᓇᐃᔨᓕᐅᑕᐅᑐᓂ ᐃᵃᵇᑲᓇᐃᔨᑐᑦᑎᒥᓂᒃ ᖃᑎᖑᑎᐅᓂ ᓴᓇᘐᐅᔨᒥ ᐃᵃᵇᑲᓇᐃᔨᵃᵇᓴᓂᒃᓴᓂᒃ ᑕᓕᐹᓐᓂᵃᵇᑲᓇᐃᔨᓂᒃ ᐃᵃᵇᑲᓇᐃᔨᑦᑎᒥᓂᒃ ᐱᑕᓐᓴᒪᓐᓴᵃᵇ ᐱᑕᑦᑎᐅᓂᵃᵇᑲᓇᐃᔨᓂᒃ ᐃᵃᵇᑲᓇᐃᔨᑦᑎᒥᓂᒃ

ᑕᒪᐃᑎᒍᓪᓕ, ᑐᖓᓕᖓᓂᓄ ᐃᓕᓴᐅᑭᓱᒃ ᐅᓄᑐᐊᖏᑕᖅᑭᒪᒪᓕᒃ ᑕᒪᐃᖅᓄ ᓄᓇᓕᖅᓄ. ᐅᖃᓱᖏᑐᒥᐅᓄᓄ ᐅᓄᖅᑭᖅᓯᒪᔪᓕᐅᖏᑐᑦ ᐃᓕᓴᖏᓐᓄᓄ ᐃᓕᓴᖏᓱᒪᓂᑯᐃᑦ ᖃᑎᖅᑎᐅᓄᓄ, ᑕᒪᐃᑎᒍᑦ 59-ᓴᖅᑭᑦ ᓄᓇᓕᖅᑎᐅᑦ ᐊᖏᖅᔪᖏᖅᑐᑦ 25-ᓂᑦ 64-ᓄᑦ ᑐᖓᓕᖓᓄᓄ ᐃᓕᓴᐸᑎᓄᒃ ᐱᐊᓂᔪᓱᖅᑭᒪᒪᓕᒃ ᓇᑐᓇᐃᒃᑯᓂᖏᖅᑕᖅᓱᒪᖅᑭᑦᑐᑦ. ᐃᓚᑐᐊᓄᐃᓕᓐᓂᕐᓗ, ᐃᖏᓵᓴᑐᑎᑎᒥᐅᑦ ᖁᑯᑎᖅᓂᖅᑭᓯᒪᔪᓕᐅᖏᑐᑦ ᑐᖓᓕᖓᓄᓄ ᐃᓕᓴᖏᓱᒪᓂᑯᖏᖅᑐᑦ ᑕᒪᐃᖅᓄᓕᓂᒪᖅ ᓄᓇᓕᖅᓄ ᓄᓇᕐᒥ, ᐃᓚᒪᖅᑲ 36-ᓴᖅᑭᑦ ᐊᖏᖅᔪᖏᖅᑐᑦ 25-ᓂᑦ 54-ᓄᑦ ᓇᑐᓇᐃᒃᑯᓂᖏᖅᑕᖅᑲᑎᑦ ᑐᖓᓕᖓᓄᓄ ᐃᓕᓴᐸᑎᓄᒃ ᐱᐊᓂᖅᓯᓂᑐᐊᑎᒃ. ᖃᑎᖅᑎᐅᓕᒻᒥᓄ ᓄᓇᓕᖅᓄ, ᐃᖏᓵᓴᑐᑎᑎᒥᐅᑦ ᐅᓄᖅᑭᖅᓯᒪᔪᓕᐅᖏᓕᖅᑎᑦ ᓯᓕᑐᐃᓴᖅᓱᐊᐊᒥᑦ ᓇᓕᐅᐃᒃᑯᓂᖏᖅᑕᖅᑭᖅᑐᑦ (16-ᓴᖅᓂᑦ) ᐃᓕᓴᖅᓱᐊᐊᒥᓄᓄ ᓯᓕᑐᐃᓴᖅᓱᐊᐊᒥᓂᓗ ᓇᓕᐅᐃᒃᑯᓂᖏᖅᑕᖅᑭᖅᓯᒪᔪᑦ 1/4-ᖃᐅᑎᓂᓗᑎᑦ ᑯᒍᖁᓂᐅᑦ (22-ᓴᖅᓂᑦ) ᖁᒃᖃᑎᖅᓯᓂᓗᑎᒃ 1/10 (12-ᓴᖅ) ᐃᖏᓵᓴᑐᑎᑎᒥᐅᓄᒃ. ᐃᓕᓴᖅᓱᐊᐊᓂᖅᓄᓄ ᓯᓕᑐᐃᓴᖅᓱᐊᐊᓂᖅᓄᓂᓗ ᐅᑭᐅᖏᓕᖅᑕᖅᑐᒥ ᓯᓕᑐᐃᓴᖅᓱᐊᐊᓂᖅᓄᓄ ᐃᓕᓴᖅᓱᐊᐊᒥ (NAC). ᓯᓕᑐᐃᓴᖅᓱᐊᐊᖏᖅ ᑭᓇ ᒪᑐᐃᓂᒪᔪᖏᖅ ᑕᒪᐃᓄᖅ ᖃᑎᖅᑎᐅᓄᖅ ᐃᖏᓵᓴᑐᑎᑎᒥᐅᑦ ᐃᓕᓴᖅᓱᐊᖏᓕᒪᑦ, ᑕᒪᐃᓄᓕᓯᒪᔪᖏᖅ ᖃᑎᖅᑎᐅᓄᖅ ᓯᓕᑐᐃᓴᖅᓱᐊᐊᒥᓄᓄ ᑕᒪᓐᓇ (NAᔾ 2008). ᐃᓕᓴᕐᓚᓴᖅᓯᐃᑦ NAC-ᒥ ᒪᑯᐊ ᓴᓇᔪᓕᓇᔪᑎᑦ, ᓇᓕᐃᓚᖅᑯᓂᖏᖅᑕᕐᕕᐅᔪᓇᖅᑐᑦ ᑎᑦᔨᒪᑕᕐᕕᐅᔪᓇᖅᑐᑦᓗ, ᐃᖏᖅᓇᐃᒐᖅᓄᓄ ᐃᓕᓴᖅᓱᐊᓕᒪᑦ ᑕᐅᓂᒃ, ᐃᓕᓴᕐᑎᓯᓕᒡᓗᓗ, ᐊᓚᒪᓗ ᐱᐊᓂᖅᓯᓂᓱᒪᓕᕐᕕᐊᓂᖅᓄᓄ, NAC-ᑯᓂᓄ ᐊᔪᕐᓂᖅᓴᐃᔪᓇᖅᑎᑦᑐᑦ ᐊᓚᒪᓗ ᐃᖅᔪᖅᓴᕐᑎᖅᑐᖅᓯᒪᓕᖅᑐᒃ, NAC-ᑯᓂᓄ ᐊᔪᕐᓂᖅᓴᐃᔪᓇᖅᑎᑦᑐᑦ ᐃᓕᓴᖅᓱᐊᓂᓄ ᐃᖏᓵᓴᑐᑎᑎᒥᐅᑦ ᐃᓕᓴᖅᓱᐊᖏᖅ

ΔL∆ᑊLCᓕ (404.9 100,000-Cİᓂ). ᐊძᓕ∆ᑦϽՈᐅᓕᖏLC >ᕐᖏᒥᓂ ᑲᵒᓗᑦᖁᑦᓭᕃᑐᑦ (206.8 100,000-CLᓂ) ᕃძᕃՈᖅϽᑊᒪᓗᐅᖏLC ᓄσϿᒥᐅᓂ, ᓗCL∆ᕃᓗᑊᒪᖏLᑦ ᐊᓗᖏᵒᓂ ᑲσᒪᒥᐅᓂ ∧ᐟᑦ (56.9 100,000-Cİᓂ). C∆L∆ᵒᓂᖏᓓᓄᑦ ᓄσϿᒥᐅᑦ Δᐅᓗᖏᑦ σ∆ᵒᓂᕃᖅᐅᓂϛᕃᑐᐅᐟᑦ ᑲσᒪᒥᐅᓕİᓂᑦ (DHSS 2004; NTI 2008). ᐊძᓕ∆ᵒᓂᕃᖅᐅᐟᓂᓕ, ᓄσϿᒥᐅᑦ ΔᐅᐟᵒσᖏᒪLC 71.6-ᓂᵇ ᐅPᐅᓂᵇ Δᐅᙆᖏᓓᓂᑦ ᐊᑊᒪᓗ 15.2 ᐅPᐅᕃbᓕᔪᑎᵇ 65-ᓄᑦ (2007/2009 ∧CᕃbϽϛᐟᵒᓂᕃᖅΔᑦ). Cძᓕᔪᑎᑦ Δ∆ᑎᐊᔪᐊᖏᑎᵇbᔪᐊᕃᕐᓂᑎᵇ, ᐊᵇᓂᐊᔪᵇ ΔᔪᐊᕃᖅΔᐟՈϽᖏᒪLC ∧ᐱᐅᑊᐅᑎᑦᓂᐊᖏᵒᖏᓄᑦᑐᐅᓂ ᕈᑎϽᒥᐅᓂ ᓄσϿᒥ, Ոᑭᙆᐅᖏᓂᑎᵇ ΔᔪᐊᕃᖅΔᐟᓄᑦ ᐊᑐᓂ ᓄσᓂᑦ Cძᓀᕃᑐᕃᑕᐅᖏᓂᑎᵇ. Δᓂᵇ ΔᕃbᔪᐅϽՈᐊᒥ ᑕᵒᓇᐅϽᑦᔪᓂ Cİᓂ ΔᔪᐊᕃᖅΔᐟᓄᕃbᑐᕃᑐᕈ ᕈᑎϽᒥᐅᓂ ᓄσᓇᖏᓄᕃᑕᕃLC >ᓪCϽᕃᓂᑎᑦ. ∧ϽᐟՈᑎᑦᔪᑎᑦᓂ ᕃbᓄΔᖏᑎᓀΔᵇძՈᑦ ᓄσᓇᖏᓂ ᕈᑎϽᒥᐅᓂ ᓄσᓇᖏᵒᓂ ᕃძᑎᖏᓂᑦᖁᖏLC Δᓀᒥᐅᓂᕃᑐᑦᑐᑎᑦ CᒪᔪLᓂ Δᓂᒋᒪᑎᵒᓂ.

CᒪΔՈᔪᑦᓂ ᓄσᓇᖏᒥᐅᓂ ᕃbᓄΔᖏᑎᓀΔᵇძՈᑦ, σᔪᓄσΔᓀᕃᑐᕃᑐᒋᓀᐟᑦ ᐅძᓄᖏᒐ AANDC’s ᓄσᓇᖏᓂ ᕃbᓄΔᖏᑎᓀΔᵇძՈ∆ᓂ ᐅᵇϽϛᐅᑎᑐ ᐅᓀᓇᕃᓂᐸᑐ, ∧CᕃbᔪᐊᑕᓇᖏᑎᑐϽᕃᑐ ᕈᑎϽᒥᐅᓂ ᓄσᓇᖏᵒᓂ. ΔᕃbᔪᵇϽϽՈᐊᒥ ᕃძᓀᔪᕃᑐϽᒥᔪ ᕃძᑎᖏᓂᑦᖁᕃᑐᕃᕐᓂᕃᖅᑐϽᑦ ᕈᑎϽᒥᐅᓂ ᐅᵒᖏᔅᓄᑦᓂᵒᓂᑦ ᓄσϿᒥᐅᑦ. C∆ᓀᐊᐊᒥ, ძİᑌᐊᖏᒥ, ᐊᑊᒪᓗ ᐅᓀᓇᕃᖅϽᒥ ᐊᑎᑦᖏᵒᖁᖅᓀᔪᑎᵇ (53, 55, ᐊᑊᒪᓗ 56, σᑭᑕᓀᔪᑎᑦ), Δᓂİᓗᑎᑦᓀᐅᓂᖁᖅᓀᔪᑎᵇ Δᑊᔪᑎᔪᐊᑎᑦ Δ∆ᑎᐊᔪᐊᕃᓀᵒᖏᵒ∆ᓂ ᐊbᐅᖏᑎᑕᑕᐅᐟᵒᓇLC. ∧ᓀᓀᕃbᑕᕃᑐᑦ ᕈᑎϽᒥᐅᓂ ᓀძᑎᖏᓂᑦᖁᓇᐅᓀᒥᐟᑦ ΔᕃbᔪᵇϽϽՈᐊᒥ, ᓀძᓀᔪᕃᑐϽᒥ, ᐊᑊᒪᓗ ᐅᓀᓇᕃᖅϽᒥ. ძİᑌᐟᖅᒥ ᐊᑎᑦᖏᵒᖁᖅᓀᔪᑎᵇ ∧ᓀᓀᕃbᑕᕃᑐᑦ Δᑊᔪᐊᓄᖏᑦᓗ Cძᓀᔪᑎᑦ ᐊᓇᖏᑎᑦ ᕈᑎϽᒥᐅᓂ ᓄσᓇᓂ. Δᓇᖏᑎᓇᑦ ᐊᵇᓇᖏᑎᑦ Δᑊᔪᑎᔪᐊᑎᑦ ᕈᑎϽᒥᐅᓂ ᓀᓀᕃbᑕᕃᑐᑦ Δᑊᔪᐊᓄᖏᑦᓗ ΔᕃbᔪᵇϽϽՈᐊᒥ, ᓀძᓀᔪᕃᑐϽᒥ, ᐊᑊᒪᓗ ᐅᓀᓇᕃᖅϽᒥ. ძİᑌᐟᖅᒥ ᐊᑎᑦᖏᵒᖁᖅᓀᔪᑎᵇ ∧ᓀᓀᕃbᑕᕃᑐᑦ Δᑊᔪᐊᓄᖏᑦᓗ (57, 56, ᐊᑊᒪᓗ 50%, σᑭᑕᓀᔪᑎᑦ). ᑌᖒLՈᵇძᑦ Δᑊᔪᑎძᑎᖏᵒᓂᵒᵇ ∧Cᕃbᑎᓂᕃᖅᑊᐅᐟᑦ ᐊϽᕃᑐᐊᑊᔅᓂ, ᐊᑊᒪᓗ ᑌᖒLՈᵇძᑦ Δᑊᔪᑎძᑎᖏᵒᓂᵒᵇ ᑭᓪᓚᐊᑦ ∧ᐟᵒᓇᕃᑐᓪᑎᵇ ∧ᓖLC ᑭᓇᐅᑊᑭᕃᖅᓀᔪᐊᒪᒍᑦ, ᓪᓕᓖᔅᓄᓪᔪ, ᐊᑊᒪᓗ ∆ᓄ∆ᑕᓪᒥᐅᑕᐅᒍᑦ ∧ᑊᓇϽᔪᐊᑦᖏᑦ ᕆᓖᓂᐅᓀᵒᓂᵒᵇ ᑭᓪᓚᐊᑦᖏᑦ ᐊᓖᑕᓪᒥᐅᑕᐅᒍᑦ ∧ᑊᓇϽᔪ

ᐃᓗᐊᖏᓂᖅᓴᒍ ᐱᖅᑯᓯᖅᑕᕐᓇᖅᓯᒪᓂᖅ ᐃᖅᖢᓇᐃᔨᖅᑎᐅᑕᕐᑐᑎᖅ ᐅᔾᔨᕆᓂᐊᖏᕐᕕᑦᑎᓂᒃᓂ ᑕᐃᒪᓐᓇ ᐃᓗᐊᖅᓯᒡᓕᕐᓂᕐᓇᖅᑐᑦ ᐃᓄᓕᓯᓂ ᓄᓇᕗᒻᒥᓂ ᖃᓄᐃᖅᑕᐅᔪᓐᓇᖅᑐᖅ. ᐊᓯᔪᖅᑕᐅᔨᑦᑕ ᐊᑐᓂ ᐃᖅᖢᓇᐃᔨᖅᑲᓱᑦ ᐃᓄᓕᓯᓂ ᖃᐅᔨᒪᓂᕐᒥᓂᕐᓇᖅᑐᑦᑕᐅᓂᖅᓴᖅᓯᐅᑦᓯᓗᓂᖅᑎᒃ, ᐱᐅᔪᒍᑦ ᐱᐅᓂᕐᑐᒍᒧᑦᓴᓐᓂᒃ ᐃᔪᓐᓇᖅᓯᒪᓂ, ᐅᐱᑐᕆᐅᑕᐅᔪᕐᓂᕐᒪᔪᑦ ᐱᐅᔪᒍᑦ ᐱᐅᓂᕐᑐᒍᒧᑦᓴᓐᓂ ᐊᑯᓂᓐᓂᖅᓴᖅᓯᓐᓂᒃ ᐃᓄᓕᓯᓂᑕᓐᓇᖅᑐᖅ, ᓴᕿᔪᒃ ᐊᑯᓂᓗᒃᑐᑦ ᓴᓇᔨᓐᓂᖅᓴᖅᓯᓐᓂᒃ ᐃᓄᓕᓯᓂᑕᓐᓇᖅᑐᖅ ᐃᓄ

ᐃᑲᐃᓇᕐᓂᖏᑦᓂᐊᖏᑐᑦ ᐊᑲᐅᖕᒋᓕᐅᕈᑕᐅᓕᒋᓕᕐᓂᓇᖅᓚᒃ, ᑭᓯᐊᓂᓕ ᐅᑎᕈᓇᓗᓴᒋᑎᒃ ᐱᖏᑯᓯᖏᑎᒍᓂ, ᐊᑲᓯᓴᐃᖕᒋᒻᒪᕐᓴᑦ, ᐊᑯᓂᓂᒃᓯᓂᓴ ᐊᑲᓯᓴᐊᓂᖏᑦᓂᑎᒃ ᐊᑯᓂᐅᖕᖏᑦᑐᒥᒃ, ᐱᖏᑯᑎᑦᕈᑕᐅᓵᖕᓂᒋᒻᒪᕐᓴᑦᓂᑎᒃ. ᐊᑯᓕᐃᓂᓂᖕᓂᓕ ᑲᑎᓴᓂᑦ ᐃᑲᐱᖓᕈᑕᐅᓵᕐᓴᑦ ᑲᑎᓴᓂᑦ ᑕᐃᒪᖏᓴᓂᑦ ᐱᓵᖕᓂᐊᓕᖕᖏᑦᑕᑦ ᓇᓕᐅᖕᒋᓕᕈᑕᐅᓵᓕᒋᓕᓴᓂᑎᒃ ᑕᒪᓂᑐᐊᖏᖅ LSA-Γ ᐱᓂᐊᖏᓂᖏᖏᑕᐅᖕᓴᓂᑎᒃ, ᐃᓕᖏᒋᓕᐃ ᐃᑲᐃᓇᕐᓂᓚᓂᖏᖏᑕᖖᒋᑦ ᐊᓯᖏᑦᓂᓄᓂᑦ ᐱᓕᓂᓇᓕᖏᖅᑐᑦ ᑕᒪᓂ RSA-Γ. ᑭᓯᐊᓂᓕ ᑲᑎᓴᓂᑦ ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᒋᖏᑦ ᑕᐃᒪᓕᐊᐃᓇᖅ ᐊᑲᓯᓴᐊᓂᖏᑦᓂᑦ. ᑕᒪᓇᓗ ᑐᑭᒋᑕᐅᐅᓕᖅ **ᐊᑲᓯᓴᓇᖏᓐᓄᒋᖏᖏᑎᓄᓂᑦ** ᓇᓕᐅᖕᒋᓕᕈᑕᐅᓯᒪᓕᖅ ᑕᐃᒪᐃᑐᐃᓇᐃᓇᐊᕆᑲᖅᓂᖏᓐᓄᓂᑦ ᐃᑲᓕᖅᑲᖅᑕᐅᖕᓴᓂᑐᓂ ᐊᑯᓂᐅᖕᒋᓕᓴᓂᑎᒃ ᓴᓕᓂᐅᖕᓴᓂᑎᒃ.

ᐊᓯᖏᓐᓂᑐᓂ ᓄᓇᓂ ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᑕᖏᑦᓂᑦ ᓇᓕᐅᖕᒋᓕᕈᑕᐅᓯᒪᖏᓕᕐᓴᑦ ᖃᑎᒋᔭᐅᓕᐅᖕᖏᑎᒍᓂᑦ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐱᓇᓚᓂ ᓴᓇᕐᓂᐊᓕᐅᓂᑦ ᐃᑲᐃᓇᕐᓂᓚᔭᐅᓕᖕᓴᖅᑐᑦ ᑕᒋᓂ VSEC-Γ ᐃᓗᐊᖏᓴᐊᔪᑎᓄᓂᑦ ᓄᓇᓕᖕᓂᓗᓗ ᖃᓄᐃᓂᑦᓴᐃᓂᑎᓄᓂᑦ. ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᑕᖏᑦᓂᑦ ᓴᓇᓂᓂᑦ ᐃᓗᐊᖏᓴᓴᐊᔪᑎᓄᓂᑦ ᐊᓯᓗᓗ ᓄᓇᓕᖕᓂᓂᑦ ᐃᓗᐊᖏᓴᓴᐊᔪᑎᓄᓂᑦ ᐊᑯᑐᐊᓂᖏᖏᑎᒍᓗᒍ ᑭᓯᓂᕐᑎᓂᑦ ᐃᑲᐃᓇᕐᓂᖏᖏᑎᒍᓗᒍ ᑕᒪᓕᐅᕈᑕᐅᓵᓕᒋᓕᒃᑐᑦ ᐊᑯᓂᐅᖕᒋᓕᓴᓂᑎᒃ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐃᑲᐃᓇᕐᓂᖏᖏᑎᒍᓗᒍ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐅᑭᐅᖕᒋᓕᕈᑕᐅᓵᓕᒋᓕᒃᑐᑦ ᑕᒪᓕᐅᕈᑕᐅᓵᓕᒋᓕᓴᓂᑎᒃ ᑕᒪᓕᐅᕈᑕᐅᓵᓕᒋᓕᓴᓂᑎᒃ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᑕᖏᑦᓂᑦ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐅᑭᐅᖕᒋᓕᕈᑕᐅᓵᓕᒋᓕᓴᓂᑎᒃ ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᑕᖏᑦᓂᑦ ᑕᒪᓕᐅᕈᑕᐅᓵᓕᒋᓕᓴᓂᑎᒃ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐃᑲᐃᓇᕐᓂᖏᖏᑎᒍᓗᒍ ᐃᓐᓇᖕᓂᓕᒃᑐᑦ ᐃᑲᐃᓇᕐᓂᓚᓂᐊᖏᖅᑕᖏᑦᓂᑦ

ᐊᐅᓪᓕᐅᕐᑲᕐᑕᕐᑐᖅ ᓴᕐᒥᑦ ᓯᑎᐱᓗᒍᑦ ᐊᖏᕐᒍᒍᒫᑦ, ᐃᖏᓪᓗᓂᐅᔪᖏᖅᓱᒃ ᑐᓴᖏᒥᐅᐅᔪᓐᓇᕐᑐᖅ ᑲᑎᑦᓗᓂ 30-ᓄᑦ ᐊᓘᒐᓗ ᐃᓚᖏᑲᕐᓯᓂ ᑕᐃᓯᒪᓂᑐᖏᕐᒥᐸᒃ ᕿᐊᑦᓴᓪᓂᐸᐃ ᓂᐅᔨᐅᓂᒃ ᐅᒥᐊᓘᓂᒃ ᐅᑎᕐᓂᒃ ᐱᖓᓱᓕᐅᑦ, ᓚᓯᓴᑎᑦᓂᖏᕐᓯᓂᒃ, ᑕᓀᑎᐅᓚᐊᕐᑐᖅᑐᒥᐅᖏᕐᑕᖏᕐᓯᓂᒃ ᐊᓘᒐᓗ ᑕᓪᓕᓐᓂᐅᑦ ᐱᖓᓱᓕᐅᑦ ᓄᓇᓕᒫᒥ ᐅᓇᓱᓕᓚᐅᕐᓂᐅᑦ ᓄᓇᓗᓂ, ᐊᓘᒐᓗ ᐊᓯᖏᓐᓂᐊᕐᓂᒃ ᐅᓄᖅᓯᓂᒃ ᐊᓯᖏᓐᓂᒃ ᐅᑎᖅᑕᐅᓂᒃ ᓄᓇᓗᓂ ᐊᑐᕐᓂᒃ ᑕᐃᓚᖅ ᐊᓯᖏᓐᓂᐊᕐᑐᖅᑕᐅᓂᒃ ᐅᓄᖅᓯᓂᒃ ᐊᓯᖏᓐᓂᒃ ᐅᑎᖅᑕᐅᓂᒃ ᐊᐅᓚᑦᓯᐊᕐᓂᒃ ᐊᑐᖅᑕᐅ

ᐃᑲᐅᓇᕐᓂᖅᑭᑕᐅᔪᓇᖅᑐᖅ, ᐊᑯᓂᐅᓂᐊᕐᓂᓕᓂᓗ, ᐊᒻᒪᓗ ᐱᖅᑯᓯᑐᖅᖢᓄᑦ ᐅᑎᑭᓇᖅᑐᓗ ᐱᓕᕆᐊᓂᖅᐸᑕ ᑕᑦᓗ. ᐊᑯᓕᐃᓂᓂᕆᓇᓴᖅᑕᖏᓐᓂ ᐃᑲᐅᓇᕐᓂᖅᑐᖅᑐᑦ ᐃᓭᓂᓂᐅᓯᖏᓐᓴᑯᑦ ᑭᓯᐊᓂ ᑕᐃᒪᐃᖅᑕᕐᓂᐊᖅᒪᒃᑯᑦ ᐃᑲᐅᓇᕐᓂᖅᑐᖅᑐᑦ ᐅᓇᐃᓇᑯᑕᖅᖢᓄᑦ ᐊᒥᐊᓂᖅ ᐃᑲᐅᓇᕐᓂᖅᑐᖅᑐᑦ ᐊᒥᐊᑯᓯᓴᐅᓕᕐᓂᑦ ᐃᑲᐅᓇᕐᓂᖅᑐᖅᑐᑦ ᐊᒥᐊᑯᓯᓴᐅᓕᕐᓂᑦ **ᐊᐅᓯᓗᐊᖏᓪᓕᑐᒃ.** ᐊᒥᐊᐅᑯᓯᓴᐅᓕᕐᓂᐊᖅᑐᖅ ᐃᑲᐅᓇᕐᓂᖅᑕᕐᓂᐊᖅᑐᖅᑐᑦ ᓴᓇᖅᑐᐅᓂᖏᓐᓄᑦ ᑕᐃᓕᑦ ᐱᖅᑯᓯᑐᖅᑐᓂᖅᑐᓂᑦ ᓄᓇᒃ ᐊᑐᕈᑎᖏᓐᓇᓄᑦ ᐊᓯᖏᓐᓇᓄᑦ ᐃᓄᐃᑦ ᐃᑲᐅᓇᕐᓂᖅᑕᕐᓂᐊᖅᑐᖅᑐᑦ ᐃᓗᐊᓂᖅᑐᓗ ᓄᓇᒃ ᐊᑐᕈᑎᖏᓐᓇᓄᑦ ᐊᓯᖏᓐᓇᓄᑦ ᐃᓄᐃᑦ ᓴᓇᖅᑐᐅᓂᖏᓐᓄᑦ ᐃᓗᐊᓂᖅᑐᓗ ᐃᓕᓴᐅᕐᓂᖅᑐᓗ (NSA)-ᒥ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓐᓇᖅᑐᖅᑐᓄᑦ, ᖃᓄᑕᐃᓐᓇᖅ ᓄᓇᐃᑦ ᑭᓚᖏᓐᓄᑦ ᐃᑲᐅᓇᕐᓂᖅᑕᕐᓂᐊᖅᑐᖅᑐᑦ ᓄᓇᒃᑲᓂᐊᕐᓂᖅᑐᖅᑐᑦ.

ᐃᓄᓴᖅᑎᖅᑕᑦ ᑭᓇᐅᔨᖅᓴᐅᑎᖅᑎᖅᑕᑦᓗ ᓄᓇᒥᑦ

ᐃᓄᐃᑦ ᐱᖅᑯᓯᑐᖅᑎᑎᑦ ᓄᓇᒥᓂᒃ ᐊᑕᖅᑲᑕᖅᓴᑎᑦ ᐃᓄᓴᖅᑎᖅᑎᒥᓗ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓐᓇᖅᓱᓕᑦ ᓄᓇᒥᓄᑦ ᐊᐅᑕᐊᓂᖅᓴᐅᓕᕐᓂᑦ. ᐃᓄᐃᑦ ᖃᑎᖅᑎᐅᓂ ᑕᐃᒪᓕᖅᑐᓂ ᐃᓄᓴᖅᑎᖅᑕᑕᖅᓴᒪᓕᒥ ᐃᓄᐃᑦ ᖃᐅᓵᒪᕐᑐᖅᑐᓂᖅᑐᓂᒃ ᐊᑕᖅᓴᑎᑐᒃ, ᐅᕐᖤᔪᓐᓄᑦ ᐱᖅᑯᓯᑐᖅᑐᓂᓐᓂᖅᑐᓂᒃ ᐊᖤᑎᑐᓂᒃ ᐊᑕᐳᓇᐅᑎᑐᓂᒃ ᐊᖤᑎᑎᓂᑐᓗ, ᐅᑭᐅᐊᓇᖅᑎᑐᓂᒃᑐᓗ, ᓄᓇᕆᓂᓗ ᐊᕐᕈᐅᖃᑦᑕᕐᓴᑎᑐᒃ, ᑕᐃᒪᐃᑕᐅᖃᑦᑕᕐᓕᒥ ᑕᒪᓂ ᓄᓇᒥᒃ ᐊᑕᐳᓇᐅᑎᑎᓂᖅᑐᓂᒃ ᐊᖤᑎᑎᓂᑐᓗ. ᐃᓄᐃᑦ ᖃᑎᖅᑎᐅᓂ ᐊᖏᔪᓇᐅᑎᑐᓂᒃ ᐃᓕᓴᕐᓂᖅᓴᒃ, ᐃᓅᖃᓇᓂᐊᖅᑐᓂᒃᓗ, ᑭᑭᑎᑎᓂᑐᓂᒃᓗ, ᓄᓇᕆᓂᓗ ᐊᕐᕈᐅᖃᑦᑕᕐᓴᑎᑐᒃ ᑕᐃᒪᐃᑕᐅᖃᑦᑕᕐᓕᒥ ᑕᒪᓂ ᓄᓇᒥᒃ ᐊᑕᐳᓇᐅᑎᑐᓂᒃᑐᓗ ᐊᖤᑎᑎᓂᑐᓗ ᐃᓕᓴᕐᓂᖅᓴᒃ ᑲᑎᒪᓂᖅ. ᐃᓚᒌᒃ ᖃᐅᔨᒃ ᐊᖤᑎᑎᓂᑐᓗ ᑕᐃᒪᐃᓐᓇᖅᓱᓕᑦ ᐊᓯᖏᓐᓇᓄᑦ ᐊᑐᕈᑎᖏᓐᓇᓄᑦ ᐃᓄᐃᑦ ᓴᓇᖅᑐᐅᓂᖏᓐᓄᑦ ᐊᖤᑎᑎᓂᑐᓗ ᐱᓕᕆᔨᖅᓴᐅᓕᕐᓂᑦ ᐃᓄᓴᖅᑎᖅᑕᑕᖅᓴᒪᓕᒥ ᐃᓄᐃᑦ ᓴᓇᖅᑐᐅᓂᖏᓐᓄᑦ ᐊᖤᑎᑎᓂᑐᓗ ᐃᓕᓴᕐᓂᖅᓴᒃ ᐃᓅᖃᓇᓂᐊᖅᑐᓂᒃ

(CAGs). ᑐᓴᕋᓱᐊᕐᑲᕐᓯᓗᓐᓗ ᐅᓴᖏᓐᓂᐊᕐᓵᓘᓂ ᐃᖅᑲᐅᐊᕐᓴᖅᑎᓂᑦ, ᓄᓇᖓᓂᒃ ᐊᑐᖏᑦᑲᖅᑐᓂᑦ, ᓄᓇᖓᓂᓗ ᐊᖓᔪᓂᒃᑯᑦ ᑲᑦᔨᖏᑎᒃᓴᖓᓂᑦ HTOs ᐊᒻᒪᓗ ᕿᐊᒪᓂᓂᑦ, ᐊᒻᒪᓗᑦᑕᐅᖅ CAG-ᓂᑦ ᑕᑯᓇᖓᑦ ᑕᐃᒪᖓᓂᑦ ᑐᓴᐅᒪᑎᑕᕐᖏᑦᑕᕐᒪᓗᓂᒃ ᐃᓕᐊᓇᓇᖅᑐᖓᓂᒃ ᐊᒻᒪᓗ ᐁᖕᑭᐊᕐᓴᖏᑦᑕᕐᓗᓂᒃ ᐊᐅᓪᓚᐅᕐᔪᑎᖓᓂᒃᓴᖓᓂᑦ ᐃᓗᓐᓄᑦ ᐊᐅᓪᓚᐅᕐᔪᑎᖓᓂᓪᓗ, ᐊᓯᔾᔨᓪᓚᐅᖅᑐᑦ ᓄᓇᕗᑦᑐᓂᑦ ᑲᑎᕋᖅᑐᑦ ᕿᓐᓄᓴᖅᑕᐅᖅᓯᐅᓪᓚᕆᓂᑦ, ᐊᒻᒪᓗ ᐊᓯᔾᔨᓪᓗᓂᒃ ᐅᓄᖅᓯᖓᓂᓂᑦ ᐊᒻᒪᓗ ᓇᒫᓯᖓᓂᓂᑦ ᓄᓇᕗᑦᑕᓱᐃᓐᓇᑦ. ᐊᒥᐊᓯᐅᓴᖅᑕᖏᑦᑕ ᐃᓕᐊᓇᓯᑎᖅᑲᐅᑦ ᓇᓪᓕᐅᑦᑕᐅᕐᓯᒪᖏᓪᓕᐊᑦ ᐊᖏᔪᓗᐃᖏᕐᓂᖅᓯᖓᓄᖅᑕᐅᕐᓴᓗᓐᓂᒃ, ᐊᒻᒪᓗ ᐅᑎᖓᓄᖅᑕᐅᕐᓴᓗᓐᓂᒃ ᐱᓕᕆᓂᖅᓯᐅᓪᓚᕆᓂᑦ ᐊᐅᓪᓚᐅᕐᔪᑎᖓᓂᒃ ᐱᖅᔨᔪᑐᑐᓂᑦ ᐊᖏᔪᓗᐃᖏᕐᓂᖅᓯᖓᓄᖅᑕᐅᕐᔪᑦ (ᐊᒻᒪᓗ ᑕᒪᓐᓇᐊᖅ ᕿᓇᐃᐅᔪᒥ ᐃᓅᓂᒪᓗ) ᐱᑕᖅᑎᓂᐊᖅᓯᐅᓂᒃ ᑕᐃᓕᐊᓇᖅ ᕿᓇᐃᐅᔪᑦ ᓇᔪᖅᑕᒪᓗᓂ ᐊᒻᒪᓗ ᖃᑎᖅᑎᐅᓄᐊᖅ ᐃᓅᓯᕆᐅᓗᓐᓂ LSA-ᒥ. ᑕᒪᐃᑎᒍᓕᓂ, ᐱᐅᖓᑕᑐᒃ ᐃᓅᓯᕆᐅᔪᓇᓱᓂᖅᑕᑦ VSEC-ᒥ ᓄᓇᕗᑦ ᐃᓅᔪᑎᖅᑲᖅᓯᑎᒃ ᐱᓇᓯᐊᖅᑲᖅᑐᓄᓕᕐᓂᑦ ᐊᑐᕈᓇᐅᑎᖓᓂᕈᓐᓇᑦ **ᐊᖏᔪᓗᐃᖏᕐᓂᖅᓯᖓᓄᖅᑕᐅᕐᓴᕐᓂᑦ,** ᑕᐃᒪᐃᓐᓇᐊᕐᓯᓯᓂᕆᐅᖓᓂᑕᑦ ᐊᒻᒪᓗ ᐊᖏᔪᐊᓕᒃ ᓯᓚᐅᓴᕆᐅᑦᓂᑎᒃ ᐊᒻᒪᓗᑦᑕᕐᑕᐅᖅ, ᐊᑐᖓᓂᖅᑲᖅᓯᐊᓴᓕᓂᑎᒃ ᓴᓇᖓᓕᕐᓂᖅ ᑕᒪᓐᓇᐅᑦᓂᓄᐊᖅ ᓄᓇᕗᑦ ᐃᓅᔪᑎᖅᑲᖅᑐᓄᓕᕐᓂᑦ ᐊᓐᓂᓐᓄᖓᒃᑯᑦ ᑕᒪᐅᖅᑲᐅᑦᓂᑎᒃ ᑕᐃᒪᐃᓐᓇᐅᑦᓂᓄᐊᓕᒪᓕᕐᓂᑕᑦ ᐅᓄᖅᓯᓂᑦᑐᓂᓕᕐᓂᑦ ᑕᐃᒪᐃᓐᓇᐅᑦᓂᓄᐊᓕᒪᓕᕐᓂᑕᑦ ᐃᖅᑲᐅᐊᕐᓴᖅᑕᐅᓂᖅᓴᖅᑐᓂᒃ

ᓄᓇᒥᑕᕆᐃᑦ ᓂᕆᑭᑦ

ᓄᓇᒥᑕᕆᐃᑦ ᓂᕆᑭᑦ ᐅᒪᔨᓂᑦ ᐱᖅᑕᑦᕿᒪᑕ, ᐱᑭᖅᑐᓂᓪᓗ, ᐊᓚᒪᓗ ᓱᑭᖅᓱᒪᔨᓂᑦ ᐊᑐᖅᑕᑦᕿᒪᑕ ᐃᓄᐃᑦ ᑕᒪᓂᕆᒥᐅᑦ ᓂᕆᑭᑎᓪᓗᓂᑎᓪᓗ ᐃᓗᐊᖅᑕᑦᕿᒪᑕ ᐃᓄᐃᑦ ᐊᖏᔪᓱᑕᑦᕿᑐᑦᓗ ᐅᒪᔨᓂᖅ, ᐃᖅᑲᓐᓂᓂᐊᖅᑕᑦᕿᓯᐅᓗᓗ, ᑲᑎᖅᓱᐃᖅᑕᑦᕿᓯᐅᓗᓗ ᐱᑭᖅᑐᓂᖅ (ᐊᐟᓂᓂᐊᖏᓐᓄᑐᖅᑕᑦᕿᑕᐃᒪᑎᑦᑎᒃᓴᑦ ᑲᓇᑕᒥ 2010). Ċᐅᑯᐊ ᓂᕆᑭᔾᑲᖅᑕᑦᕿᑐᑦ ᐱᓚᒪᓇᐅᑎᑕᐅᔨᓂᑦ ᑕᒪᓂᕆᒥᐅᓄᑦ ᓂᕆᑭᑎᐊᖏᓐᓂᖅᓯᒪᓂᑦ ᐊᐟᓂᓂᐊᖏᖅᑎᑦ, ᐃᓗᐊᖅᑲᐃᓕᑎᖅᑲᖅᓯᑎᑲᑦ ᑎᑎᒍᑭᓕᖅᑐᑦ ᑕᐃᒪᓐᓇᖅᑐᑦ ᐱᓚᒪᓇᐅᑎᑕᐅᔨᓕᑐᑦᓗᑎᑦ. ᐃᓄᐃᑦ ᑕᒪᖅᑯᓂᖓ ᐱᖅᑕᑦᕿᒪᑕ ᐊᖏᔪᓱᑕᑦᕿᑐᑦ ᐱᓚᒪᓇᐅᑎᑕᐅᔨᓕᑐᑦᓗᑎᑦ ᐃᓗᐊᖅᑕᑦᕿᒪᑕ ᐃᓕᓴᕐᓂᖅ ᐱᓚᒪᓇᐅᑎᑕᐅᔨᓕᑐᑦᓗᑎᑦ ᐃᓗᐊᖅᑕᑦᕿᒪᑕ ᐃᓕᓴᕐᓂᖅ ᐱᓚᒪᓇᐅᑎᑕᐅᔨᓕᑐᑦᓗᑎᑦ ᐃᓗᐊᖅᑕᑦᕿᒪᑕ ᐃᓄᐃᑦ

ᓯᓚᑎᐅᓂ), ᐃᓕᓴᕐᓇ 5-ᒥᓗ (ᓄᓇᒥᑕᓴᐃᑦ ᐊᐅᑎᖏᑦ), ᐃᓕᓴᕐᓇ 6 (ᐃᒪᖏᑎᐊᖅᑯᓗᒍ ᐊᐅᑎᕋᑎᐅᓂ), ᐃᓕᓴᕐᓇ 7 (ᐃᑭᖅᒥ ᐃᒪᖅᒍᑦ ᐊᐅᑎᕋᑎᐅᓂ), ᐊᓚᒪᓗ ᐃᓕᓴᕐᓇ 10-ᒥ (ᐊᐅᓪᓚᑕᐅᓴᐅᑎᕿᓄᑦ ᓯᖏᓐᓄᐃᓕᓴᐅᑦ).

ᑐᖅᓴᓕᒋᑦᓯᓂᑦ ᑕᒪᑦᑯᐊ ᓄᓇᒥᑦ ᓂᕆᑭᓴᐅᓴᓄᑦ ᑐᖅᓴᓕᖅᓯᑦ ᐅᐸᑐᕋᖅᑕᐅᓪᓚᐅᕐᖏᓴᑦ ᖃᓄᐃᑎ ᑕᒪᑦᑯᓄᖅ ᐃᐸᓴᓐᓂᕐᓂᖅᓯᐊᖅᑐᑦ ᑐᑭᑕᑭᐅᓪᓚᐅᕐᖏᓪᓕᐊᓂᒃ ᑯᓐᓂᕐᓄᓂᑦ ᐅᐸᑐᕋᐅᑎᖃᖅᓯᓗᑎᒃ ᐃᓪᓂᕐᓄᓂᑦ **COPC**-ᓂᒃ ᓄᓇᒥᑦ ᓄᓇᒥᑦ ᓂᕆᑭᖃᖅᑐᓂᒃ ᓄᓇᒥᑕᓴᐃᑦ ᑐᖅᓴᓕᖅᓯᐊᖅᑐᑦ ᐅᐸᑐᕋᐅᑎᖃᖅᓯᓗᑎᒃ ᐃᓪᓂᕐᓄᓂᑦ ᖃᓄᐃᑎᖃᖅᑐᓂᒃ. ᑐᖅᓴᓕᒋᑦᓯᐊᖅᑐᑦ ᖃᓄᐃᑎ ᐊᑯᓪᓚᕐᑐᒃ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᑐᑦ ᐊᑎᓚᓗ ᐊᓄᑎᖅ ᐊᒃᑎᑎᓪᓚᑦ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᑐᑦ ᓄᓇᒥᑕᓴᐃᑦ ᓂᕆᔨᑦ ᐊᑲᓴᐃᖅᑲᓇᖅ ᐃᐸᓴᓐᓂᕐᓂᖅᓯᐊᖅᑐᓂᒃ ᐃᓪᓂᕐᓄᓂᑦ ᓂᕆᑭᓐᓄᐊᐅᐸᓂᖅᑐᓂᒃ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᓯᐊᖅᑐᑦ ᖃᑭᒪᔪᐅᕐᓂᖅᓯᐊᖅᑐᑦ ᐊᑲᓴᐃᖅᑲᓇᖅ ᐊᑲᓴᐃᖅᑲᓇᖅᓯᐅᑎᓂᒃ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᓯᐊᖅᑐᑦ ᓄᓇᒥᑕᓴᐃᑦ ᓂᕆᔨᑦ ᐊᑲᓴᐃᖅᑲᓇᖅ ᐊᑲᓴᐃᖅᑲᓇᖅᓯᐅᑎᓂᒃ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᓯᐊᖅᑐᑦ ᐃᓪᓂᕐᓄᓂᑦ ᐃᓕᓴᕐᓂᖅᓯᐊᖅᑐᑦ ᐊᑲᓴᐃᖅᑲᓇᖅᓯᐅᑎᓂᒃ ᐊᑐᖅᑕᐅᖃᖅᑐᕐᓂᖅᓯᐊᖅᑐᑦ ᓄᓇᒥᑕᓴᐃᑦ ᓂᕆᔨ

ᐃᒪᐃᓇᖅᓂᖏᖅᓂᐊᕃᖏᑐᑦ ᓴᓇᕆᐅᓂᖅᓱᓄᑦ ᑕᒪᐃᓇ ᐃᖏᓗᐃᓄᑦ, ᐃᒪᖏᐅᑕᓇᓄᑦ ᐊᐅᔨᑦᑕᐅᓗᒃ ᑎᐃᒋᐊᓄᑦ, ᓇᒃᑐᖏᓐᓇᓄᑦ VEC-ᓂ. ᐃᓄᐃᓄᑦ ᐋᓐᓂᐊᕐᓇᖏᑐᖏᓕᒋᐊᓂᖅᑐᑦ ᖃᐅᔨᓴᖏᐅᑕᐅᑎᕐᕕᑦ ᓯᑕᕐᖃᐅᔨᕐᓯᖅᑕᖏᑦ ᐊᒃᓱᓗᐊᖓᕐᓂᖅᓯᒪᓕᐅᖏᑐᑦ ᐃᓄᐃᓕᖅᑐᑦ ᓴᓇᕆᐅᓂᖅᓱᓄᑦ ᐊᑐᓴᓴᐅᑕᐅᓂᖅᑐᑦ ᐊᓂᒍᖅᑕᐅᓂᖅᓱᓄᑦ ᐃᓄᐃᓕᖅᑐᑦ ᓴᓇᕆᐅᓂᖅᓱᓄ

Atanguyan Naetomik Okaohen

Hanigayokmi Havaak (Havaak) kulmik oyagaktakveoyomayok nanminigiyaoyok Sabina-konin Oyagakheoktinin iloani Oalikheani Kitikmeot, Nunavumi. Havaak pikahuyun havakveoloagumayun: Goose-mi Oyagaktakvik, George-mi Oyagaktakvik, Umiyalo Uheyakvikhaan (MLA-goyok) inikaktok oalikheani hinaani hivugaani Kigaom. Sabina-kon ihoakhaehimayun Avataoyomik Aktoknigagun Okaohikmik (EIS-mik) tikoakhiyaagani ilitokhaklogilo aktokneolaktun avataoyomun inuknulo Havaamin, taemaeginakhonilo atogeakakniginik okaotaoyonik Nunavumi Nunataknikun Agikatigegutaoyomi (NLCA-mi) Nunavumilo Avatilikiyin Katimayinin (NIRB-konin) Maligoakoyaenik Ihoakhakniginik Avataoyomik Aktoknigagun Okaohikmik Hanigayokmi Havaamin (NIRB-koni Titikam Napaa 12MN036; NIRB-koni 2013-mi). Una ataotimeoyun EIS-mi piyotikaktok ilitokhakniginik aktogutaolaktonik avataoyomun hilaenakmik piyotikaktonik Havaami hulilogagutinin kigoagun atulikmata ihoakhaotin monagiyotilo havaan.

Hunaonigin Atoktaoloaktun Inuhikmi manikhakheogutinilo Pikaknigin (VSEC-goyun) piyotigiyaen Sabina-kon inoen katimakatigivlogin, atoknigin Igilgaan Kaoyomayaenik (TK-mik), maligoaleoktinin kivgaktoktin maligaogakhaniklo ihomagiyakhanik, atoligumayaelo okaotaoyun NIRB-kon EIS-mi maligoakhaen (NIRB 2013-mi). *Inoen Igilgaan Kaoyimayaen ukoa Sabina-kon, Hanigayokmi Havaak, Naonaeyaotin Igilgaan Kaoyimayaenik Havaami Unipkaak (*KIA-kon 2012-mi) okaotaokhaktok TK-nik hivonikhiyotikhanik. Atokata ukoa ihoakotin, ukoa inoen inuvigiyaen tikaoktaoyun VSEC-mi: igilgaaknitanik pikotikaktun, manikhakeogutinik pivaleanik, havaakhan, ilihaknik ayoekhayotilo, aneaktaelinik nunagiyaoyonilo inuhikateaknikhak, agunahoakveogitin nuna ihoakotilo atoknigin, aolaenaktonik manikhakheogutinik nunaniklo atokniginik, nikaenaelo. Taemanigaalok inituklen, inoen aneagitaagani ilitokhakniga, avataoyomilo ihomaloknaknigagun ilitokhaknik ihomagiyaoyun Okaotaoyaagani tamaetalo atugeakaktun hivonikhiyotin okaotaoyun EIS-mi maligoagakhani ilaoyun uvani makpigaami.

Aktogutaolaktun VSEC-nik naonaeyagaoyun naetomik iloani Ilitokhakveoyum Nunam (LSA-mi) aginikhaklo Kanitoani Ilitokhakveoyok (RSA-mi). LSA-mi RSA-milo ilikun okateakhimayun igilgaaknitakaktoni, inoen manikhakheogutikhaenik, nunanik atoknigagun, nikaenaelo. Igilgaaknitalikiyotini, LSA-ga 5-kilamitamik avatigini amigiyaoyun tamaeta Havaani pikotin, RSA-galo ayikotaa nunameotanik RSA-mi. Inoen manikhakheogutaeni, LSA-ga piyotikaktok oalikheanik Kitikmeoni nunagiyaoyoni, RSA-galo ayikotaa manikameoyonik RSA-mi. Inoen manikhakheogutaenilo, LSA-ga ilakaktok oalikheani Kitimeoni nunagiyaoyun, RSA-galo ilageakhimayok ilaoligeagani kivalikhen Kitikmeoni nunagiyaoyonik Yalonaemiklo. Nunanik atoknigagun, LSA-mi ilakaktok 5-kilamitamik avatigani Havaami pikotin RSA-lo ataotimukhimayuk nunan manikameoyonik takyomilo RSA-ginik. Tamaeta aktogutaolaktun Havaamin ilitokhagaoyun Inigiyaoyukhak Ihoakhaktaotilogo, Hanataoytilogo, Oyagaktakveotilogo, Utiktitaovaleatilogolo Ilitkoheanun Umiktiknigalo, Kigaogulo umiktaakhimalikan Havaami havaohikhan.

Ukoa naetomi okeoheoyun taya avataoyomik, Havaami hulilogagutin aktoknikakneaktun inoen inuhenik VSEC-nik, ihoakhaotin, aktoknigagun naonaeyaotin, atolaakalo, katitpaleayun aktokniginik naonaeyakniginik atuni VSED-goyun.

Inukaktinago

Inukaktinago Nunamik ilitokhaon (RSA-goyok) kaligekpaleahimayonik nunaoyun Taemanigaalok (~1.8 Ga-mi) Beechey Lake-mi, kivlogaoyun kaguktanin oyakanin manetonilo, heokanin, mikiyonilo ilaoyuyaaktonin. Ilaogiyaoyuyaakhimayun oyakan ihomagiyaoloaktun taemaniknitan,

ilaohiyaoyuyaakhimayun oyakan pikalimaginmata oyakani kikituyaaktonik aalagukataktulo oyakan ilipkalimaginmata kikiyuyaaktonik hunavaloknik agitilaagani takukhaovaktun taemanigaalok.

Inukaktinagu ilitokhaotikagitok RSA-nik, talvuna naonaepkotikagitok pikakniganik kikituyaakhimayonik oyakani hunavalikni Beechey Lake-mi Goulburn Groups-nilo, humigaaknigin naonaektaogaloakhotik ikalguni kaligektuyaakhotik oyakan nipihimayuyaaktun (Cecile unalo Campbell 1977-mi). Takukhaoloaktun heogavaloen RSA-mi kugulen Archean-min Proterozoic-mun ukeogini (~2.6-1.8 Ga-mi). Umayovaleon kihukaheotihimayun oyakani naonaepkotin ukunani ukeoni takuhaoyotaoloaktok kaligektonik oyakan nipihimayuyaaktun. Ukoa kaligen, kigikninoatun itun taemaelihimayaen hikinaknikmin halomaelgunoen. Taemaekatagitoni, naoninoagin halomaelgun ilipkamalaolaktun (Schopf 2006-mi). Kaligektonik oyakan nipihimayuyaaktun takoyaohimayun akungani aalatkenik naktitokaktuyaaktunik oyakanin Hanigayokmin aoktukhimayugaloen oyakani Beechey Lake-milo kaligektuyaakhimayun oyakan (Lambert 1998-mi). Naniyaohimayolo Kilohiktomi kanitoani kigaom (Pelechaty unalo Grotzinger 1988-mi), Gouldburn Groupan-mi heokani. Avuhimayuyaktun ukoa heogavaloen, mikinikhan heogalean ilipkamaveoyaagani naoninoanik pikaktuyaalimagitok.

Igilgaanitanik Pikaktun Inituklen

Kaganoak inigiyaoyukhami naonaeyaotin havaagiyaohimayun iloani Havakveoyomayum Nunani (PDA-ni), igilgaaknitakaktulo LSA-ni RSA-nilo 2001-mi, 2002-mi, 2004-mi, 2007-mi, 2010-min 2013-mun. Ilagin inuveohimayonik hivonikhiyotin iloani RSA-goyum kahaktun 1970-ni ukeoni 1990-nilo ukeoni.

Havaamin aktoknigilaaktaen VSEC-nik igilgaaknitanik pikaktun inituklen ilakaktun kahaktaonigini igilgaaknitani pikatun inituklen. Hanayaotilogo, Havaamin hulilogagutin aktoknikalaktun igilgaaknitanik pikaktun iniguklinik ilakaktun: ahivaktigiyun manikhaeyolo apkotikhanik tukhoalo inikhaenik; ahivaktigiyun, manikhaeyun, nunalikiyulo tungavikhanik iglukpaelo tungavikhaenik; nunanik ahivaetilogin kagaktitaaktitiyulo oyagaktakvik hanayaagani; atagukvik oyakaniklo ikagunik katitigivik. Kigoagun aktoknigin nahogiyaoyun inigiyaoyoni iloani 50-metamik PDA-min apkotivlo inikhaani. Ukoa nunan aktoktaolaktun nunan aalaguktaovaleatilogo hanayonin. Igilgaaknitanik pikaktun nunan akungani 50-metamin 1-taosan metamun Havaami pivaleaniginin aktoktaolaktun hanayaolikan oyagaktakveolikalo inugeakhimaleakpan talvani nunami.

Pikaktok 305-nik kaoyimayoayonik igilgaaknitanik pikaktonik nunanik iloan igilgaaknitanik RSA-mi Tibbitt-min Tahikyoamun Ukeomi Apkun Tikitakveoyok Ilitokhaniganik Nunanik. Pikaktok 132-nik kaoyimayaoyonik igilgaaknitanik pikaktonik nunanik iloani 1-taosan metamin, 84-goyun akungani 150-metamin 1-taosan metamun ihomagiyaovlotiklo aktoktaolimaginiginik hanayaolikan oyagaktakveolikalo. Ukoa 14-goyun nunan akungani 50-metamin 150-metamun PDA-min aktoktaoneagunakhiyun inukaenalikan hanayonik oyagaktaktoniklo. 34-goyun igilgaaknitanik pikaktun nunan ilaoni 50-metamik PDA-goyum aktoktaoneakuktun hanayaolikan.

Taemaeginaktok, inigiyaoyun atoktaelilogin Havaak ihoakhaklogo atulikoyaoyok monagiyutikhak Havaaklo ihoakhakhimayok mikinikhaoligeagani aktoknigin igilgaaknitanik pikaktonik nunan. Igilgaaknitanik pikaktonik nunan ihomagiyaohimayun Havaak ihoakhaktaotilogo ayoknaetagaagalo aktoktaoyoetun. Atoknigin ukeoginakmi apkotin atogeokpaaligutaoyok aktoknigilaaktaenik igilgaaknitanik pikaktun nunan ikikliyaagani nunakuktun aolan. Kiheani, aktoktaoginigin ayoknakan, ihoakhaotikhan igilgaaknitanik pikaktun nunan havaagiyaoneakun hanayaoligeaktinagu. Kitulikaa igilgaaknitanik pikaktok nunan naonaeyagaohimagitun naniyaoyun hanayaotilogo, oyagaktakveotilogo umiktiktaotilogolo ihivgeoktaoneakun Hvaami igilgaaknitalikiyimin, titigaktaolotik, okaotaolotiklo Kamavanun Nunavumi, Havakveoyok Ilitkohilikiyinin Inuyutiniklo atoklogo ‘Nanihiguvin Piyotikhak’. Ukoa nunan ilagineakan ayikotaenik monagiyotin ihoakhaotilo atoktaoyun taya kaoyimayoayonik igilgaaknitanik pikaktonik nunani okaotaoyomi kuleoyoni.

Taktogitaagani ihoakhaokhaotilunen atokata, kigoagun aktoknigin kaoyimayaoyun igilgaaknitanik pikaktun nunan **Ihomalutaovaalaagitun.** Ugahiktigekmata kanitoani igilgaaknitanik pikaktun nunani pikagitok ataotimukpaleayonik aktokniginik tiktaoyoniklunen aktokniginik Havaamin VSEC-ni igilgaaknitanik pikaktun nunan.

Inoen manikhakheogutikhalo

Ilitokhaknigin aktoknigilaktaenik Havaamin inoen manikhakheogutilo ihomagiyakaktun talimanik VSECS-nik: 1) manikhakheogutin pivaleanigin; 2) manikhakheogutin atulaktun; 3) havaktun; 4) ilihaknik ayoekhayutikhalo; 5-lo) aneaktaelinikun nunagiyaoyonilo inuhikateaknikhak. Ataotimun kulin aktogutaolaktun tikoaktaoyun, kigoagun saevan kigoagun aktogutaolaktun, malguk ihoetuk kigoagun atogutaolaktuk, ataohiklo aktogutaoyok ihoaktomik ihoetomiklo kigoagun aktogutaoyuni. Ihoaktun kigoagun aktogutaoyun okaotaoyun kiheani ihomagiyaovalaagitun iliyaogitotiklo ataotimukpaleanigini tiktaoyonilunen aktokniginik ilitokhaotini. Ihoetun kigoagun aktoknigin naonaeyaktaovaaktun ihomagiyaoyageakakmagaa, ilaovlotiklo ataotimukpaleayoni tiktaoyoilunen aktokniginik ilitokhaknigini.

Manikhakheogutin Pivaleanigin

Kitikmeon ayikegitoni manikhakheogutikaktun, ihomagiloakhogin kitulikaa ikayoktokniginik, nanminik manikhakheogutikaktun, igilgaalo hulilogagutaenik. Ilitagiyaohimayhun manikhakheogutikhan atokloaktun ilakaktun ukuniga: kavaman titikikiyen, monakhin ayokhaktolikiyilo, ilihaknik, neoviktitiyotin, hanayin, aolagutin, polaktonun ikayutin, hanaoyaktin mikhoktilo, oyagaktakvikhanik nalvakheoktin pivaleanigilo (Naonaeyaotini Kanatami 2007b-mi). Ikayoktoeyin tungavigiloaktaan Kitikmeoni manikhakheoktun, havaktitivlotik kanitoani 80%-mik havaktonik. Aheanitaok, havaagiyaoloaktun oegugiyaelo havakveoyun – ilakaktok ihoakotilikiyin havakveoyun hanayulo – 20%-mik nunagiyaoyoni havaktonik (Naonaeyaotini Kanatami 2007b-mi). Nunavumi Tamaeni Humilikaa Hanaogan (GDP-goyok) agiklivaleahimayok kanitoani 26.5%-mik, 1,357-mileatalamin 1,765-mileatalamun akungani 2007-min 2011-mun. Pivikhakaknigin havaagiyaovaleayaagani oyagaktakvikhan nahogiyaoyun atoktukhani 25-ni ukeoni, manikhakheogutin amigaekpaleaginageagani Kitikmeoni nunagiyaoyonilo.

Havaamin hulilogaagutin kigoagun ihoaktonik aalagugutilaaktok manikhakheogutin amigaekpaleaniginik, aalatkenik, havaoheniklo. Manikhakheogutinun aktoknigin Havaam piyotikaktun katrakaktitaoyonik havaktonilo, nahogiyaoyolo ahenik aktoknikalakmiyok havaktukhanik, inoen manikhaaginik, GDP-mik, kavamalo manikhaaginik. Manikhakheogutin Pivaleaniginu Opalogaeyaon Havaktolikiyotinulo Oplaogaeyaon okateaktok ihoakhaotinik amigaegutaolaktonik ikayuheanik Havaamin nunagiyaoyoni Kitikmeonilo pivaleaniginik (takologo Makpigaak 10, Oegoeni 24-mi 28-milo). Ikayuhean agiklivaalikneaktun Havaamin, ikayoktokniginik nunagiyaoyoni Inoenaknik ukeoktaktomilo manikhakheogutinik, ayogeogeagani, nunagiyaoyonilo maniknik atoktitiyaagani manikhakeogutikhanik.

Tamaeni, amigaekpaleanigin manihakheogutin aalatken nahogiyaoyun Havaamin ukoa okaotaoyun ima: amigaekpaleanigin nunagiyaoyonin havaktun, agiklivalealotik manikhaakhan, akiliktogaoyulo; Havaamin akiliktogaoyun (nunagiyaoyomi, Kitikmeoni) taya manikhakheogutaoyonin Kitikmeonin Nunavumilo, agiklivaleanigin manilikiyotinun ihoakotin kahaktun taya manikhakheokgutikaktonun; ilageagutin nutanik manikhakheogutikhanik agiklivaleaniginiklunen taya manikhakheogutin Kitikmeoni atoktitiyun ihoakotinik ikayutiniklunen kahagitugaloanik hivoagun; pivaleaniginiklunelo, ilageagutiniklunen manikhakheogutikhanik ukunani, Inoen nanminigiyaeni manikhakheogutini. Amigaekpaleanigin manikhakheogutikhan, aalatken, havaohelo nahogiyaoyun ihoaktomik kigoagun aktokniginik VSEC-ginik manikhakheogutin pivaleaniginin. Kigoagun aktoknigin ihoakneaknahogiyaokman, aktoknigin ihomagiyaogitun ilageagutini ataotimukpaleaniginik tiktaoyoniklunen ilitokhaknigini.

Manikhakheogutaolaktun

Kavaman Nunavumi ikayoktoelaoktun havakveoyoni manikhakheogutaoloakhotiklo Kitikmeoni nunagiyaoyonin. Kavamani havaktun olasiktulo manikhakheogutaoloaktun inuknin unalo, ila, ikayutaokman nanminik manikhakheoktonik atuni nunagiyaoyoni. Atokloaknigin kitunulika ikayoktoeyotinik piyotaoyok kanogininin, ila alapaaknaktukman hila, ahivanetuvlotik, inukugitutik, pikotikakpalaagitotiklo atoktukhanik, ukoa taemaenigin ayokhaotaokmata nanminik manikhakheogutin pivaleaniginik. Nanminik manikhakheogutikaktun ukoaloan hiniktaktitiyun neoviktitiyolo, aalatkelo mikiyun ihoakotinik ikayutiniklo atoktitiyun atuni nunagiyaoyoni. Ikaloktuteak, tukligiyaalo Kugluktuk, takukhaoteaktuk nanminik manikhakheogutikaktun ilaoyotikakloaktun manikhakheoktoni. Pikaktok amigaetonik manikhakheoktonun ikayutinik Kavamanin Nunavumi uktokhimakoeyotinik pivaleaniginik nunagiyaoyoni manikhakheogutikhanik. Manikhaktitogin mikiyun manikhakhoektun, inoen, timeoyun, hamlitkonilo kavamaoyun pipkagaovaktun Nunavumi Havakveoyomik Manikhakheogutikhan Pivaleaniginik Aolagutilikiyilo monagiyaovlotiklo Kitimeoni titigakveanin Kugluktumi. Hitaman manikhakveolaktun ilakaktok ukuniga: Mikiyonik Manikhakheogutikaktun Ikayuheakhaenik, Hanaoyaktin Mikhoktilo Ikayuheagin, Atoligeagani Manikhaan Manikhakheogutigiyaagani Havaak, Pitkohiklo Havaami Ikayoktigeknikun (NDEDT 2011-mi).

Havaak aalagugutilaaktok amigaekpaleaniginik aalatkeniklo Inoen ukeoktaktomilo manikhakheogutaenik. Una aktokniga okaotaoyok pivaaligutikhaanik nutaan manikhakheogutikhan ayogeoknigilo taya manikhakheogutaoyun agiklivaaligeagani aalaniklo pilotiklunen nunagiyaoyomin Havaam havaktitiyoheanik akiliktogeaniklo Havaamin manikhaaginin havaktun. Pigeagutin amigaekpaaligeagani manikhakheogutikhan atulaktun okaotaoyun Manikhakheogutikhan Pivaleaniginik Opalogaeyaonmi (Makpigaani 10-mi, Oegoani 24).

Havaamin hulilogaagutin agiklivaaligeagutaoneaknahogiyaoyun aalatkeniklo Inoenakni ukeoktaktomilo manikhakheoktoni ilakaktun ukuniga: pikakniginik katragoyun ilagiyaelo katrakaktun havaanik, ukoaloan atoktitiyun ihoakotinik ikayutiniklo nunagiyaoyoni kivgaktoktinin; ilageagutinik inum manikhaaginun, neoviktoknitkiyaoligeagani nunagiyaoyoni inoen. Nahogiyaoyok nunagiyaoyoni manikhakheogutini hulilogaagutin ilikun nahogiyaoyok agiklivaaligeagani akitoyonik manikhakheovaagutikhanik (ila mangit atoknigin agiklivaaligeagani manikhakheogutoayok hatkiknigalunen nutam manikhakheogutikham). Nunagiyaoyoni manikhakheogutin havitiyaoneaktun atoktakhaenik uktogeagani Havaami havageamikni, hatkiktitaoyun Havaamin ihoakhaotinin monagiyotinilo atoktunin aginikhaoyaagani ikayutaoyun katragoyunin atulaktonik nunagiyaoyonilo atoktitiyotinik ihoakotinik ikayutiniklo. Aalaguknigin agiklivaleaniginik aalatkeniklo Inoen ukeoktaktomilo manikhakheogutin nahogiyaoyun ihoageagani, aktokniga okaoheogitok ataotimukpaleayonik tiktaovaleayoniklo ilitokhaotini.

Havaakhan

Atolaktok havaktonin Kitikmeoni nunagiyaoyonin kanitoani 3,475-goyun 2006-mi. Havaenaktun ukunani ayikeni nunagiyaoyoni kanitoanetok 2,185 inoen, naonaegutaoyok tamaenin ilaoyonik 62.9%-mik. Havagitun amigaetkiyaoyun Okhoktumi Taloyoanilo (31.9%-goyok 31.4%-miklo, taemaetpuk) naonaeyakata amigaetilaagin Kanatami Nunakakaktun inoen (14.8%-goyok). Havagitutaok Nunakakaktun inukni Nunavumi, Kitikmeon aolaenaktok amigaenikhaovlotik pigahonin aviktokhimayoni (23.5%-goyok), kiheani taemaetuyaaktok aviktokhimayoni amigaenigin (20.1%-goyun). Tamaeta Kitikmeoni nunagiyaoyun ilaoyokakhimayok amigaetonik ilihaknikmi, manikhakheogutini, neovikvikni, ahenolo ikayutinik havaakaktoni. Ukoa havaohen mikiyun, ugaheaktomeoyoilo ukeoktaktomi nunagiyaoyuni (Naonaeyaotin Kanatami 2007b-mi). Kanavaman Nunavumi havaktitilaktulo kitikmeoni Aviktokhimayomi. Ikaloktuteak aginikhanik iglumeoyonik manikhaoheinik Kitikmeoni nunagiyaoyonin (71,936-talamik), kanitoani 22%-mik aginikhanik nunagiyaoyomin tukleoyok aginikhanik iglumeoyun manikhaaginik (Kugaakyuk uvani 58,624-talamik) kanitoani 20%-mik akitutkiyamik Nunavumi tamaenin.

Ilalo, tamaeta nunagiyaoyun okaktun amigaetonik uplum ilaenani havaakhakaknigakhotik ukoagoyun kanitoani 58%-goyun Ikaloktuteami 87%-mun Okhoktumi.

Havaak nahogiyaoyok aktokniganik VSEC-nik havaktonik ima: 1) aalaguknigin havaktun manihaagilo; 2) aalaguknigin ayogeogutikhaen havaktun; 3-lo) aalaguknigin uktoktun havaakhanik. Ihoakhaotinun monagiyotinulo atoktakthaen ayoekhavikhakaklotik, havaktikhakheoknikmik, havaktikaenageaganilo ihoakhakhimayun ilaovaaligeagani nunagiyaoyoni Inoen Havaami havaakhani okateakhimayulo Havaktolikinikun Opalgoaeyaonmi (Makpigaak 10-mi, Oegoani 28). Atuligumayaoyun pivaaligutaoyok akhugutinik havaktukhanik ukunigalo: Havakatigeknikun Atuligumayaenik; Havaktitaoloagumayonik Atuligumayaenik; Hvakun Ayoekhayaagani Atuligumayaenik. Ihomagiyaoyun havaktiloaknigin Inoenaen nahogiyaoyok igiklivaaligeagani inukni havagitun kaveonigin. Havaaklo kaoyipkakneakaen nunagiyaoyoni manikhakheogutikaktun, timeoyolo, hamleoyolo havaktitiyutikhaenik katraniklo havaakhanik hivoani atokpaleaniganin Hanaveoneaktum Oyagaktakveolikalo havakatigineakaelo mikhivaaligeagani ihoetu aktoknigin amigaekata uktoktun nunagiyaoyomin havaktukhani.

Tamaeni, havaktun manikhaalo aktoknigin Havaamin ikayutaopeaktun ihoakhitilaktoklo inuyuhenik Kitikmeoni ilagenin. Havaamin havaktukhan katrakaktitaoyulo nahogiyaoyun amigaekpaaligeagani ayogoegutikhaen havaktun, ayogeogeakloaknigin kaoyimaliktaelo Kitikmeoni havaktun. Ayogoekpaaligutin ihomagiyaoyun ikiklitivaleanikhaanik havagitun amigaeniginik, atoktitivaaliklotik manikhakheogutin amigaekpaaligeagani, havalaaligeaganilo Kitikmeoni havkatun ikayoktogeagani hivunikhami havaanik. Aalaguknigin manikhaagiyaoyun havagitulo amigaenigin, aalagukniglo ayogoeknigini havaktukhan, nahogiyaoyun ihoaktomik kigoagun aktokniginik VSEC-ni havaktulikiyotini.

Havaamin havaktun katrakaktulo ihoeliyutineagunakhiyun aalagukniginik nunagiyaoyoni uktoktoni havageamikni. Ila, Havaak hatkigutaoyok inuk taya havaktok Kitikmeoni Nunami ipigageagani taya havaagiyaktik oyagaktakvikmi havaligeamikni. Kiheani, amigaenikhan Kitikmeoni inoen havaktun aheni nahogiyaogitun taemageagani taya havaagiyaktik havageamikni Oyagaktakvikmi. Havaak pihimayoklo amigaekpaaligeagani ayogoeknigin kaoyimayaelo nunagiyaoyomi havaktun, kigoagun kahakhivaaligeagani havaktukhan nunagiyaoyonin. Tamaeni, kigoagun aktokniga aalagukniginik havaakhakheoktun nunagiyaoyomin ihomaalutaovalaagitun ukunaneginaktoklo inoen manikhakheogutilo LSA-ni nunagiyaoyoni. Atoenakniga ihomagiyaoyok hivitovalaagitomik (piyotikaktok havakveoniganik Havaak), ilageagutin ayikekhotik, taemaekatakniga kagugugaaganlo. Kigulikmik, aktokniga kigumun aolalaaktok, taemaetuyaaknikha tuniktonikhaalo okaotaoyuk. Kigoagun aktokniga **Ihomalutaovalaagitok.**

Nalaotagaoyun kigoagun ihoetun aktoknigin ilitokhagaovaktok ilagani ataotimukpalealaktuni aktokniginik ilitokhaonmi (CEA-mi). Nunami kiklikhaa CEA-m ilageakhimayok ilaoligeagani ukoa havaan inoelo hulilogagutaen Kitikmeoni Nunateamilo ihomagiyaoyun aktogutaolaktun ilaoni inoen manikhakheogutilo RSA-gani piyotikaktun taya inukni. Ataohik taemanin, hitaman taya, talimalo hivunikhami havaan ataotimukpaleayonik aktoknikalaktun aalagukniganik VSEC-mi havaanun piyotikaktonik uktoktonik nunagiyaoyomi havaktukhan Kitikmeoni inuknin. CEA-mi okaktok pivaleaniga Havaam ataohik amigaetulunen ilageagutin havaan kigoagun ihoeliyutaoneaktun'aalagukniginik uktoktonin nunagiyaoyoni havaktukhanik'. CEA-mi nalonaegutiyok pivaleaniganik Havaam ataohik amiholunen ilageagutikhan havaan kigoagun iheotonik 'aalagugutineaktun havaktikhakheoktoni nunagiyaoyoni'. Ataotimukpaleayun kigoagun aktoknigin nahogiyaoyun kikloanun aolaligeagani, mikiyonin agivalaagitonik, nunagiyaoyomeginaklotiklo. Hivitoniga nalohoektaoyok hivitovalaagitomik (oyagaktakveotilogo Havaak) ilageagutilo aolalimagitun, kagugugaekpalo. Kigoagun ataotimukpaleayun aktoknigin ima itok, tiktaolaktun piyotigiyaen monagiyaogitpan.

Ihomagiyaohimayun takukhaonigin nutikpaleanigin aktoknigin havaktonin manikhakheogutinio ilaoni inoen manikhakheogutilo RSA-gini. Nulaktun aktokniginik ilitokhaotin nalonaegutiyun havaakhakheoktun

nahogiyaogitun aginiginik aheani Kitikmeon Nunaoyum kiheani nahogiyaoyun havaakhanik piloageagani ukuniga. Nuniginun aktoknigin Havaamin nalonaektaoyun ihoaktonik talvuna naonaeyagaovaagitun.

Ilihaknik Ayoekhayotilo

Atuni ilitokhagaoyun nunan, ukoagugituk Kigaok Umikmaktuklo, pikaktun sikulihaanik, nukakhelo ilihakvean agayukhelo sikugutaen. Sikuktun pipkaktitaoyun iniktigeagani ayoeniganik 12 naonaepkotiniklotik (ayikotaaniklunen) nunagiyamikni. Okhoktumi ineon ilihateakhimaginikun Kitikmeoni, avatkomayun 59%-mik inukakniginik ukeokaktun 25-nin 64-mun inikhihimagitun ayoeniginik 12-mik aheniklunen naonaepkotinik ilihaknikun. Taemaegitok, Ikaloktuteami inoen ilihaknikhaoyun nunagiyaoyoni, kanitoani 36%-goyun ineon ukeokaktun 25-nin 64-mun inikhihimagitun ayoeniginik 12-mik aheniklunen naonaepkotinik ilihaknikun. Ukunani Kitikmeoni nunagiyaoyoni, Ikaloktuteak amigaevyaktun inoen ilihakpaalikhimayun naonaepkotikakhotiklo (16%-goyun) ukeoktaktomilunen ilihakhimayun naonaepkutikaktun (24%-goyun) ihomagikpata aalat nunagiyaoyun. Ilihateaknigin havaklotik ayoekhahimageami hanayotinulo naonaepkotinik ataohik hitamani aviktokata inugeaknigin Kugaakyukmi (22%-goyun) avatkomakavuktok ataohik kulini aviktokata inugeaknigin (12%-goyok) inugeakniginin Ikaloktuteami. Ilihakpaaligutin atoktitaoyun Nunauvmi Ukeoktaktomi Ilihakpaalikviknin (NAC-konin). Ilihakpaalikvik kivgaktoeyok Kitikmeoni Nunagiyaoyonik togaaktakveanin Ikaloktuteami, havaakaktun tamaenik ilihakpaaligutikhanik Kitikmeoni (NAC 2008-mi). Ilihaotikhan NAC-kutigun ilakaktun hanayukhan ilihaotikhaenik, naonaepkotikaligeagani ilihaotikhan, havaakhanik pivaleanikun ilihaotikhanik, iliteagutikhanik, ilihakhimagutikhaniklo. NAC-kon pivaktulo ayoekhayutikhanik ikayutaoyaagani oyagakheoktini.

Aktogutaolaktun Havaamin ilihaknikmik ayoekhayutikhaniklo ilakaktun aalagukniginik ilihagumaneom ayoekhayumayulo, aalagukniginiklo inulgamen ihomagiyaenik pitkoheniklo ilihaknikmik ayoekhanikmiklo. Sabina-kon nahogiyun ikayoktogeamikni nunagiyaoyoni kavamanik, ilihaeyinin, Inoen timigiyaenin, ahenilo oyagakheoktini ilaoyonin ikayokatigegeamikni natkiknigagun Kitikmeoni ayoekhavikhamik ilageagutikhanilunen oyagaktakvikmi havaligeagani ayoekhayutikhanik NAC-koni. Okaotaohimaktun nunagiyaoyonin pivaaligutinik okaotaoyun Nunagiyaoyoni Ilaoniginik Opaogaeyaonmi (Makpigaami 10, Oegoani 26). Havaktukhan ayoekhaniginun Atuligumayaenik, okaotaoyok Havaktulikinikun Opalogaeyaonmi (Makpigaami 10, Oegoani 28), okateaktok upiyotikhanik ikayutaovaaligeagani Havaamin havaktun nunagiyaoyonin pivaleaniginik atoligumayaenik ikayoktigegutinik; ikayoktoelotik nunagiyaoyoni ilihaotikhanik ayoekhayutikhaniklo havaanik; pikakloni havakvikmi ayoekhayutikhanik havaaklo pivaaligeagani; havaktikageagani Inoen Havaktun Ayoekhayulo Ihoahaeyikhamik; upipkaklogin inulgamen iyoakhiyuyaaklotik ikayutikhanik.

Naetomik, aalaguknigin atogeagani ilihaknik ayoekhaniklo, aalagukniginiklo inulgamen ihomagiyaen ilihaknikmik ayoekhanikmiklo, nahogiyaoyun ihoaktomik kigoagun aktoknikakniginik VSEC-mi ilihaknikun ayoekhanikulo. Ilitokhaknik naonaegutoayok Havaak ihoaktonik aktoknikakneakniganik VSEC-mi ilihaknikun ayoekhanikulo. Taemaenman, aktoknigin ilihaknikmik ayoekhanikmiklo okaotaogitun ataotimukpaleayoni nutpaleayonilunen aktokniginik ilitokhaotini.

Aneaktaelinik Nunagiyaoyonilo Inuhikateaknikhak

Nunavumeon ikinikhan haonikluktun, aokluktun, aniknagiktun, tikliktaklaokniginiklo aogin ihomagikpata Kanatameotan. Kiheani, amigaenikhan Nunavumeon ukumaetpalaan puvalavlotik, amigaenikhaovlotiklo kagutikaktun (512.1-goyun 100,000-ni inukni) ihomagikpata Kanatameotan humilikaa (404.9-goyun 100,000-ni inukni). Aneagutikaknigin kagutimik (206.8-goyun 100,000-ni inukni) amigaekpalaan Nunavumeoni, kanitoani hitamaektokhugo amigaenigin Kanatami (56.9-goyun 100,000-ni inukni). Nunavumeotan nahogilaaktun inukhagitaamikni inuknin Kanatameotanin (DHSS 2004-mi; NTI 2008-mi). Amigaenigin, Nunavumi inoen inuhikakneaktogiyaoyun 71.6-ni ukeoni inutilogin 15.2-goyulo ukeoni ukeokaktun 65-nik (2007-min 2009-min tamaeni). Inugeakpalagitkaloaktilogo, amigaetonik

monakhikaktun ikayutiniklo atolaktaenik Kitikmeoni nunagiyaoyonetonin. Taemaetkaloaktilogo Ikaloktuteak talvatoak nunagiyaoyoni monakhikaenaktok, polaktaktoniklo taktinik takoyaagani aneaktonik aheni nunagiyaoyoni tikikatakhogin nunan. Nunagiyaoyoni aneaktaelinikun Kitikmeoni, amigaenigin inmikni tokotivaktun ihomalutaoyok.

Ihomagiyaoginaktok nunagiyaoyoni inuhikateaknikhak, okaotaoyok AANDC-konin nunagiyaoyoni inuhikateaknikhamik naonaepkotaoyomi, ikituyaaktun Kitikmeoni nunagiyaoyoni. Ikaloktuteak Kugluktuklo amigaetkiyaoyuk, ayikotanik amigaetkiyaniklunen Nunavumi tamaenin. Taloyak, Kugaakyuk, Okhoktuklo ikinikhaoyun (53, 55, unalo 56, kanotoani), ukunaniloak iglulikiyotini naonaepkotini. Ihoeknakpaktun iglolikiyotilo piyotaoyun nunagiyaoyomi aneaktaelinikmik inuhikateaknikmiklo. Ihoenakhimayun Kitikmeoni nunagiyaoyoni amigaetkiyan Ikaloktuteami, Kugluktumi, Okhoktumilo. Kugaakyuk ihoanaktokakpalaagitok ihomagikpata aalat Kitikmeoni nunagiyaoyun. Iglukhanik ayokhaotaogaloakhoni tamaeni Kitikmeoni nunagiyaoyoni, naonaevyaktok inugeakpalaakniginik agilgagiyaoyun Okhoktumi, Taloyoani, Kugaakyukmilo (57, 56, unalo 50%-goyun, kanotoani). Kitulikaa iglukhaen atoktaoloaktun akiliktogaevlotik, atogeakaniginiklo kitulikaa iglukhaenik taemaeginakneakukman manikhakheogutikateaginmata, hilalo, humenigilo nunan ayokhaotiyun nanminik havaakaktun ilaoniginik.

Aktoknigin Havaamin Aneaktaelinikun CWB-nilo nahogiyaoyun ihoakneakniginik ihoeneakniginiklo ilakakhotiklo: aalagukniginik inuhikmi ayoenigin havaktun Havaami; aalaguknigin inum ilagelo akiliktoeyohenik; aalagukniginiklo ilagen iglumeoyulo havaagiyaenik. Upiyotin manikhakheokgutinik havaani, monaginigin manilikiyotin, atogeakaktaeniklo ilagiyaenik havaami nahogiyaoyun ikayutaoyaagani ikayoktoklogilunen ihomaleogutaoyun inuhikmilo ayogoegutinik amigaekpaaligeagani. Pivaaligutikhan ihoakhakhimayun atokpaaligeagani pihimaenageagani ihoaktun Havaamin aktoknigin nunagiyaoyoni ukoalo amigaekpaaligutaoyukhan Inoenaknik havaktunik (ila, EFAP-mi, manilikiyotinik monagiyaagani okaoyiyutikhanik) okateakhimayoni Havaktulikiyotinik Opalogaeyaotini (Makpigaami 10, Oegoani 28-mi).

Havaak nahogiyaoyok amigaekpaaligeagni inuhikmi ayogeogutigiyaen inum pihimayum Havaami piyotikaktomik havaamik, piyotaoniganik kigoagun ihoaktomik aktokniganik VSEC-mi Aneaktaelinikun CWB-milo.

Tamaknik ihoaktun ihoetulo kigoagun aktoknigin nahogiyaoyun Aneaktaelinikun CWB-milo aalagukniganin inum ilagelo akiloktoeyuhenik. Nunagiyaoyoni inoen havaktun Havaami atulaakan akitukpaleayun manikhaatik ihoetomik (ila peanaknikmik, imigaknaktonik atoknigani taagaktoknikmiklo) ihoetomiklo inuhiknik atoklotik, una ihoetomik aktoknikakneaktok CWB-mik. Kiheani, manikhaan atoktaoyun iligaeyakpaaligeagani inuhikmik (ila ihoakhakan iglugiyaoyok, nikikhakateaknik) ilaleotikpan ahenik ihoaktonik aktokniginik piyotaoyun Havaami havaknikmin piyotikalaktok agiyonik ilageagutikhanik CWB-mi. Aalaguknigin inum ilagelo akiliktoeyuhen, ihoakata ihoetpatalunen, naonaektaoyun ihomaluknakpalaginiginik, naetun hivitovalaagitunun atoknigin aalaguyoetonilo ilageagutani. Una kigaogun aktokniga nahogiyaoyok taemaelinigani iloani inoen manikhakheogutilo RSA-mi. Una kigoagun aktokniga kikloagulaktok taemaekatagitonilo. Tamaeni, ihoetun aalaguknigin inoen ilagelo akiliktoeyuhenik **Ihomalutaovalaagitun.** Una naonaektaoyok taemaeneagunakhiyok ikayoktuktaovlonilo tunikhimayutinin. Tamaeni, aalaguknigin ilagen iglumeoyulo nahogiyaoyun ihoetomik kigoagun aktoniganik. Ihomaloknakniga uma iheotum kigoagun aktokniganik mikiyok nalaotagaokman aktoknikakneakniganik ikitonik iglumeotani. Kigoagun aktoknigin kikloanun aolalaktok, hivitovalaagitok, taemaekataenakneaktok, aalagulimagitoklo ilageagutaani. Humeniga uma kigoagun aktoniganik nahogiyaoyun aolaenakniginik LSA-mi kiheani ilaleotilaaktun RSA-mi. Tamaeni ihoetun aalaguknigin ilageni iglumeoyonilo **Ihomalutaovalaagitun.** Una naonaektoayok taemaeneaknahogiyaoyok ikayoktaovlonilo tunikhimaniginin.

Kigoagun ihoetun aktoknigin Havaamin Aneaktaelinikun CWB-milo ilaohimayun ilitokhaonmi ataotimulaktoni aktoknigini. Okaotaohaktomi, humenigin kiklikhaeni ineon manikhakheogutilo CEA-mi ilageakhimayun ilakageagani ukuniga havaanik inoelo hulilogagutaenik Kitikmeoni Nunateamilo ihomagiyaoyun aktoknikalakniginik ilaoni inoen manikhakheogutilo RSA-gani atoktaoyun taya inuknin. Ataohik taemani, hitaman taya, talimalo hivunikhami havaan piyotikaklaktun ataotimukpaleanigink aalagukniginik aneaknaelinikun nunagiyaoyonilo inuhikateaknikhamik. Ilitokhaon naonaegutaoyok pivaleaniga Havaam ataohiklo amihulunen ilageagutikhan havaan ihoetonik ihoaktoniklo kigaogun aktoknikakneaktun VSEC-mi aneaknaeliniku nunagiyaoyonilo inuhikateaknihamik. Ukoaloan, aalaguknigin inum ilagelo akiliktuhenik pivaleaniginin amigaetun havaan ihoaktonik ihoetonilo kigulikalaktun. Kigoagun ataotimukpaleayun aktoknigin nahogiyaoyun kikleagulaknigini, agivalagitotiklo, taemaekataenakneakhotiklo, hivikitomik aolakhavyaklotiklo aolalimagitulo ilageagutini. Una kigoagun ataotimukpaleaniginik aktoknigin iloaneginakneaknahogiyaoyok LSA-mi kiheani ilaleotilaktok RSA-mi. Havaknik manikhaalo piyotaoyun Havaamin ataohikmilo amigaetonilunen havaanin nahogiyaoyun kigoagun tamaeni ataotimukhimayonik aktokniginik Aneaktaelinikun CWB-milo; kiheani, ilagini inoen takukhaolaktun ihoetun ataotimukhimayun aktonigin piteagitkumik ihoetomiklunen akiliktoegumik neoviktamiknik. Una ataotimukpaleaniga kigoagun aktoniga naonaektaoyok **Ihomalutaovalaaginiganik.** Una nalohoektaoyok taemaeneaknahogiyaoyok tuniktuvyakhotiklo.

Kigulikmik, pivaleaniga ataotim amigaetulunen ilageagutikhan havaan nahogiyaoyok amigaegutiniganik iglumeoyun kaoyimayun ihoetomik kigoagun aalagukniganin ilagen iglumeoyulo kanoginigin. Una kigoagun ataotimukpaleayun aktoniga ihoetok, kikloagulaaktok, ihomaloknakgitok, aolakhalimagitok, aolalimagitonilo ilageagutani. Taemaekatakniga uma kigoagun ataotimukpaleayun aktokniginik atoenaktok iloaneginakneaktogiyaoyok LSA-mi, ila atolakmiyok aktoniga oeguleotiloni RSA-mi. Ataotimukpaleayun kigoagun aktonigin taemataok **Ihomalutaovalaagitun.** Una naenaektaoyok taemaeneaknahogiyaoyok ikayoktaovlonilo tunikhimayonin.

Nutpaleanigin aktoniginik ilitokhaon ihivgeokhiyok aktoniginik Havaamin VSEC-ni aneaktaelinikun nunagiyaoyonilo inuhikateaknihamik. Kigoagun aktoknigin Havamin aneaktealinikun nunagiyaoyonilo inuhikateaknikhamik nahogiyaoyun takukhaoloakniginik inukogitoni ukeoktaktomi nunagiyaoyoni. Tamaknik kigoagun aktonigin nahogiyaoyun takukhaoginiginik aheani Kitikmeonin Nunagiyaoyomin.

Ihomagiyaoteaktun nulaktun aktonigin aneaktaelinikun atoktun Nunateami Havaamin atoenakmata aneaktonik monakhiyotinik. Havaak nahogiyaogitok nuniganik aktokniginik aneaktaelinikun atoktonik Nunateami ukununa talvuga talvangalo tikmivlotik aolanikakmata Havaami atokniginiklo monakhiyutaoyun aneaktonik Havaam iglukpakakveani. Havaami havkatun atokhimakoyaoyun aneaktun ikayoktigiyaenik agilgamikni nunagiyaoyoni atulakhotiklo monakhiyotink aneaktonik Havaam iglukpakakveani piyageakakan.

Nunanik Atoniga

Ilitokhakniga aktogutaolaktun Havaamin nunanik atokniganik ihomagiyakaktun malgukni VSECS-nik: 1) igilgaan pitkohigigitaenik nunanik ihoakotiniklo atokniginik; unalo 2) inuhimageagani mankhakheogutin nunaniklo atoknigin. Ataotimun pigahun aktonigilaktaen tikoaktaoyun piyotikakhotik atuni VSEC-ni, kigoagun ataotimun sikseoyun aktogutaolaktun. Tamaeta aktogutaolaktun naonaeyagaoyun ihoetonik kigoagun aktokniginik. Ihoetun kigoagun aktonigin ilitokhagaovaaktun naonaegeagani agitilaagin.

Igilgaan pitkohigigitaenik nunanik ihoakotiniklo atokniginik

Manikhakheokveoyun nunan amigaevyaktun agunahoakveoyun, polaktakveoyun, oyagaktakvikhanik nalvakheokveoyun, aolakveoyun umeaktokveoyulo. 2012-mi, 22-goyun atoenaktun nalvakheokveoyun havaan Kitikmeoni Nunami. Una ikitkiyaoyok 95-nin atoktonik nalvakheokveoyonik havanik Kitikmeoni

2011-mi, ukoalo 35-goyun ilaoni oalikheani Kitikmeon. Taya, oyagaktaktokaginman Kitikmeoni. Pikaktok ataohikmik naonaeyaeyotinun laeseoyomik Ikalokpiknik ikalokheokveoyaagani iloani nunanik atoknigini RSA-mi kanitoani nunagiyaoyum Kigaom; ikalokheoktokaginman huli ayokhaotikagamik akyageagani ikaloktatik ikalolikivikmun. Agunahoaktitiyun Nunavumi ihoakhaktaolikpaktun nunagiyaoyoni HTO-kon titigakveanin. Agutikhan ihomagiyaoloaktun agunahoaktitiyonin ilakaktun tuktunik, umikmaknik, akhanik, nannunik, amakuniklo (Hanigayokmi Havaak Ilitokhanigani 2012-mi; Nunavumi Polaktolikiyin 2012-mi). Ilaenani ukeom manikameoven polaktolikiyolo havakveoyun aolavaktun humilikaa Kitikmeoni Nunami. Ataohik haneanetok Kigaom (kigaokmi Polaktolikiyin). Akmavaktok June-min September-mun ukeotoagaagan, manikameovik hinikvigilaaktaan 30-ineon iglukakhotiklo Kapanik iglugaloaginik. Nunanik Polaktun huliyotikakpaktun kayaktokhotik Kigaokmi, pihuyakhotik, takuyaktoevlotik, ilitkohiknik nunameotaniklo tukihititaovlotik (Hanigayokmi Havaak Ilitokhaknigagun 2012-mi).

Unatoak ilageknigin Havaamin igilgaalo pitkohigigitaenik atokniginik nunanik ihoakotiniklo nalaotagaoyun polaktonin hulilogagutaenik atoknikaklaktun ukunanga: aalaguknigin atokniginik nunan ihoakotilo; aalaguknigin kaoyimayaoniginik manikami avataoyomik; aalagukniginlo amigaenigin humenigilo ihoakotin. Unaloak, ataohik aolapkaeyok, Kigaokmi Polaktoklikivik, ilaani atokpaktun nunanik haneani Umiyan Uheuyakveani (MLA-mi) ilaoni nunan atokniginik LSA-mi, ahelo nuan ilaoni RSA-mi, aoyaotilogo. Pikakton malguknik ihoaktokun monagiyotikni ihoakhaotikniklo atoktaoyonik mikhivaaligutaoyuk ihoetomik aktoknigiyutaolaktonik Havaamin, ikayoktutaoteakniga atogaloakhogo kigoagun piyotikaktonik igilgaan pitkohigigitaenik nunanik ihoakotiniklo atoniginun. Monagiyotin ihoakhaotilo atoktun naniyaolaktun tamakni ilihimayukni Havaam kanoginigini, ukoalo ilageautin ihoakotin pihimayun atokhogin tikoaktaohimayonik ihageagiyaoyonik. Ihoakhaotin tikoaktaoyun piyotikaktoni nipaakniginik hayukniginiklo, hilavlo halomaniganik uvani Nipaaknigagun Nunami Ihoakhaotini Amigiyotiniklo Havaami iloani Agutikhanik Ihoakhaotinik Amigiyotiniklo Opalogaeyaotimi (Makpigaami 10-mi, Oegoani 20), uvanilo Hilam Halomaniganik Amigiyotinik Monagiyotiniklo Opalogaeyaonmi (Makpigaami 10-mi, Oegoani 17).

Aktoknigagun ilitokhaotin tikoakhiyun ataohikmik kigoagun aktoniganik Havaamin VSEC-gini igilgaan pitkohigigitaenik nunanik ihoakotiniklo. Una kigoagun aktokniga nalaotagaoyok haneaneginakniganik nunanik atoknigagun LSA-mi, kanitoaniloak MLA-goyum, agiyugitok aktoknikaktok ikitonik atoktonik taya atoktaoloakgitomi. Una kigoagun aktoniga okaotaoyok hivitovalaaginiganik atonigagun (oyagaktakveotilogo Havaak), kagugugaagan taemaekakaktok, kikloanulo pilakhoni uktukan. Kigulikmik, humeniga talvanetok Havaam inigiyaani kiheani ilakaktokn nunanun ilaoni tunungata nunanik atoknigani LSA-mi. Tamaeni, una kigoagun aktokniga **Ihomalutaovalaagitok** taemaenakuktok. Tunihimayotigiyaan.

Ataotimuktigutaolaktok aktoniganik ilitokhakniga (CEA-mi) pihimayok ihoetok kigoagun Havaamin aktokniga nahogiyaokman. Nunami kiklikhaa nunanik atokniagun CEA-mi ilageakhimayok ilakageagani ukuniga havaanik inoelo hulilogakvenik oalikheani Kitikmeon ihomagiyaoyok aktonikakneaknahogiyaoyok iloani nunanik atoknigagun RSA-mi piyotikaktun taya nunanik atoknigagun hulilogagutinik. Havaamin kigoagun aktonigin igilgaan pitkohigigitaenik nunanik atokniginun ilaleotilakmata kigoagun aktokniginik malguk havaagiyayugaluk, ataohik taya havaak pigahulo hivunikhami havaakhan. CEA-mi naonaegutoayok pivaleanigin Havaam ataohiklo amihulunen ilageagutikhan havaan piyotaolaktok ataohikmik ihoetomik kigoagun ataotimukpaleayonik aktoniganik igilgaa pitkohigigitaenik nunanik atoknigagun; unaloak, aalaguknigin kaoyimayaoyun nunami avataoyomi. Una ataotimukpaleayok kigoagun aktoniga okaotaoyok agivalaaginiganik, hivitovalagitoni, kikloanun aolalakhonilo. Taemaekatakniga kigoagun aktoniganik nahogiyaoyok taemaekataginiganik nunamilo agitilaagan haneaneginakneaktok. Tamaeni, una kigoagun ataotimukpaleayunik aktokniga **Ihomalutaovalaagitok.** Kigoagun ataotimukpaleayonik aktonigin Havaamin igilgaan pitkohenik atogitotik nunanik avatkolimagitok kikligata Nunavumi Nunatakveoyum Nunamin (NSA-min) talvuna, piyotaolimagitok nutpaleayonik aktokniginik.

Atoenaktun Manikhakheogutikhan Nunaniklo Atokniginik

Inoen ilitkohen inuyuhelo ilaleotiteakhimayun nunanun. Inoen Kitkmeonin piyotikaenaktun Inoen Kaoyimayatokaginik, kaoyimaniginiklunen nunanik avataoyomiklo. Atoenakniga nunanik ila agunahoakveovlotik, ikalokheokveovlotik, nanigeaktokveovlotik, katitigiveovlotiklo, atokpaktun humilikaa nunanik atoknigini RSA-mi. Kanitoani kulin 20-nun agunahoakhimaktun agunahoakpaktun kigaokmi nunami (Umikmaktuk/Kigaok Agunahaoktiloan Ilagen 2012-mi). Tuktun, amakun, kalvelo agunahoaktaolakpaktun; kiheani takyomi aguneaktun nattiknik aheniklo umayonik atonakpaktugaloak. Beechey Lake tikitaoloakveoyomayok agunahoaktoin aguneakpaktun uvani nunani agutikhageaktukman, pinikhonilo nunan, atulakhotiklo initukleoyun iglukpanoelo. Pikagaloaktilogo aolakveokataktonik nunami, nunanik atoktun malikpaktun agutikhanik aheagun aolalaagunakhiyun ihomamigun hilam kanoginigagun, aolagutaoyuv, ahenilo piyotaoyonik. Ikalokheokpaktulo nunanik atoktamikni RSA-mi kigaokmi aalatkenilo tatini kukanilo. Ihomagiyaoloaktun ukoa Ikalokpen, ihun, kapihilen, ukan, kanayun, hulukpaogalo. Aalat aguyaovaktun Kigaokmin ukoa amumayun, uviluyakaktun, itkoyan, uplogeatun itonoen, kanageaktonoelo natkamoetan takyoni. Akpen, heknan, kikmiknaen, paongan, mahoet, kaplaen, kigutagiknan, akpelo pukuktoavaktun iloani RSA-goyum (Umikmaktuk/Kigaomilo Agunahoaktin Ilagen 2012-mi; Ikaloktuteami Agunahoaktin Ilagen 2012-mi). Pikaktok kavinikligeak iglukpanoanik Kitikmeoni, nanminigiyaoyolo iglukpanoen, nanigeaktoktulo iglukpanoagin, tupikakvelo aolaenaktonik papagealgin nalageaniklo.

Atoenaktonik manikhakheogutin nunaniklo atoknigin aktoktaolaktun ukunanga: aalagukniginin atoniginik nunanik ihoakotiniklo; aalaguknigin kaoyimayaoniginik manikami avataoyokmik; aalaguknigin amigaenigin humenigilo ihoakotikhan. Pikaktok malguknik monagiyutinun ihoakhaeyotinulo aotktonik ihoakhaotaokmata aktokniginik atoenaktonik manikhakheogutinik, ihoakhaeyotilo Havaam kanoginigagun, ihoaknikhanik monagiyotikhanik, amigiyotiniklo. Atoenakniga nunani hulilogagutinik ayoknaegutineaktok pivikhakakniginin havaktun himaotigekataktun, talvuga talvangalo tikmivaklotik Havaami aolanikaktomi, ikayoktoeyuhenik nunanik atoktun pivaleaniginiklo nunanik atoktun kaoyimayaenik. Ihoakhaotin tikaoktaohimayun piyotikakloaktomik nipaaknigagun hayuknigagulo, hilavlo halomaniga uvani Nipaakniginik Avataoyomi Ihoakhaotinik Monagiyotiniklo Havaami, ilaoni Angutikhanun Ihoakhaotinik Amigiyotikhaniklo Opalogaeyaonmi (Makpigaami 10-mi, Oegoani 17). Atoenaktun tohoamayotin nunagiyaoyoni inuknik nunagiyaoyonetulo hatkigutaoneaktun kagugugaekpan kitulikaa katimakatigilogin katimakatigilogilo Ikaloktuteami Kugluktumilo Nunagiyaoyuni Ihomakhakheoktin Ilagen (CAG-goyun). Tohakvigiyaovakneaktun oyagaktakvikmi havaktonin, nunagiyaoyonin nunanik atoktun, nunagiyaoyuni HTO-goyun hamleoyulo, ukunangalo CAG-nin inmiknin pivageagani atoenaktonik kanogilivaleanigagun ihoakhaklogilo monagiyotinun pitkoheoyun piyageakakan.

Atulikata ihoakhaotin monagiyutilo piyotin, pigahun inuknik aktoknigkaktun VSEC-mi manikhakheogutinik nunaniklo atokniginik tikaoktaoyun: aalaguknigin atokniginik nunanik ihoakotiniklo, aalaguknigin kaoyimayaoliknigank manikami avataoyok, aalaguknigilo amigaenigin humenigilo ihoakotikhan. Katitpaleayun aktokniginik nahogiyaoyun igataomagitun taemaenigin, kikleagulakhonilo. Atuni kigoagun aktoniga hivitogitok (oyagaktakveohimaktilogo Havaak) talvaneginakneakhonilo kitumolikaa Havaam inigiyani LSA-milunen. Tamaeni, ihoetomik kigoagun atiknigin VSEC-ni atokhimaginageagani manikhakheogtuin nunaniklo atoknigin piyotikaktonik **Ihomalutaogitotik,** taemaelilagunakhiyok tunikhimayulo. Ilageagun, ikayuhean Havaamin atoktiyotaohimaalaktok igilgaan atoenageagani nunanik atokniginik agikligeaklogo ayokneaknahogiyaoyomin manikhakheogutin amigaekpaleagin havaktulo manikhaaginik piyotikaktoni Havaamin

Ataotimuktigutaolaktok aktokniganik ilitokhaon pihimayok ila ihoetun kigoagun Havaamin aktoknigin nahogiyaokmata. Okaoheohaktoni, humeniga kiklikhaa nunan atokniginun CEA-mi ilageaktaoyok

ilakaligeagani ukoniga havaanik inoelo hulilogagutaenik oalikheani Kitikmeon ihomagiyaoyok aktoknikalaktogiyaovloni iloani nunani atoknigagun RSA-mi piyotikaktun taya nunanik atoknigagun hulilogaagutinik. Havaamin kigoagun aktoknigin Atoenaktonik Manikhakheogutikhanik Nunaniklo Atoknigagun ilaleotilaktun kigoagun aktoknigiyaolaktomik malguknin taemani havaaknin, ataohikmin taya havaagiyaoyomin pigahulo hivunikhami havaakhan. CEA ihivgeokhiyok pigahunik kigoagun aktoknikakniginik Havaamin: aalaguknigin atokniginik nunan ihoakotilo, aalaguknigin kaoyimayaoniganik nunami avatoayomik, aalaguknigilo humeniginik amigaeniginiklo ihoakotin. CEA-goyok naonaegutiyok pivaleaniganik Havaam ataohiklo amihulunen ilageagutikhan havaan piyotaolaktun ihoatonik kigoagun ataotimukpaleayonik aktoniginik atoenaktonik agunahoaktin. Atuni kigoagun ataotimukpaleayun aktoknigin okagaoyun agivalaaginiganik, hivitovalaagitok, kikloagulakhonilo. Atokatakniga kigoagun ataotimukpaleayonik aktokniginin nahogiyaoyok taemaekataginiganik nunamilo humeniga una RSA-mi. Tamaeni pigahun kigoagun ataotimukpaleayun aktoknigin atuni naonaeyaktaoyun ila **Ihomalugiyaogitoni** taemaeneaktuyaakhonilo. Tunikhiyun kiteanetuyaaktok Tuniktohiyotin akunganeoyun pihimayok ikayutaoyaagani una nalohoektaoyok.

Kitikmeoni nunanik atoktun okagitun aolagutinik hilataani NSA-goyum piyotikaktonik atoenagegani agunahoaknik. Taemaenman, Havaak pilimagitok nutiknigini aktokniginik atoenaktonik nunanik atoktonik.

Nikaenaen

Nikaenaen agutikhan, naotean, halomaelgulo atoktaoyun inuknin nikaovlotik monakhiyutaovlotiklunen aneaktonin katitigaoyun agunahoaknikun, ikalokheoknikun, pukuknikulunen naoteanik (Aneaktaelinikun Kanatami 2010-mi). Ukoa nikin atoknikaktun nikikateagutinik, havaotikakhotiklo, aginikhaovlotiklo ilitkohikmi igilgaalo atokniginik. Inoen pivaktun nikaenaknik aguneakhotik, nankigeaktokhotik, paongaktakhotik, mahuktakhotik, havaotikaktoniklo naoteanik nikaenaknin LSA-mi, ikalokheoknikulo iloani atpanilo kukan uvani nikaenaknik LSA-mi aktoktaolaktun halomaniginik nikaenaen nigiyatik.

Halomanigin nikaenaen piyotikateaktok halomaniganin haneani avataoyomik (ila, nunaenak, immak, naotealo). Halomaelguvaloen katitikpaleayun avataoyomin talvanelaktun nikaoyun nikaeni nikaenaen nigiyaovaktun inuknin. Pikalakniga ihoetomik aktokniganik inukni nigivaktoni halomaelgukakata nikaenaen piyotikaktok kanogaalok halomaenikakniganin, kitulo agitilaagalo nikaenaom nigiyaoyum (ila, mahoen naotealunen, nukeni amea tiguklunen), ukeokaknigalo nigiyum (ila, piholihaak inikniklunen), kanogaalok aktiginiganik nikaoyum, kagugugaagalo nigiyaovakniga.

Pikagitok humugaoyoetonik inuknik inuyutikaktonik nikaenaknik nigivlotik LSA-mi; kiheani, ilaga ukeogani hivigitomiklo atoktaoigin nunanik takukhaovaktok (takologo Nunanik Atokniga, Makpigaami 8, Oegoani4). Inoen inuyun nikigiloaktaen agunahoaknikun nikaenaen atokataenagunakhiyun nunanik (nuna atoktaokatagitkaloaktilogo) unalo, taemaenman, ihomagiyaoloaktun ilitokhaotini.

Kaveoyuknakhiyun Halomaelguvaloen Ihomalutaolaktun (COPC-goyun) takukhaolaktun nikaenaknik LSA-mi oyagaktakveotilogo Havaak ukoalo ilaleotiyutin atoktun oyakikivikmi, halomaelgun halomaktigaoyoni anaguni kagaktitaotinilunen puyoen, okhovaloelo. Ilageagun, kimagaoyun hunalikaa ignikotinin ila PAH-goyun, dioxins-lo, puyoelo ikumayun akhalutin ikolatiyotilunen. Ukoa halumaegutilaktun ilitokhagaoyun aktoknigilaktaelo okaotaoteaktun amihoni ihomagivlogin ihoakhaotikhan monaigiyutikhanulo atuligumayaen, atokhogilo ihoaknikhan ihomaleogutin. Havivalokakpaktun inminik nikaenaen LSA-mi, ilani agitilaagin avatkuyutivaktun maligoagakhanik kiklikakniginik (ilalo nunaenakmi), inmiknik, timimigun nunamilo piyotinik. Havaagiyaoyomayok haviknik oyagaktakveokman havivaloknik pikaknigin avatoayum aalagulaktun Havaak pivaleakpan, havivaloen tikoaktaoyun kanogaalok ilitokhakniganik aktoknikalaknikata halomaniginik nikaenaen. Iloengaomayun ihoakhaotin monaigiyotinulo atuktun talvaneneakun mikinikhaoyaagani

ahivageaganiluenn aktoknigilaktaen avataoyomik kanoginiganik (hilam, immam, natkanetun imavalokni, nunaenak, naotealo) nikaenaelo inmigun (ikaloen agutikhalo). Ukoa okateaktaoyun Makpigaami 4 (Kilaenakmi Avataoyok), Makpigaak 5 (Nunami Avataoyok), Oegoani 6 (Imiktaakan Avatigiyaen), Makpigaani 5 (Nunami Avataoyok), Makpigaak 6 (Imiktaakhan Avataoyok, Makpigaami 7 (Takyomi Avataoyok), unalo Makpigaak 10 (Monaginigagun Opalogaeyaotin).

Atokata nikaenaen naonaepkotikhanik ilitokhakniganik kanogilinigagun, nikigiyaonigin nikaenaen nikaenaknik LSA-mi takukhaoyun aneagutaolaeniginik tikoaktaohimayonin COPC-nin nunagiyaoyoni inukmin nigiyomin ilagikmagu naonaepkotin kanoginigini. Atokata halomanigin amigaenigilo naonaegutaoyun aktokniginik ilitokhaon, halomanigin nikaenaen alagukpalaalimagitok naonaeyaotini kanoginiganin. Talvuna, inoen aneaginigin nigikpata nikaenaknik iloanin nikaenaen LSA-mi alagukneaknahogiyaogitok taotuktaokpata naonaeyaotinni kanoginigin. Kigoagun aktokniginik nalvagitun anealakiyotigigitaelo inoen nigiyun nikaenaknik nahogiyaoyun piyotaoyonik Havaami hulilogagutinin pikotinilunen havakveotilogo Havaak. Pikaginman nahogiyaoyonik Havaamin Kigoagun aktoknigiyaenik, pikagitokn ataotimukpaleayukhanik aktokniginik nutpaleayoniklunen aktokniginik. Tamaeni aktoknigiyaa Havaamin VEC-ni nikaenaknik **Ihomalutigiyaogitok.**

Inoen Aneaginigin Avataoyomiklo Ihomalutaoyok llitokhakniga

Inoen aneaginigin avataoyoklo ihomaluktaoyok ilitokhaknigin ilakaktok tamatkeomayonik kiguligeniklo havaohiknik ihoakhakhimayun tikoakhiyaagani, ilitokhaklogin, naonaeyateaklogilo aktoknigin Havaamin avataoyomik inoelo aneaginiginik. Hivulen ilitokhaotin ihivgeokhiyun taya kanogaalok halomaelgukakniginik nipaakniginiklo talvani haneanilo nunani Havaamin inikhiyaagani naonaeyaotikhamik ilitokhaelikan hivinikhami aktoknigilaktaenik Havaam kanogituniganiklo kahaktaotinagun nunan ila utiktitaagani ilitkoheanun havaakhanik. Ilagani ineon aneagitaagani avataoyoklo ihomalutaoyok ilitokhakniga, naonaepkotin ihivgeoktaoyun hilam halomaniganik; imiktaakhanik heokalo natkani halomaniginik; takyomi imakmik natkanilo heokan; imiktakvikhanilo umayuvaloen, ikaloen, angutikhalo; nunaenak naotealo; manikaveoyun angutikhan; nikaenaen; nipaknigalo.

Avataoyomik ihomalugiyaoniganik ilitokhaon tikoakhiyok 13-nik Atokloaktonik Nunami Pikaniginik (VEC-ni) atoknikaktun ilitokhanigagun Havaamin aktokniganik avataoyokmik namateakniganik piyotikaktonik imiktaakhan avatigiyaani, takyum avatigiyaani, manikamilunen avataoyok. Inuknik aneagitaagani ihomalutaoyomik ilitokhakniga piyotikakloaktok hitamanik VEC-nik ilitokhageagani aktoknigin Havaamin ineon aneagiyuhenik: unaloak hilam halomaniga, imagiknigin, nikaenaen nigiyaoyun, nipaakniklo. Avataoyomik ihomalugiyaoniganik ilitokhaon halumaelgutinik naniyaoyonik pikagitok Havaamin piyotikaktonik Halomaelgunik Ihomalutaolaktonik (COPC-nik). Talvuna, ihomalutaoyageakagitok Havaamin aneaginiginun ikaloen imakmeotalo nunagiyaenik, ikalokakniginik, angutikhan, tikitpaktun tikmiyan, nikanaktotulo VEC-gani. Inuknik aneagitaagani ihomaloknaknigani ilitokhaon halomaelgunik naonaegutaoyok ihomaluknakpalaagitok inuknin Havaami iglukakveani. Aneagutaolaktun aktokniginin ilakalaktun kukulakiniginik anikhagutinik igeaga puvaelunen. COPC-nik nanihigitun aalagugutaolaktomik imigakhanik immakni nikaenakniklunen ihomagikpata naonaepkotiloan kanoginigin. Kigulikmik, inoen aneaginigin avataoyoklo ihomaloknaknigagun ilitokhaon nipaakniganik naonaegutaoyok una Havaak iloanenigaktaoyok tohayaoyagani nipakniga ihoakhenageakaktok iglukpaen hanayaoniginin kanoginiginilo.

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Appendix V8-6E. Predicted Metal Concentrations in Soil from Dust Deposition for Sites within the Terrestrial Environment Local Study Area

Appendix V8-6F. Predicted Metal Concentrations in Lichen (*Cladina stygia* and *Stereocaulon paschale*) and Sedge (*Carex aquatilis*) due to Root Uptake of Metals from Soil and Direct Deposition of Metals in Dustfall for Sites within the Terrestrial Environment Local Study Area

Appendix V8-6G. Predicted Metal Concentrations in Bog Blueberry (*Vacciunium uliginosum*) and Bog Cranberry (*V. vitis-idaea*) due to Root Uptake of Metals and Direct Deposition of Metals in Dustfall for Sites within the Terrestrial Environment Local Study Area

Appendix V8-6H. Predicted Metal Concentrations in Lichen (*Cladina stygia* and *Stereocaulon paschale*) and Sedge (*Carex aquatilis*) for Sites within the Terrestrial Environment Local Study Area

Appendix V8-6I. Predicted Metal Concentrations in Bog Blueberry (*Vacciunium uliginosum*) and Bog Cranberry (*V. vitis-idaea*) for Sites within the Terrestrial Environment Local Study Area

Appendix V8-6J. Predicted Metal Concentrations in Air at George and Goose Camps

Appendix V8-6K. Predicted Water Quality in Lakes of the Goose and George Property Areas within the Human Health Risk Assessment Local Study Area due to Direct Deposition of Metals in Dustfall

Appendix V8-6L. Predicted Metal Concentrations in Soil from Dust Deposition for Sites within the Human Health Risk Assessment Local Study Area

Appendix V8-6M. Predicted Metal Concentrations in Lichen (*Cladina stygia* and *Stereocaulon paschale*) and Sedge (*Carex aquatilis*) due to Root Uptake of Metals from Soil and Direct Deposition of Metals in Dustfall for Sites within the Human Health Risk Assessment Local Study Area

Appendix V8-6N. Predicted Metal Concentrations in Bog Blueberry (*Vacciunium uliginosum*) and Bog Cranberry (*V. vitis idaea*) due to Root Uptake of Metals and Direct Deposition of Metals in Dustfall for Sites within the Human Health Risk Assessment Local Study Area

Appendix V8-6O. Predicted Metal Concentrations in Lichen (*Cladina stygia* and *Stereocaulon paschale*) and Sedge (*Carex aquatilis*) for Sites within the Human Health Risk Assessment Local Study Area

Appendix V8-6P. Predicted Metal Concentrations in Bog Blueberry (*Vacciunium uliginosum*) and Bog Cranberry (*V. vitis idaea*) for Sites within the Human Health Risk Assessment Local Study Area

Acronyms and Abbreviations

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Acronyms and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AANDC	Aboriginal Affairs and Northern Development Canada
ACIA	Arctic Climate Impact Assessment
AEMP	Aquatic Effect Monitoring Plan
asl	above sea level
ASTDR	Agency for Toxic Substances and Disease Registry
ASTt	Arctic Small Tool tradition
ATV	all-terrain vehicle
BIPR	Bathurst Inlet Port and Road
BP	Before present. A term used to refer to the antiquity of archaeological materials or cultures. Generally, BP is recorded in relation to 1950.
BTF	biotransfer factor
BW	body weight
CAG	community advisory group
CCME	Canadian Council of Ministers of the Environment
CEA	Cumulative Effects Assessment
CHARS	Canadian High Arctic Research Station
CLO	community liaison officer
CMC	Canadian Museum of Civilization
Co-op	co-operative
COPC	contaminant of potential concern
CWB	community well-being
DFO	Fisheries and Oceans Canada
DHSS	Government of Nunavut Department of Health and Social Services
EDI	estimated daily intake
EFAP	Employee and Family Assistance Program
EIS	Environmental Impact Statement
ELDE	estimated lifetime daily exposure
ER	exposure ratio

FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GN	Government of Nunavut
GN-DCH	Government of Nunavut Department of Culture and Heritage
GPS	global positioning system
HQ	hazard quotient
HTO	Hunters and Trappers Organization
IIBA	Inuit Impact and Benefit Agreement
ILCR	incremental lifetime cancer risk
INAC	Indian and Northern Affairs Canada (currently known as AANDC)
IOL	Inuit Owned Land
IQ	Inuit Qaujimajatuqangit
IRIS	Integrated Risk Information System
JECFA	Joint FAO/WHO Expert Committee on Food Additives
KHS	Kitikmeot Heritage Society
KIA	Kitikmeot Inuit Association
Lithic	Made of stone.
LSA	Local Study Area
ML/ARD	metal leaching/acid rock drainage
MLA	Marine Laydown Area
MOU	memorandum of understanding
NAC	Nunavut Arctic College
NAHO	National Aboriginal Health Organization
NBCC	Nunavut Business Credit Corporation
NDEDT	Government of Nunavut Department of Economic Development and Transportation
NHC	Nunavut Housing Corporation
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Lands Claims Agreement
NLUP	Nunavut Land Use Plan
NPC	Nunavut Planning Committee
NSA	Nunavut Settlement Area
NSSI	Nunavut Sealift and Supply Inc.

NTCL	Northern Transportation Company Ltd.
NTI	Nunavut Tunngavik Inc.
NTKP	Naonaiyaotit Traditional Knowledge Project
NU	Nunavut
NWT	Northwest Territories
PAG	potentially acid generating
PAH	polycyclic aromatic hydrocarbon
PDA	Potential Development Area
Project	The proposed Back River Project.
PTWI	provisional tolerable weekly intake
RCMP	Royal Canadian Mounted Police
RfD	reference dose
RIA	Regional Inuit Associations
RMWI	Recommended Maximum Weekly Intake
RNFB	Revised Northern Food Basket
RSA	Regional Study Area
SEMP	Socio-economic Monitoring Plan
STI	sexually transmitted infection
TCWR	Tibbitt Contwoyto Winter Road
TDI	tolerable daily intake
TEA	Transboundary effects assessment
TIA	Tailings Impoundment Area
TK	traditional knowledge
TRV	toxicity reference value
US EPA	United States Environmental Protection Agency
VEC	Valued Ecosystem Component
VSEC	Valued socio-economic component
WHO	World Health Organization
WMF	water management facility

1. Archaeology

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1. Archaeology

1.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

The Back River Project (the Project) is located in the Kitikmeot region of Nunavut. The Project includes the Goose Property, the George Property, and a Marine Laydown Area situated in the southern portion of Bathurst Inlet, and connecting winter roads. The mine plan for the Project is a 10-year operating mine life based on currently known resources, though continued exploration may extend projected mine life. A combination of open pit and underground mining methods will be used for mineral extraction. Waste rock will be stored in designated storage areas on the surface or backfilled in mine workings at both properties. Tailings from the mill will be stored in a single Tailings Impoundment Area (TIA) in the area of the mill.

Potential Development Areas (PDAs) have been identified for the Goose Property, the George Property, and the Marine Laydown Area. Since the Project design is at the conceptual phase, the actual footprint of the facilities are likely to shift within these PDAs as further geotechnical investigations are undertaken and the design of the facilities is finalized. The PDAs makes allowances for potential relocation of certain facilities within their boundaries. For VSEC archaeological sites it is assumed that the entire area of the PDA will be disturbed.

The baseline data used to determine the effects of the Project on the VSEC archaeological sites are discussed below.

1.1.1 Territorial and Federal Legislation

All archaeological and paleontological sites in Nunavut are protected under territorial or federal legislation. Archaeological and paleontological sites are protected under Section 51 of the *Nunavut Act* (*Nunavut Archaeological and Paleontological Sites Regulations 2001)*. In addition, archaeological sites and as yet unrecorded archaeological sites found on federal Crown Land are protected by the *Territorial Land Use Regulations* of the *Territorial Lands Act* (2013) and by the *Canada Oil and Gas Operations Act* (*Canada Oil and Gas Geophysical Operations Regulations 2012*).

Permits to conduct archaeological and paleontological research throughout Nunavut are applied for and issued under the *Nunavut Act* (*Nunavut Archaeological and Paleontological Sites Regulations 2011*). In addition, work conducted on Inuit Owned Lands or within the Nunavut Settlement Area should be conducted in accordance with Articles 21 and 33 of the *Nunavut Land Claims Agreement* (1993).

Locational information pertaining to archaeological sites is protected by a Data Licence Agreement issued by the Government of Nunavut. A condition of the data license stipulates that archaeological sites will not be plotted on a map which could be made available to the public unless the scale of the map is less than or equal to 1:2,000,000 and the positional accuracy has been randomized. Due to these restrictions no maps depicting archaeological site locations are included in this document.

1.1.2 Ethnographic Background

The primary resource consulted for ethnographic information is the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp.'s Back River (Hannigayok) Project* (KIA 2012) as this is the most detailed and geographically relevant study pertaining to the region. The study was prepared on behalf of the Kitikmeot Inuit Association's Land and Environment Department for Sabina Gold & Silver Corp.'s (Sabina's) Back

River Project, and used oral data collected between 1995 and 2000, that was subsequently verified through a series of workshops. This study is also referred to as the Naonaiyaotit Traditional Knowledge Project (NTKP; KIA 2012).

Additional literature consulted includes Nunaga: Ten Years Among the Eskimo by Duncan Pryde (1971); Thunder on the Tundra: Inuit Qaujimajatuqangit of the Bathurst Caribou by Natasha Thorpe et al. (2002); Fur Trade Posts of the Northwest Territories, 1870 - 1970 by Peter Usher (1971); archaeological studies by Keith and Stewart (2005), Mathiassen (1927), and Morrison (1978, 1979); ethnographic and ethno-historic accounts by Boas (1964), Franklin (1823), Hearne (1911), Jenness (1921, 1922, 1923a, 1923b, 1928, 1946), Rasmussen (1932), and Savard (1966). Ethnographic research has been conducted in this region since the early 20th century and more detailed ethnographic information can be found in Damas (1972, 1984), Jenness (1921, 1922, 1923a-c, 1924a, 1924b, 1928, 1944, 1946), Roberts and Jenness (1925) and Savard (1966), Stefansson (1914, 1919, 1921). Additional ethnographic information can be found in Boas (1964), and Birket-Smith (1959).

1.1.2.1 Cultural Setting

The Inuit of the Central Arctic (or Kitikmeot) are the known as the Kitikmeot. The Kitikmeot were previously referred to in the ethnographic literature as the “Copper Inuit” because early Europeans noted their use of native copper found in their lands to fashion tools and other objects (KIA 2012). Their territory includes: portions of Victoria and Banks Islands; the Barren Lands south to the Back River; Beechey Lake west to Contwoyto Lake; and extends from Wise Point, west of the Coppermine River and east to Perry River (Damas 1984). Their dialect is considered to be in the Inuit-Inupiaq (Eastern Eskimo) division, one of the major languages of the Eskimo Aleut language family (Woodbury 1984). The NTKP divides the Kitikmeot of western Kitikmeot into three regional groups: the Ocean Inuit, Nunamiut, and Kiligiktokmiut. The Ocean Inuit lived in coastal areas north of the Project area, and their lifeways focused on marine resources such as seal. The Nunamiut lived in the tundra west of the Project area and focused on terrestrial resources, primarily caribou. The third group, the Kiligiktokmiut, are the Kitikmeot group most closely associated with the Project area and, consequently, are the focus of the following discussion.

Kiligiktokmiut translates as “people of the small stiches” because of their skill at sewing (KIA 2012). Their traditional land use encompasses all of Bathurst Inlet and many of the surrounding drainages, including the Hood, Burnside, Western, Ellice, and Perry rivers (KIA 2012).

Samuel Hearne’s encounter with the Inuit in 1771, when he travelled to the Central Arctic on behalf of the Hudson’s Bay Company, is the first reported European contact with people in this area (Hearne 1911). Hearne also encountered a large group of aboriginal people he called Copper Indians hunting deer as they crossed the Coppermine River. This group provided him with information regarding the mouth of the river.

Many of the late 19th and early 20th century accounts of Inuit life were documented during expeditions undertaken to establish Canada’s sovereignty in the Arctic. In the early 1900s Vilhjalmur Stefansson conducted several research projects amongst the Inuit. He documented much of the seasonal round of the Copper Inuit who, as well as hunting seal and whale along the coast also travelled as far as Great Bear Lake to hunt and collect wood in the summer (Stefansson 1914). Stefansson documented 125 Inuit camped west of the mouth of the Coppermine River in late May. The majority of this group were heading south to Dismal Lake and Dease River, though a few families were going to hunt caribou around the Rae River and another group would spend the summer fishing at Bloody Falls (Stefansson 1921). According to A.P. Low, who voyaged with the Neptune in 1903, the Inuit would move south in September to hunt the Barren Lands caribou only returning to the coast when enough snow had fallen

to make the return trip on dog sleds (Low 1906). The intensive fur trading activities that would change the seasonal round of the Copper Inuit did not occur in the region until the 1920s when trading posts were established near Bathurst Inlet (Neatby 1984).

The introduction of fur trade posts and missionaries in the central Arctic Coast during the 1910s and 1920s resulted in rapid and profound changes to the lives of the Copper Inuit (Jenness 1946, Thorpe et al. 2002). However, the Kitikmeot already had some exposure to the fur trade and access to some European goods through trade with the Dene to their south (Rescan 2007).

With the introduction of the fur trade, many Kitikmeot families now incorporated into their seasonal round visits to a post at Christmas and Easter to trade. By the 1940s and 1950s, they had begun to travel less and were spending more time at settlements in the Bathurst Inlet area, including Kingauk (Bathurst Inlet), Katimanik (Arctic Sound) and Omingmaktok (Bay Chimo). This move was in part due to the increasing availability of small motorized watercraft which facilitated travel during the summer months. By the 1960s, rather than following the caribou herds far south during the winter, they wintered at the government-serviced communities at Ikaluktuuttiak (Cambridge Bay) and Kugluktuk (Coppermine) where there was access to better housing, schools, and medical services (Thorpe et al. 2002).

1.1.2.2 Kiligiktokmiut Traditional Knowledge

Due to their geographical position near Bathurst Inlet and Beechey Lake, the Kiligiktokmiut could harvest a range of terrestrial and marine resources, most importantly caribou and ringed seal. This contrasts with the neighbouring Kitikmeot groups: the marine-focused Ocean Inuit and the terrestrial-focused Nunamiut (KIA 2012).

The Kiligiktokmiut had access to the mainland Bathurst caribou herd throughout most of the year; however, during winter months only a portion of the herd wintered in the Kiligiktokmiut area around Beechey Lake, while the remainder of the herd wintered north of the Kiligiktokmiut area (KIA 2012). The NTKP describes the movement of caribou as frequently changing and of variable distribution across the landscape (KIA 2012); however, the herd's main calving areas are consistently described as being in southern Bathurst Inlet and at Beechey Lake (KIA 2012). Other species were also hunted to supplement caribou, including muskox, ground squirrel, hare, and waterfowl. Fishing was common during the spring and fall, with Arctic char being the main species fished (KIA 2012). Campsites were often located along lakes and streams to take advantage of fishing opportunities. The Kiligiktokmiut used small shrubs for wood (KIA 2012). No important sources of copper or carving stone were noted within the Kiligiktokmiut area in the NTKP study.

Traditionally, the Kiligiktokmiut were highly mobile, travelling long distances in small groups seeking widely distributed resources. They lived in temporary camps consisting of igloos in the winter and tents made from animal skins during the summer (KIA 2012). Maps in the NTKP report show the communities of Kingauk (Bathurst Inlet) and Omingmaktok (Bay Chimo) as focal points for travel throughout the region, with intensive use of southern Bathurst Inlet, Bathurst Lake, the Western River and Beechey Lake for travel, gathering and camping (KIA 2012). One informant described camping for nine nights as they travelled on foot from Beechey Lake to the community of Bathurst Inlet, a distance of approximately 160 km (KIA 2012).

Kiligiktokmiut lifeways changed during the 1900s with their increasing participation in the fur trade. The Kiligiktokmiut began incorporating trips to fur trade post into their annual travels. The fur trade introduced them to new types of European goods including foods, tobacco, tools, firearms, and snow machines, as well as Anglican and Catholic missionaries (KIA 2012). However, the first permanent community in Bathurst Inlet, called Bathurst Inlet (or *Kingoak*), did not exist until the establishment of

a Hudson's Bay Company fur trade post during the 1920s. Animal species that were previously of marginal importance to the Kiligiktokmiut, such as wolverine, became more widely trapped and traditionally trapped species, such as fox, became more intensively harvested (KIA 2012).

1.1.2.3 Kiligiktokmiut Land Use within the Project Area

The following sections summarize Kiligiktokmiut traditional knowledge within the Project area, divided into four main geographic areas: 1) Southern Bathurst Inlet, 2) Bathurst Lake, 3) the Western River, and 4) the Goose, George and Beechey lakes area.

Southern Bathurst Inlet

The NTKP study documents extensive use of the southern portion of Bathurst Inlet by the Kiligiktokmiut as a travel, resource gathering and camping area. Southern Bathurst Inlet is a main calving area for the Bathurst caribou herd, and this in turn attracts a number of other species, in particular grizzlies and wolves (KIA 2012). An area where ringed seals were hunted is mapped in Bathurst Inlet east of the proposed Marine Laydown Area (KIA 2012), and Bathurst Inlet is described as a well-known area for hunting wolves (KIA 2012).

The NTKP study identifies a major nadlok (a narrowing in a body of water where caribou swim across during the ice-free season) in Bathurst Inlet that includes the [DW2]proposed Marine Laydown Area (KIA 2012). A nadlok is a narrowing in a body of water where caribou swim across during the ice-free season and, because of this, are important hunting and camping areas (KIA 2012). This method of hunting is described in Keith and Stewart (2005):

> *Other hunters would be hiding in the qajaq [kayak] at the water's edge for the caribou to enter and begin crossing the lake. Once they were committed to crossing, the hunters would move behind the animals and spear them using a caribou lance called a kaput* (2005:14).

Keith and Stewart also note that Diamond Jenness believed that Bathurst Inlet had a relatively large number of kayaks due to the prevalence of this hunting method (Jenness 1922; Keith and Stewart 2005).

Two fur trade posts are identified in Southern Bathurst Inlet in the NTKP study. One is mapped on the first point of land on the eastern side of the inlet, several kilometres north of the mouth of the Western River. This post corresponds to historic and prehistoric archaeological site McNj-28 recorded by Rescan during baseline studies for the Project, and is likely one of the earliest Hudson's Bay Company posts in the inlet, dating to the 1920s (KIA 2012; Usher 1971). The second post is mapped on a point of land on the western side of the inlet, within the proposed Marine Laydown Area. This post has a place name associated with it (*Tikighik*); however, this name is not defined in the NTKP study (KIA 2012).

A number of "major camps" are described as being on both sides of Bathurst Inlet, but their locations are not defined further (KIA 2012). These camps may be associated with some of the archaeological sites that have been recorded along the shores of the inlet, as many of these have a historic component. In particular, Fishing Creek and Fishing Lake, located outside of the proposed Marine Laydown Area to the northwest and west, is identified as an important camp area and grave site (KIA 2012).

Bathurst Lake

Bathurst Lake is described as an important camping area and caribou calving area (KIA 2012). The lake is important for trapping foxes and fishing Arctic char (KIA 2012). Grizzlies are mentioned as being

numerous around Bathurst Lake. Specific camps described in the NTKP study include one on an esker south of the lake, and another at the north end of the lake where families wintered (KIA 2012). Additionally, a trading post is described as having been located at the southern end of the lake (KIA 2012). The camp at the north end of the lake may be the Tahikaffaaluk Site (McNk-3 to McNk-13) described in detail in Keith and Stewart (2005). The site has numerous features including dwellings, caches, hunting features, and cooking and food preparation areas. There are discreet domestic and hunting areas, divided by bedrock ridges (2005). Keith and Stewart estimate that the site predates 1920s or 1930s, as there were no artifacts to indicated reliable access to Western goods.

Western River

The Western River was an important travel corridor to Beechey Lake and important camping areas are located on both sides of the river and at its mouth (KIA 2012). An important nadlok is located at a rapids on the Western River, east of Bathurst Lake, where caribou would sometimes die if the water was too rough to cross (KIA 2012). Caribou could also die if they got stuck in the cliffs that border the Western River Valley (KIA 2012). Arctic char from the Western River were fished by hook and bait and grizzlies are described as numerous within the valley (KIA 2012). It is noted that "trees" (likely willow) are plentiful within the Western River Valley (KIA 2012:64), and because wood is very scarce within the Kiligiktokmiut area, prehistorically, the valley may have been an important location for gathering this resource. However, to date, there has been very little archaeological study of the Western River Valley. There are currently five sites (McNj-4, McNj-5, McNj-14, McNj-16, and McNj-42) recorded near the mouth of the river, including both historic and prehistoric hunting and camping sites. Two large historic camp sites (LkNh-1 and LkNh-2) recorded by Campbell (1975) 70 km upstream on the Western River do not correspond to any specific sites identified in the NTKP study.

Goose and George Property Areas, and Beechey Lake

While the NTKP study does not contain much traditional knowledge specifically relating to the Goose and George property areas, Beechey Lake, located to the south, was an important area for the Kiligiktokmiut. Beechey Lake is essentially a widening of the Back River and the area is a major calving ground for the Bathurst caribou herd (KIA 2012). Caribou pass through the Beechey Lake area around August but would also spend the winter here because the snow was less deep due to the rocky terrain in the area (KIA 2012). Specific named camping areas are identified along Beechey Lake including Tudlak, Hannigayok, Kongok and Papegak (KIA 2012), several of which are identified as sites where families would overwinter. Beechey Lake is also identified as an important fox hunting area and a fishing spot where people would net for grayling, codfish, longnose sucker, lake trout and whitefish (KIA 2012). The Goose and George property areas are described primarily as part of the travel corridor between Beechey Lake and other areas like Bathurst Inlet (KIA 2012). Archaeological sites (LiNj-2, LjNj-2 to LjNj-6, LjNi-3, and LjNi-4) have been identified within the Tudlak, and Hanningayok areas suggesting repeated use dating back to the prehistoric period.

1.1.2.4 Summary — NTKP and Cultural Heritage Resources

The NTKP study adds to our understanding of known archaeological sites in the Project area, and identifies specific land use sites and areas that may have potential for archaeological sites. The most intensive land use occurred along Bathurst Inlet and up the adjacent river systems (KIA 2012). The Kiligiktokmiut were highly mobile "multi-taskers" (KIA 2012), who began residing in permanent settlements only after the establishment of Hudson's Bay Company posts after the 1920s. Seasonal activities focused on hunting caribou and ringed seal, but the Kiligiktokmiut were by necessity flexible and opportunistic, supplementing their diet with fish, birds, muskox, Arctic hare, and ground squirrel, as needed. Numerous activities would take place simultaneously while travelling the landscape, and

makes separating Kiligiktokmiut activity areas into "travelling areas," "gathering areas" or "camping areas" an inaccurate depiction of their land use.

The NTKP study also speaks to the archaeological visibility of some land use activities. Kiligiktokmiut fishing methods included the use of stone weirs on many the region's rivers and caribou hunting often involved the construction of *inokhok* ("inukshuk" and "inuksuk" are other common spellings) and *talo* (hunting blinds; KIA 2012). Such stone features should still be highly visible on the landscape today. During summer months the Kiligiktokmiut lived in skin tents, which would have been weighted down with stones resulting in the tent rings that are commonly found at archaeological sites in the region. In contrast, at winter camps where igloos were used, only stone hearths might remain (Ramsden and Murray 1995). The old burial practices described in the NTKP study are surface graves where the deceased is wrapped in caribou skins and positioned facing north (KIA 2012). Such a practice would leave little trace archaeologically. At grave sites near the community of Bathurst Inlet skeletal remains on the ground surface and animal savaging is described (KIA 2012).

1.1.3 Regional History

1.1.3.1 Early Exploration of the Arctic Coast — 1700s to 1870

This section describes the earliest European incursions into the central Arctic of Canada, and in several instances into the Back River Project area.

Samuel Hearne

The earliest exploration of the region was by a Hudson's Bay Company expedition lead by Samuel Hearne between 1770 and 1772. Employing Dene and Cree guides, Hearne led an overland expedition from Fort Prince of Wales on Hudson Bay, proceeding northwesterly, up the Coppermine River, and reaching the Arctic Ocean at Coronation Gulf (Hearne 1911).

John Franklin

Between 1819 and 1822 John Franklin, an officer in the British Royal navy, led an overland expedition to map the Arctic coastline east of the Coppermine River (Franklin 1823; Houston 1994). On August 5, 1821, travelling south by canoe, the expedition reached the southern tip of Bathurst Inlet. Franklin named the outlet of the river at the tip of Bathurst Inlet after George Back, a member of the expedition. The expedition was plagued by inclement weather and logistical problems resulting in supply shortages and the loss of half the party to famine (Houston 1994).

George Back

The first survey of Back River was undertaken by its namesake George Back in 1834. In 1833, George Back returned from Europe to launch an expedition in search of Captain John Ross and the crew of the *Victory* which had gone missing in 1829 while attempting to locate the Northwest Passage. Back believed that, if stranded, Ross would be taking refuge at Fury Beach where stores of supplies were left when the *Fury* was abandoned in 1825. A secondary goal of the expedition was continued mapping of uncharted areas of the Arctic coastline east of Point Turnagain. Back was under orders to begin returning by August to ensure he had returned before winter set in. In October 1833 they received word that Ross and survivors of his crew had returned to England, having been rescued by a whaling ship, and Back's expedition became entirely one of exploration. Back's expedition was launched from Fort Resolution on Great Slave Lake and proceeded northeasterly reaching Back River and descending the river and its treacherous rapids by canoe. At that time the outlet of the river was suspected to be at the southern end of Bathurst Inlet, where in 1821 John Franklin had named a river emptying into the inlet Back River after Back, previously a member of his crew. However, Back discovered that these

were not the same rivers; the "Back River" he followed in 1834 empties into Chantry Inlet, east of Bathurst Inlet. The name of the river that empties into Bathurst Inlet was subsequently changed to the Western River (Back 1836; Steele 2003).

Canadian Arctic Expedition

In 1913, the Canadian government, motivated by the desire to establish Canadian sovereignty over the Arctic region, funded the Canadian Arctic Expedition, a multi-disciplinary exploration and research expedition of the Arctic. The expedition lasted from 1913 to 1918 and was directed by Vilhjalmur Stefansson, an explorer and anthropologist who during a previous trip to the Arctic in 1910 had "discovered" the Copper Inuit peoples of the Coronation Gulf, and the Dolphin and Union straits areas. The Canadian Arctic Expedition was divided into two parties; a northern party led by Stefansson and a southern party led by zoologist Dr. Rudolph Anderson. The southern party included young anthropologist Diamond Jenness who beginning in August 1914 spent two years conducting ethnographic fieldwork with the Copper Inuit. The ethnographic information collected by Jenness is the earliest from the Back River Project area and, because it was conducted several years prior to the introduction of the fur trade into the region, describes a people whose culture had been minimally affected by European influences (Stefansson 1914; Jenness 1922, 1946).

Northwest Mounted Police Bathurst Inlet Patrol

In 1917 the Northwest Mounted Police (now Royal Canadian Mounted Police) launched a second attempt at conducting a patrol of Bathurst Inlet to investigate the two murders allegedly committed by Inuit men at Bathurst Inlet in 1911. The first attempt in 1914 had been a failure due in part to the officers' lack of experience in the Barren Lands. The second attempt in 1917 was an extensive operation led by officers Francis H. French and Thomas B. Caulkin. The patrol was conducted by dogsled with the party comprised of the two officers and four Inuit guides. They departed from the Baker Lake police detachment at Hudson Bay in March 1917 and reached Bathurst Inlet in May 1917. The officers were able to confirm from the Inuit living at Bathurst Inlet and Bernard Harbour that the murders were acts of self-defence. No arrests were made. The return trip took several months on dog sleds, arriving in Baker Lake on January 29, 1918 (Hulgaard and Welsey White 2002; Arctic Institute of North America 2012).

1.1.3.2 Rise of the Fur Trade on the Arctic Coast — 1870 to 20th Century

In 1870 there were no fur trade posts along the central Arctic coast, and only nine posts within all of present-day Northwest Territories and Nunavut. The nine posts were all located within the Mackenzie Valley (Usher 1971). Though between 1889 and 1907 American whalers were operating along the Arctic coast as far east as Cape Parry, they had not reached as far as Bathurst Inlet. During their whaling trips some of these whalers began to engage in fur trading with the Inuit as a side business (Usher 1971). In 1906, Roald Amundsen completed the first successful crossing of the Northwest Passage and after 1910 the Arctic fur trade quickly intensified.

The first fur trade post in the region was a Hudson's Bay Company post established in 1912 at Kittigazuit, near Tuktoyaktuk. Permanent fur trade posts began to spring up rapidly during the 1910s and 1920s. Competing posts were established by the Hudson's Bay Company, American firms like the San Francisco-based Canalaska Trading Company, and some Inuit-owned and independent trading operations. Independent traders were often former whalers trading from their schooners ("floating posts") or those setting up temporary encampments. The wreck of a beached whaling schooner observed in Daniel Moore Bay in 1975 by a Geological Survey of Canada crew may have been one of these floating posts (Campbell 1977). After the creation of the Arctic Islands Game Preserve (which included all Arctic islands and the mainland east of Bathurst Inlet) and the peak in fur prices in 1930, the Arctic fur trade economy began a steady decline (Usher 1971).

The closest fur trade post to the Back River Project area was the Hudson's Bay Company's Bathurst Inlet Post (Usher 1971). The Bathurst Inlet Post was relocated several times. The initial post was built in 1925 on the west side of the outlet of the Western River. In 1926 it was relocated to the east side of the Western River, approximately three miles north of its outlet. In 1927 the Bathurst Inlet Post was moved northwest to the northeast side of Banks Peninsula to counter a rival Canalaska Trading Company post that had been built there (KHS 2012). Between 1930 and 1964 the Bathurst Inlet Post was located near the mouth of the Burnside River, the former location of the Bathurst Inlet settlement. Finally in 1964 the Hudson Bay's Company post was moved to Baychimo Harbour Settlement (Bay Chimo or Omingmaktok), at the northeast end of Bathurst Inlet.

There were also short-lived fur trade posts in the northern portion of Bathurst Inlet including a Canalaska Trading Company post near Banks Peninsula (operated 1926 to 1937), independent posts at Kater Point (operated 1927 to 1929) and Hood River (operated 1936 to 1941), and an Inuit-owned post at Arctic Sound approximately seven miles south of Wollaston Point (operated 1931 to 1934; Usher 1971). There were no fur trade posts of note to the south of the Project area for several hundred kilometres.

1.1.4 Prehistory of the Central Arctic

The cultural traditions identified in the Regional Study Area (RSA) include the Pre-Dorset, Dorset (Early, Middle and Late), Thule, and Taltheilei. The earliest archaeological materials from this region date to approximately 3,500 BP and are associated with the Pre-Dorset culture (McGhee 1996).

Pre-Dorset and Dorset archaeological cultures are called Paleo-Eskimo, as they are not direct ancestors to present-day Inuit peoples. Rather, the Inuit are descended from the Thule culture. The Taltheilei archaeological culture is thought to be ancestral to the Dene (Athapaskan) peoples of the subarctic and northern Plains, including the Chipewyan and Yellowknife. The Arctic Neo-Eskimo, Thule and Inuit likely interacted along the borders of their territories with the Northern Plains First Nations cultures (Rescan 2007).

1.1.4.1 Pre-Dorset

The Pre-Dorset culture (3,800-2,700 BP) had a similar toolkit to the contemporaneous Independence I culture of the high Arctic, as well as the later Dorset culture. However, Pre-Dorset can be identified by a distinct assemblage of very small, well-made tools known as the Arctic Small Tool tradition (ASTt), and by several characteristic manufacturing techniques, including parallel sided or shallowly notched bifaces with straight bases. Spalled burins are also very prevalent during this period (Stenton and Park 1998). In 1965, William E. Taylor Jr. found tools made from a locally available orange-pink quartzite in association with pre-Dorset artifacts at several sites in the Ekalluk River region (Taylor 1967). Two types of harpoon heads have also been recovered from this period. The first type is thin, with an open socket, two basal spurs, one or two barbs, and a drilled line hole positioned towards the base. The second is thin with an open socket and a lashing bed, a single medial basal spur, and a centred drilled line hole. Both of these antler harpoon heads were self-bladed with no endblade slot (Park and Stenton 1998).

1.1.4.2 Dorset

The Dorset cultures (including the Early, Middle and Late Dorset) employed hunting techniques centred on the procurement of sea mammals, primarily seals, through holes in the sea ice. This reliance on sea mammals may have been due to the onset of a colder period that saw caribou wintering further to the south, beyond the reach of the Dorset people (Coltrain et al. 2004). Dorset material culture is characterized by ground and chipped slate tools, implements for cutting snow, stone oil lamps, and the absence of drilled holes in their tools. The Dorset culture produced holes through cutting or gouging, forming ovoid holes rather than the round holes created by a drill. One of the characteristic features of

Dorset culture is the rectangular stone alignments which have been identified as the remains of Dorset longhouses.

Early Dorset

The Early Dorset culture (2,700 – 1,800 BP) is characterized by the prevalence of ground and polished slate knives, microblades, and burin-like tools. Chert and quartz endblades were tip-fluted and usually triangular with straight bases and one or more side notches (Stenton and Park 1998). The Tyara Sliced harpoon head is characteristic of the Early Dorset Period. This ivory harpoon head has a thin, 'Sliced' closed socket with an elliptical cross section, a cut oval line hole, and endblade slot perpendicular to the axis of the line hole, and the concave base curves into two weak symmetrical spurs (Park and Stenton 1998).

Middle Dorset

In the Middle Dorset culture (1,800 – 1,500 BP) triangular endblades often featured slightly concave bases and side or corner notches. The use of slate and the tip fluting of microblades are less prevalent than in the Early Dorset period (Stenton and Park 1998). Two distinct harpoon head technologies were developed. The Kingait Closed Head is thin with a rectangular closed socket, a centrally located cut, oval, line hole, an endblade slot perpendicular to the line hole, and a notched base that forms two strong symmetrical spurs. The Nanook Wasp Waist is a thin self-bladed harpoon head with a rectangular closed socket, a waisted profile, a centrally located circular line hole, and a notched base that forms two strong symmetrical spurs (Park and Stenton 1998).

Late Dorset

By the Late Dorset culture (1,500 – 1,000 BP) endblades had deep concave bases and serrated lateral edges and large chert bifacial knives, ground slate knives, and asymmetrical chert scrapers which characterized tool assemblages. During this period microblade usage declined and endblades were no longer tip-fluted (Stenton and Park 1998). Though seals still constituted the majority of their diet, the Late Dorset period population increased their exploitation of other available resources as evidenced in the faunal remains from Late Dorset sites (Howse 2008). Three main harpoon types typify this period: the Dorset Type G, the Dorset Type Ha, and the Dorset Type J. The Dorset Type G are antler or ivory harpoon heads with paired line holes perpendicular to the endblade slot, and a deeply notched base that forms two sharp symmetrical spurs (the Dorset Type F is similar but is self-bladed). The Dorset Type Ha is a thin antler harpoon head with an open socket and lashing grooves, a centred line hole, and was self-bladed. The Dorset Type J is a thin antler self-bladed harpoon head with a centre line hole towards its base (Park and Stenton 1998). As well, at the Late Dorset Cadfael Site on Victoria Island anvil boulders were used for the bi-polar reduction of grey to beige and pink quartzite cobbles (Taylor 1967; Brink 1992).

1.1.4.3 Thule

The Thule culture is divided into three periods: the Classic Thule (1,100 – 800 BP); Post Classic Thule (800 – 400 BP); and Early Historic (400 – 200 BP). This culture represents an eastward migration of a new group of people from Alaska across the Canadian Arctic and into Greenland around approximately 1,100 BP. It marks a sharp transition in the archaeological record from the preceding Dorset culture. The Thule culture was more whaling-focused, and as it moved out of the western Arctic it either displaced the existing Dorset culture or moved into the vacuum left by the departure of the Dorset. The Thule culture is characterized in the archaeological record by semi-subterranean houses framed with wood or bone, the use of dog sleds, and the use of ground stone rather than flaked stone tool technology. This change in manufacturing necessitated a shift in material from chert and quartz to slate and similar materials (Stenton and Park 1998). The Thule generally appear to have preferred metal over stone when

available for the creation of sharp edge tools for working with bone antler and ivory (McGhee 1984). The Thule are considered to be the ancestors of the current Inuit population of the Arctic.

1.1.4.4 Taltheilei

The Taltheilei archaeological culture is thought to represent proto-Athapaskan peoples in the western subarctic, ancestral to the Chipewyan, Dogrib and Yellowknife. Their seasonal rounds would have followed the caribou migration north onto the tundra during the summer months. This likely brought them into contact with the Eskimo and Inuit inhabitants who also relied on the caribou migration. Taltheilei archaeological sites are characterized by the presence of Taltheilei Shale tradition artifacts though they also used quartzite and chert to manufacture tools (Pentney 2002). Noble (1971) defined the Taltheilei tradition and divided it into ten distinct complexes (Hennessey, Taltheilei, Windy Point, Waldron River, Narrows, Lockhart, Frank Channel, Fairchild Bay, Snare River, and Reliance) spanning approximately 2,000 years (2,200 BP to 150 BP). Gordon (1996) has since simplified this typology into Earliest, Early, Middle, and Late. Large Taltheilei sites have been located along the treeline where they would have congregated during the spring and fall hunts while sites to the south of the treeline and north out on the Barren Lands are generally smaller and consist primarily of tent rings and lithic scatters (Friesen 2004). Archaeological sites near Black Lake in Northern Saskatchewan include evidence of an extensive Taltheilei occupation, as well as sites with Pre-Dorset culture ASTt artifacts (Minni 1975). Additionally, Morrison (1978) recorded the Nanegoak site (MeNl-13) on the western shore of Bathurst Inlet that he classified as Taltheilei, based on a lanceolate projectile point suggestive of Hennessey or Windy Point traditions. The Black Lake and Nanegoak sites illustrate the overlapping ranges of the Paleo-Eskimo/Inuit and Taltheilei/Dene cultures. This overlap is confirmed through oral histories of the Inuit at Bathurst Inlet recorded by Keith and Stewart (2005).

1.1.5 Previous Archaeological Research in the Regional Study Area

The first archaeological studies in the region were conducted in the 1920s by Mathiassen, as part of the Danish 5th Thule Expedition in 1921-1924 (Mathiassen 1927). Southern Bathurst Inlet has been the subject of several archaeological studies. During the 1970s geologist Fred Campbell submitted reports to the Archaeological Survey of Canada describing a number of archaeological sites he observed in Bathurst Inlet while conducting work for the Geological Survey of Canada (Campbell 1975, 1977). In 1978, David Morrison conducted a survey of southern Bathurst Inlet and recorded 61 archaeological sites, although he believed most were attributable to Inuit use and that many of the sites were not prehistoric. Additional archaeological investigations have been conducted in the George Lake area by Bertulli (1991) and in the Goose Lake area by Fedirchuk (1997).

Recent studies in the southern Bathurst Inlet have been conducted in 2001, 2002, and 2010 as part of the proposed Bathurst Inlet Port and Road (BIPR) Project, which would consist of port infrastructure on the west side of Bathurst Inlet and a road southwest to Contwoyto Lake (Fedirchuk 2001; Blower 2003; Tischer 2010). In 2004 Darren Keith and Andrew Stewart conducted an oral history and archaeological study of a caribou hunting camp site (*Tahikaffaaluk*) at the north end of Bathurst Lake (Keith and Stewart 2005). Studies were also conducted for the Hackett River Project in 2007, 2010, and 2012 (Rescan 2008, 2011, 2013a) and in 2011 and 2012 for the Back River Project (Rescan 2012, 2013b).

1.1.5.1 Characterization of Archaeological Sites

For the purposes of the effects assessment archaeological sites are categorized by the antiquity and the known features and artifacts present. The majority of features at archaeological sites in the area can be adequately described using the following descriptors; stone circle, stone oval, stone rectangle, stone trap, stone alignment, hunting blind, hearth, drive lane, cache, cairn, inuksuk, burial, quarry, and kayak stand. For artifacts the descriptors include: lithic isolated find, lithic scatter, faunal

material, faunal tool, and historic material. Where possible archaeological sites have been tentatively categorized by prehistoric culture based on diagnostic lithic tools, if present.

Also, based on the known features and artifacts present, an overall functional description can be provided with the exceptions being small isolated finds and historic artifact scatters where a function cannot be ascribed. The functional descriptors include: campsite, faunal tool, grave, historic artifact scatter, historic isolated find, isolated lithic tool, lithic reduction, lithic workshop, marker, mineral exploration, quarry, resource gathering, and stone shelter. The function attributed to a site is in some cases hierarchical where the presence of a specific feature or artifact can raise it to a higher level. A grave is any site with human remains or an obvious burial features regardless of other features or artifacts at the site. The next site type in the hierarchy is campsite which encompasses all sites with evidence of habitation features including stone circles, stone ovals, and stone rectangles large enough to hold down hide or canvas tents. A site containing both a lithic scatter and a stone circle will be described as a campsite as will a site containing a drive lane or cache that without a habitation feature would be described as a resource gathering site. A resource gathering site encompasses all sites not classified as campsites that include features associated with hunting, fishing, and storage of subsistence resources including hunting blinds, caches, caribou drive lanes and sites with both features and lithics without habitation features. Quarry sites have both lithic scatters and lithic raw material with evidence of prehistoric utilization. A site described as a marker includes those with cairns, inuksuk, or stone features not obviously associated with other higher level activities like drive lanes or campsites. Lithic sites containing no features but with large numbers of flakes ($n > 50$) and/or stone tools are described as lithic workshops. Sites with small amounts of lithic debitage and no formed tools are lithic reduction sites. Single artifact sites include isolated lithic tools (if a tool is present), lithic isolated finds (only debitage), and faunal tools. Sites without features but with faunal material indicative of processing activity may be classified as resource gathering sites.

1.2 INCORPORATION OF TRADITIONAL KNOWLEDGE

1.2.1 Incorporation of Traditional Knowledge for Existing Environment and Baseline Information

The ethnographic information on travel routes, resource procurement, campsites, and burial practices related to the VSEC archaeological sites, detailed in Section 1.1.2, is primarily based on the Traditional Knowledge (TK) from the NTKP report (KIA 2012). Supplementary information was gathered from a review of the following sources; Nunaga: Ten Years Among the Eskimo by Duncan Pryde (1971); Thunder on the Tundra: Inuit Qaujimajatuqangit of the Bathurst Caribou by Natasha Thorpe et al. (2002); Fur Trade Posts of the Northwest Territories, 1870 - 1970 by Peter Usher (1971); archaeological studies by Keith and Stewart (2005), Mathiassen (1927), and Morrison (1978, 1979); ethnographic and ethno-historic accounts by Boas (1964), Birket-Smith (1959), Damas (1972, 1984), Franklin (1823), Hearne (1911), Jenness (1921, 1922, 1923a-c, 1924a, 1924b, 1928, 1944, 1946), Roberts and Jenness (1925), Rasmussen (1932), Savard (1966), and Stefansson (1914,1919,1921).

1.2.2 Incorporation of Traditional Knowledge for Valued Ecosystem Component and Valued Socio-economic Component Selection

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 (see Volume 9, Chapter 1). The TK report presents 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 initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on

April 8, 2013 and posted on the NIRB ftp site. The traditional knowledge information available for the Project is an important resource in the understanding of archaeological sites, a VSEC for this EIS.

1.2.3 Incorporation of Traditional Knowledge for Spatial and Temporal Boundaries

The information within the NTKP report (KIA 2012) was taken into account when developing the RSA. The RSA was designed to include an area large enough to capture enough known sites that conclusions regarding the potential location and frequency of archaeological sites could be estimated.

1.2.4 Incorporation of Traditional Knowledge for Effects Assessment

The effects assessment for the VSEC archaeological sites focused on the presence of archaeological sites and the distance from Project developments. The mitigation of archaeological sites that will be directly impacted by the Project will take place prior to construction. Mitigation measures required to reduce impacts to archaeological sites, if necessary, will be determined in consultation with the Government of Nunavut Department of Culture and Heritage (GN-DCH). Traditional Knowledge may be incorporated into the mitigation measures required by the GN-DCH.

1.2.5 Incorporation of Traditional Knowledge for Mitigation and Adaptive Management

The requirements for the mitigation of archaeological sites that will be directly impacted by the Project will be determined through consultation with the GN-DCH. The Inuit Heritage Trust will be included in this consultation and TK may be used to help determine the mitigation requirement on a site by site basis.

1.3 VALUED COMPONENTS

1.3.1 Potential Valued Components and Scoping

The valued socio-economic components (VSECs) considered for heritage is protected archaeological sites that potentially will be affected by development of the Project.

1.3.2 Valued Components Included in Assessment

For the heritage effects assessment archaeological sites have been scoped in as there are known archaeological sites that may be affected by development of the Project and since both known and unknown archaeological sites are protected by legislation (Section 1.1.1). All information requested in the NIRB-issued EIS guidelines relating to heritage is included in this DEIS.

1.3.3 Supporting and Supplemental Information

A review of the NTKP study (KIA 2012) indicates that the types of cultural use sites (campsites, hunting locations, burials) affected by the Project are already being addressed under the VSEC archaeological sites. There are no communities located within the Local Study Area (LSA).

1.4 SPATIAL AND TEMPORAL BOUNDARIES

1.4.1 Spatial Boundaries

1.4.1.1 Local Study Area

The LSA includes both the assessed proposed Project footprint and a 5-km buffer where Project effects are anticipated to occur (Figure 1.4-1). Archaeological sites within the LSA will be evaluated relative to anticipated Project effects.

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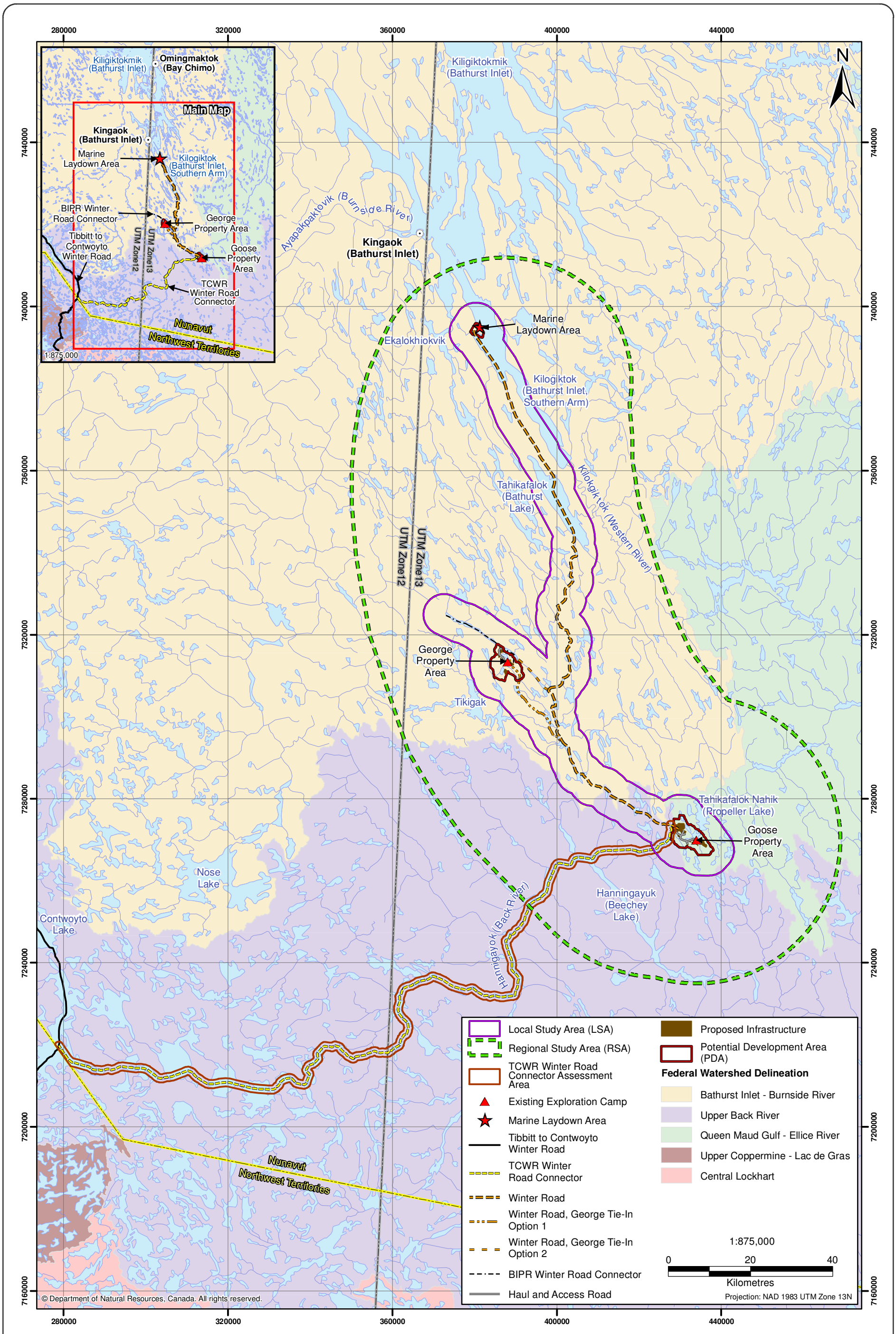


Figure 1.4-1

Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Archaeology

Figure 1.4-1

Rescan an ERM company

1.4.1.2 Regional Study Area

The RSA for the VSEC archaeological sites is consistent with the RSA used for baseline studies carried out for wildlife, soils, terrain, and ecosystems and vegetation mapping (Figure 1.4-1).

1.4.1.3 Tibbitt to Contwoyto Winter Road Connector Assessment Area

The Tibbitt to Contwoyto Winter Road Connector Assessment Area buffers the proposed road alignment by 1,000 m (Figure 1.4-1). An archaeological assessment was conducted along the alignment but, due to its temporary and seasonal nature, a large portion of it falls outside of the Project RSA and LSA. For the VSEC archaeological sites the mitigation and management measures for sites within the RSA and LSA will also be applied to those within the Tibbitt to Contwoyto Winter Road Connector Assessment Area.

1.4.2 Temporal Boundaries

Archaeological sites within the LSA can potentially be affected during both the Construction and Operational phases of the Project. During the Construction phase archaeological sites may be directly affected through ground altering activities associated with Project developments and indirectly affected through increased human presence in the area. During operations archaeological sites may be affected through increased human presence in the LSA. It is anticipated that all potential disturbances to archaeological sites will be mitigated prior to or during Site Preparation or, in the case of chance finds, during the Construction and Operational phases and therefore no additional effects are anticipated during the Reclamation and Closure or Post-closure phases or, if necessary, during Temporary Closure or Care and Maintenance.

1.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

1.5.1 Methodology Overview

The methodologies employed during the baseline studies for the Project are summarized below.

Potential Project related effects to the VSEC archaeological sites are determined below using the General Assessment Methodology (Volume 9, Chapter 1).

1.5.1.1 Literature Review

Background research was conducted, including review and evaluation of archaeological, historical, and ethnographic literature relevant to the proposed Project area and the region. When available, traditional knowledge and traditional use information was also used to assess potential. Archaeological site data requests were sent to the Government of Nunavut, Department of Culture and Heritage (GN-DCH) to obtain all known archaeological site information relevant to the Project to be included in the effects assessment.

1.5.1.2 Archaeological Impact Assessments

The archaeological baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, and the Marine Laydown Area and along the proposed access roads. The field investigations were conducted under Class 2 Nunavut Territory Archaeologist Permits issued by the GN-DCH.

Helicopter and pedestrian reconnaissance were conducted for the Project focused on the PDAs and the proposed road alignments. Helicopter reconnaissance involved a number of low and slow helicopter over-flights which allowed for the identification of areas of interest. For areas deemed as having high archaeological potential closely spaced pedestrian traverses were conducted to determine if

archaeological sites were present. Where archaeological sites were located the approximate boundaries of the sites were determined. For artifacts identified on the surface during the pedestrian survey, a brief description was recorded, Global Positioning System (GPS) coordinates were obtained, and photographs were taken. Diagnostic artifacts or artifacts felt to be at risk were collected and non-diagnostic artifacts were generally left *in situ*.

All archaeological sites identified were recorded in field notes, photographed, and GPS coordinates obtained. Site forms for all archaeological sites recorded during this study were submitted to the GN-DCH and Canadian Museum of Civilization (CMC). Permanent site designations were provided by the CMC using the Borden system.

As areas with moderate to high archaeological potential in the Project area consisted largely of surface exposures and areas of exposed bedrock, no subsurface testing was conducted. All collected artifacts were catalogued and sent to the designated repository for the Project.

The objectives of the archaeological impact assessments were:

- to identify and evaluate any archaeological sites located within and adjacent to proposed developments;
- to identify and assess possible impacts of the proposed developments on any identified archaeological sites;
- to provide recommendations regarding the need and appropriate scope of further archaeological studies prior to the initiation of any proposed developments; and
- to recommend viable alternatives for managing adverse impacts.

Fieldwork was conducted, under snow-free conditions.

1.5.2 Potential Interactions with Project and Characterization

For the purposes of the DEIS, archaeological sites will be discussed at three different levels. A general summary of all of the archaeological site types within the RSA will be provided to establish a baseline. Archaeological sites within the LSA and the TCWR Winter Road Connector Assessment Area where possible interactions with the Project may occur will be summarized and presented in a table (Appendix V8-1A). Finally detailed descriptions of sites that will be directly affected by the Project, within 50 m of the PDAs and the proposed roads, will be provided. Locational information pertaining to archaeological sites is protected by a Data Licence Agreement issued by the Government of Nunavut and due to these restrictions no maps depicting archaeological site locations are included in this document. Additional information on archaeological sites gathered during baseline studies for the Project can be found in the cumulative baseline report (Appendix V8-1B).

1.5.2.1 Archaeological Sites within the Regional Study Area

There are 269 known archaeological site with the RSA. Of the 269 sites 172 are prehistoric, 39 are historic, 26 are multicomponent sites with both prehistoric and historic features or artifacts, and 34 are of undetermined antiquity. Within the RSA there are 4 burials, 124 campsites, 36 resource gathering sites, 38 lithic workshops, 33 lithic reduction sites, 5 lithic isolated tool sites, 4 lithic isolated finds (debitage), 17 markers (cairns or inuksuk), 1 quarry site, 2 faunal tool sites, 3 historic artifact scatters, and 1 historic isolated find. Of the 269 sites, 83 contain both artifacts and features, 97 contain only features, and 89 contain only artifacts. Artifacts attributable to specific cultural traditions have been identified at 22 of the 269 sites with 19 having artifacts indicative of the Pre-Dorset, one of the Dorset tradition, and two from the Taltheilei tradition.

1.5.2.2 Archaeological Sites within the Local Study Area

There are 177 known archaeological sites within the LSA. Of the 177 sites 126 are prehistoric, 18 are historic, 17 are multicomponent sites with both prehistoric and historic features or artifacts, and 16 are of undetermined antiquity. Within the LSA there are no burials, 84 campsites, 27 resource gathering sites, 30 lithic workshops, 19 lithic reduction sites, 5 lithic isolated tool sites, 3 lithic isolated finds (debitage), 5 markers (cairns or inuksuk), 1 faunal tool sites, 2 historic artifact scatters, and 1 historic isolated find. Of the 177 sites 54 contain both artifacts and features, 61 contain only features, and 62 contain only artifacts. Artifacts attributable to specific cultural traditions have been identified at 12 of the 177 sites with 9 having artifacts indicative of the Pre-Dorset, 1 of the Dorset tradition, and 2 from the Taltheilei tradition.

There are 83 sites in the LSA within 1,000 m of Project developments that may be impacted either directly or indirectly by the Project. Of the 79 sites within 1,000 m 44 are between 150 m and 1,000 m and are considered to be at low risk of indirect impacts during construction and operations. There are seven sites between 50 and 150 m from Project developments and are considered to be at moderate risk of indirect impact through increase human presence during construction and operations. The 32 archaeological sites within 50 m of Project developments are considered to be at high risk of direct impact during construction and are described in detail in Section 1.5.2.4.

1.5.2.3 Archaeological Sites within the Tibbitt to Contwoyto Winter Road Connector Assessment Area

There are 50 known archaeological sites within the Tibbitt to Contwoyto Winter Road Connector Assessment Area that may be impacted either directly or indirectly by the Project. Fourteen of the sites are also within the RSA and 3 are within the LSA. Of the 50 sites 35 are prehistoric, 5 are historic, 4 are multicomponent sites with both prehistoric and historic features or artifacts, and 6 are of undetermined antiquity. Within the Tibbitt to Contwoyto Winter Road Connector Assessment area there is 1 burial, 11 campsites, 4 resource gathering sites, 16 lithic workshops, 11 lithic reduction sites, 1 lithic isolated finds (debitage), and 6 markers (cairns or inuksuk). Of the 50 sites 10 contain both artifacts and features, 13 contain only features, and 27 contain only artifacts. Artifacts attributable to specific cultural traditions have been identified at 3 of the 50 sites all having artifacts indicative of the ASTt.

All of the sites are within 1,000 m of proposed winter road and may be impacted either directly or indirectly by the Project. Of the 50 sites within 1,000 m 40 are between 150 m and 1,000 m and are considered to be at low risk of indirect impacts during construction and operations. There are seven sites between 50 and 150 m from the Temporary Winter Ice Road that are considered to be at moderate risk of indirect impact through increase human presence during construction and operations. The three archaeological sites within 50 m that are considered to be at high risk of direct impact during construction are described in detail in Section 1.5.2.4.

1.5.2.4 Archaeological Sites Directly Impacted by Development Components

During construction, Project activities that could have potential adverse effects on archaeological sites include: clearing and grading for roads; clearing, grading, and excavation for foundations and building footings; earth moving and blasting for mine construction; and tailing and waste rock deposition. Adverse effects are anticipated to sites located within 50 m of the PDAs and the road rights-of-way. A total of 35 known archaeological sites, discussed in detail below, are located within 50 m of the roads and Project Development Areas (PDAs). These sites have a high probability of being directly affected from disturbance due to ground altering activity by construction and are described in detail below.

Goose Property Project Development Area

There are four known archaeological sites within the Goose Property Project Development Area (PDA).

LjNh-1

Archaeological site LjNh-1 is a prehistoric lithic scatter located on a bedrock outcrop surrounded by marsh. The site has a good outlook over Llama Lake to the southeast. The site measures 18 m N-S by 8 m E-W and consists of an artifact assemblage of three pink quartzite flakes, 147 white quartzite flakes (including approximately 100 pieces of micro-debitage), and three pieces of white quartzite block shatter. No formed tools or diagnostic artifacts were observed at the site. Based on the artifacts present the site is determined to have low archaeological significance. Due to the close proximity of the site to exploration activities the surface finds were collected (Rescan 2011).

LjNh-2

Archaeological site LjNh-2 is a prehistoric isolated find. The site measures 6 m N-S by 3 m E-W and consists of a single pink quartzite retouched flake located on a bedrock outcrop surround by marsh and uneven rocky terrain. Based on the artifacts present the site is determined to have low archaeological significance. The site has a good outlook over Llama Lake to the southeast. Due to the close proximity of the site to exploration activities the surface find was collected (Rescan 2011).

LjNh-4

Archaeological site LjNh-4 is a prehistoric lithic scatter situated at on a bedrock outcrop approximately 20 m east of a small unnamed pond, within the Goose Property PDA. It measures 5 m N-S by 5 m E-W, and consists of four grey quartz flakes and two unifacially retouched flakes observed on the ground at the site (left *in situ*; Plate 1.5-1). No formed tools or diagnostic artifacts were observed and based on the artifacts present the site is determined to have low archaeological significance (Rescan 2012).



Plate 1.5-1. Quartz flakes from site LjNh-4.

LjNh-5

Archaeological site LjNh-5 is a prehistoric lithic scatter situated at approximately 320 m asl on a knoll overlooking the outlet of an unnamed creek flowing into Goose Lake, within the Goose Property PDA. The site measures 12 m N-S by 12 m E-W, and consists of a white chert and three white quartz flakes observed

in a surface exposure (left *in situ*). No formed tools or diagnostic artifacts were observed and based on the artifacts present the site is determined to have low archaeological significance (Rescan 2012).

George Property Project Development Area

There are 11 known archaeological sites within the George Property PDA.

LlNk-1

Archaeological site LlNk-1 is a small disassembled cache of undetermined antiquity located on a prominent knoll within the George Property PDA. The cache pit feature consists of several flat rocks surrounding a shallow cultural depression with differential vegetation. Based on the features present the site is determined to have moderate archaeological significance. No artifacts were identified in the area (Rescan 2011).

LlNk-2

Archaeological site LlNk-2 is a prehistoric lithic scatter located on an east-west trending esker overlooking a marshy area to the southeast. The site measures 7 m N-S by 12 m E-W and consists of one white quartzite core and one piece of block shatter. As the site is in close proximity to the George Exploration Camp and a proposed ice-road the artifacts were collected. No diagnostic artifacts were observed and the site is determined to have low archaeological significance (Rescan 2011).

LlNk-5

Archaeological site LlNk-5 is a prehistoric lithic scatter located on the top of an east-west trending esker. The site measures 11.5 m N-S by 23 m E-W and consists of one white quartzite biface fragment, three white quartzite flakes, and one piece of white quartzite block shatter (all collected). No diagnostic artifacts were identified. Based on the landform and the artifacts present the site is determined to have moderate archaeological significance (Rescan 2011).

LlNk-7

Archaeological site LlNk-7 is a prehistoric lithic scatter site located on a surface exposure between two bedrock outcrops near the LCP North Pit. Site boundaries measure 15 m in diameter. Vegetation at the site is sparse at the site, but where present it consists of dwarf shrubs, sedges, moss, and lichen. The site consists of a surface lithic scatter of approximately 100 to 200 white quartzite flakes. All artifacts were left *in situ*. Based on the number of artifacts present the site is determined to have a moderate-high archaeological significance (Rescan 2013b).

LlNk-8

Archaeological site LlNk-8 is a prehistoric isolated lithic find, located on a gravel exposure west of the haul and access road leading to the LCP North Pit and WRSA3. Site boundaries measure 10 m in diameter. Vegetation is very sparse at the site and consists of only small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of a single basal shouldered point point fragment of grey siltstone (Plate 1.5-2), suggestive of the Early to Middle Taltheilei tradition. The artifact was collected. Based on the artifact present the site is determined to have moderate archaeological significance (Rescan 2013b).

LlNk-9

Archaeological site LlNk-9 is a cache site of undetermined age, located in a surface exposure on a small bench immediately west of the haul and access road leading to the LCP North Pit and WRSA3. Site boundaries measure 10 m in diameter. Vegetation at the site is sparse and consists of a few small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of a single cache which has been

taken apart. No artifacts were observed. Based on the feature present the site is determined to have low archaeological significance (Rescan 2013b).

LlNk-10

Archaeological site LlNk-10 is a prehistoric lithic scatter site, located in a surface exposure on a small bench immediately west of the haul and access road leading to the LCP North Pit and WRSA3. Site boundaries measure 65 m N-S by 30 m E-W. Vegetation at the site is sparse and consists of a few small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of three surface lithic scatters with a total of approximately 400 flakes all of white quartzite, as well as several biface fragments. All artifacts were left *in situ*, with the exception of the biface preform collected from lithic scatter 1 (Plate 1.5-3). Based on the artifacts present the site is determined to have moderate-high archaeological significance (Rescan 2013b).



Plate 1.5-2. Early or Middle Taltheilei point fragment (LlNk-8:1) collected from site LlNk-8.



Plate 1.5-3. White quartzite biface preform (LlNk-10:1) collected from site LlNk-10.

LlNk-11

Archaeological site LlNk-11 is a prehistoric lithic scatter site, located in a surface exposure on a knoll between the LCP North Pit to the west and Long Lake to the east. Site boundaries measure 15 m in diameter. Vegetation at the site consists of patches of dwarf shrubs, sedges, moss, and lichen. The site consists of one surface lithic scatter of approximately 30 white quartzite flakes. All artifacts were left *in situ*, with the exception of one quartzite graver which was collected (Plate 1.5-4). Based on the landform and the artifacts present the site is determined to have moderate archaeological significance (Rescan 2013b).

LlNk-12

Archaeological site LlNk-12 is a prehistoric isolated lithic find site, located in a surface exposure on a terrace on the north-western shore of George Lake, near the haul and access road to the north of Locale 1 Pit. Site boundaries measure 10 m in diameter. Vegetation at the site is minimal but where present consists of dwarf shrubs, sedges, moss, and lichen. The site consists of a single grey quartzite scraper which was collected from the surface (Plate 1.5-5). Based on the artifacts present the site is determined to have low archaeological significance (Rescan 2013b).

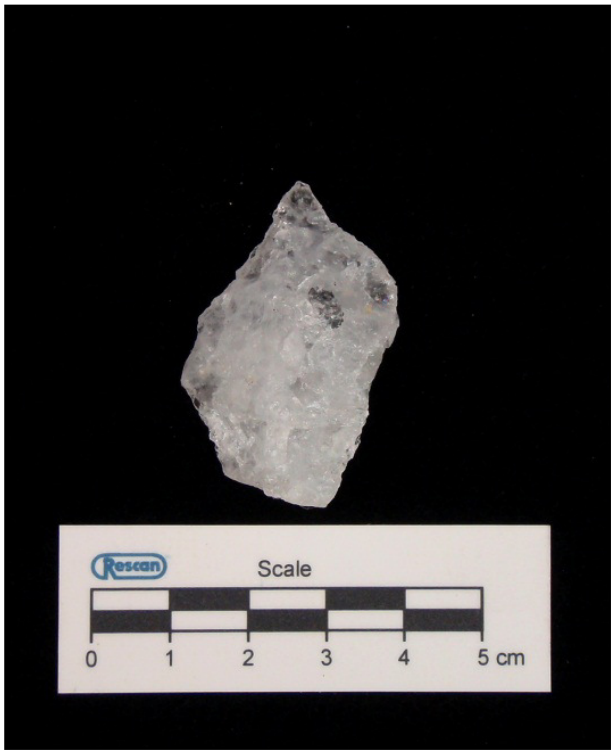


Plate 1.5-4. Clear quartzite graver (LlNk-11:1) found at site LlNk-11.



Plate 1.5-5. Grey quartzite scraper (LlNk-12:1) collected from site LlNk-12.

LlNk-20

Archaeological site LlNk-20 is a prehistoric campsite located on an esker in the southeast of the George Property PDA and west of the George to Goose Winter Road. Site boundaries measure 12 m in diameter. Vegetation at the site is very sparse and consists of only a few patches of grass and lichens. The site consists of one stone circle with some animal bone fragments around the feature. No artifacts were found at the site. Based on the features and artifacts present the site is determined to have moderate archaeological significance. (Rescan 2013b).

LlNk-21

Archaeological site LlNk-21 is a prehistoric lithic scatter site located on an esker within 50 m of the George Property PDA and west of the George to Goose Winter Road. Site boundaries measure 8 m in diameter. Vegetation at the site consists of small patches of ground-covering bushes and lichens. The site consists of one lithic scatter containing four white quartzite flakes. All artifacts were left *in situ*. Based on the artifacts present the site is determined to have low archaeological significance. (Rescan 2013b).

Marine Laydown Project Development Area

There are 15 known archaeological sites within the Marine Laydown PDA.

MdNl-5

Archaeological site MdNl-5 is a campsite of undetermined age located on a bedrock exposure overlooking Bathurst Inlet within the Marine Laydown PDA. The site was originally recorded in 1978 (Morrison 1978) and was revisited during the 2012 field assessments. Vegetation at the site is consisting of patches of mosses, lichens, and grasses. The site is in good condition. All previously recorded features were relocated and an additional eight features including two stone alignments, two stone circles, one cache, one fire pit, a temporary shelter, and a pavement of flat stones were recorded. Site boundaries have been revised and now measure 175 m N-S by 185 m NW-SE (Rescan 2013b). Based on the features and artifacts present the site is determined to have moderate-high archaeological significance.

MdNl-6

Archaeological site MdNl-6 is a prehistoric campsite located in a surface exposure overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 230 m E-W by 60 m N-S. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one cache with a pavement of stones beside it (Plate 1.5-6), two stone ovals, and one lithic scatter of approximately 40 white chert, and pink and white quartzite flakes was located in a surface exposure. Seven artifacts which are suggestive of the Arctic Small Tool tradition were collected from the site (Plate 1.5-7). Based on the features and artifacts present the site is determined to have high archaeological significance (Rescan 2013b).



Plate 1.5-6. Cache (F1) at site MdNl-6.



Plate 1.5-7. Artifacts collected from site MdNl-6.

MdNl-7

Archaeological site MdNl-7 is a prehistoric lithic scatter site with historic components located on a slope overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 175 m E-W by 140 m N-S. The sparse vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of two stone ovals, one with a pavement of flat stones, lithic scatters located in surface exposures included eighteen lithic tools (Plate 1.5-8), approximately 20 flakes of white chert, and white and green quartzite, 4 single chert flakes, and 1 white chert core, as well as one wooden peg, one rifle cartridge (223 Remington, first issued in 1957), and one piece of worked antler (Plate 1.5-9). Several of the lithic artifacts from the site are suggestive of the Arctic Small Tool tradition and were collected along with the rifle cartridge. All other artifacts were left *in situ*. Based on the features and artifacts present the site is determined to have high archaeological significance (Rescan 2013b).



Plate 1.5-8. Artifacts collected from site MdNl-7.



Plate 1.5-9. Worked antler from site MdNl-7.

MdNl-8

Archaeological site MdNl-8 is a prehistoric lithic scatter site overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 100 m in diameter. Vegetation at the site is sparse consisting of patches of mosses, lichens, and grasses. The site includes lithic scatters, located in surface exposures with a total of 200 flakes of light grey quartzite, grey and white chert, clear quartz, grey siltstone, and orange banded chert, as well as ten lithic artifacts which were collected (Plate 1.5-10). Three of the collected artifacts are suggestive of the Arctic Small Tool tradition. Based on the features and artifacts present the site is determined to have high archaeological significance. (Rescan 2013b).



Plate 1.5-10. Artifacts collected from MdNl-8.

MdNl-9

Archaeological site MdNl-9 is a prehistoric campsite overlooking Bathurst Inlet located within the Marine Laydown PDA. Site boundaries measure 35 m NW-SE by 15 m SW-NE. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one small stone circle which may be a hearth or cache and one larger stone circle. No artifacts were found at the site. Based on the features present the site is determined to have moderate archaeological significance (Rescan 2013b).

MdNl-10

Archaeological site MdNl-10 is a prehistoric campsite located on a surface exposure overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 15 m diameter. The sparse vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone rectangle (Plate 1.5-11) and one quartzite spall tool. The artifact was left *in situ*. Based on the artifacts present the site is determined to have moderate archaeological significance (Rescan 2013b).



Plate 1.5-11. Stone rectangle (F1), with Bathurst Inlet in background, at site MdNl-10.

MdNl-11

Archaeological site MdNl-11 is an historical hunting site overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 24 m N-S by 10 m E-W. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one piece of sinew rope. The artifact was left *in situ*. Based on the artifact present the site is determined to have moderate archaeological significance. (Rescan 2013b).

MdNl-12

Archaeological site MdNl-12 is a prehistoric cache site located on a break-in-slope overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 10 m N-S by 21 m E-W. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one cache

and one cairn. No artifacts were located at the site. Based on the artifacts present the site is determined to have moderate archaeological significance (Rescan 2013b).

MdNl-13

Archaeological site MdNl-13 is a prehistoric lithic scatter located in a surface exposure on a terrace overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 10 m diameter. Vegetation at the site is sparse consisting of patches of mosses, lichens, and grasses. The site consists of one lithic scatter containing two white quartzite flakes. All artifacts were left *in situ*. Based on the artifacts present the site is determined to have moderate archaeological significance (Rescan 2013b).

MdNl-14

Archaeological site MdNl-14 is a campsite of undetermined age located on a rise immediately west of Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 65 m N-S by 15 m E-W. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of two stone circles. No artifacts were found at the site. Based on the features present the site is determined to have moderate archaeological significance (Rescan 2013b).

MdNl-16

Archaeological site MdNl-16 is a historic campsite located on a terrace within the Marine Laydown PDA. Site boundaries measure 27 m E-W by 18 m N-S. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone circle and historic debris, including tin cans, a toy NASA Land Rover truck that started being produced in 1987, caribou bone fragments, plastic fragments, and wooden tent pegs. No prehistoric artifacts were found at the site and all historic artifacts were left *in situ*. Based on the artifacts present the site is determined to have low archaeological significance (Rescan 2013b).

MdNl-17

Archaeological site MdNl-17 is a campsite of undetermined age located on a bench overlooking the beach within the Laydown Pad. Site boundaries measure 20 m N-S by 10 m E-W. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone circle and one hearth. No artifacts were found at the site. Based on the features present the site is determined to have moderate archaeological significance. (Rescan 2013b).

MdNl-18

Archaeological site MdNl-18 is a campsite of undetermined age located on the shore of Bathurst Inlet east of the Laydown Pad. Site boundaries measure 15 m in diameter. Vegetation is sparse to non-existent at the site, but a few small patches of low ground cover are present. The site consists of one stone circle and a scatter of broken animal bone. No artifacts were located at the site. Based on the features present the site is determined to have moderate archaeological significance. (Rescan 2013b).

MdNl-19

Archaeological site MdNl-19 is an historical isolated find site located on the shore of Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 10 m in diameter. Vegetation at the site consists of grasses, mosses, and lichens. The site consists of one wooden oar with one end wrapped in metal (Plate 1.5-12). No other artifacts were found at the site (Rescan 2013b). Based on the artifact present the site is determined to have low archaeological significance.

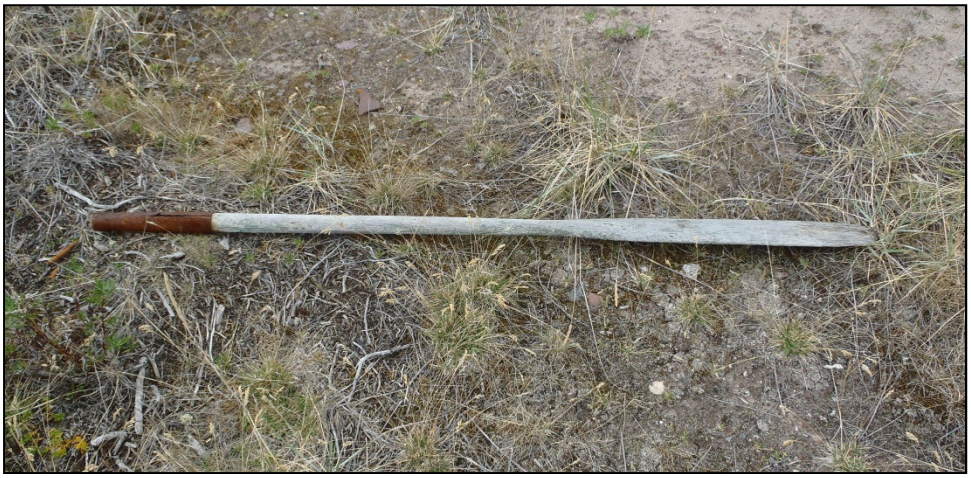


Plate 1.5-12. Wooden oar with wrapped end found at site MdNl-19.

MdNl-20

Archaeological site MdNl-20 is an historical artifact find site located on the shore of Bathurst Inlet within the Marine Laydown PDA north of the Laydown Pad. Site boundaries measure 10 m in diameter. The site consists of one piece of a wooden lid, with a curved side and a lip, two pieces of wood, and a rusted metal pin. No other artifacts were found at the site. All artifacts were left *in situ*. Based on the artifacts present the site is determined to have low archaeological significance. (Rescan 2013b).

Proposed Road Rights-of-way

There are two known archaeological sites within 50 m of the proposed winter roads.

LlNk-18

Archaeological site LlNk-18 is a prehistoric lithic scatter site located in a surface exposure on a knoll along the western shore of Upper Long Lake. Site boundaries measure 12 m in diameter. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site consists of one lithic scatter containing approximately 10 to 20 white quartzite flakes. All artifacts were left *in situ*. Based on the artifacts present the site is determined to have low archaeological significance (Rescan 2013b).

McNj-18

Archaeological site McNj-18 is a campsite of undetermined antiquity located on the beach along the eastern shore of Bathurst Inlet. The site measures 24 m N-S by 88 m E-W and includes three stone circles and a rectangular stone alignment, likely from a canvas tent. Historic metal debris, including the remains of a stove and table legs, were observed at the site. There is the potential for additional artifacts beneath the vegetation (Rescan 2011). Based on the features and artifacts present the site is determined to have moderate archaeological significance.

Tibbitt to Contwoyto Winter Road Connector

There are three known archaeological sites located within 50 m of the Tibbitt to Contwoyto Winter Road Connector.

LfNo-3

Archaeological site LfNo-3 is a lithic workshop with located on surface exposures to the south of a creek that connects two lakes located to the east and west. The site measures 60 m x 50 m and includes lithic

scatters located on the two knolls and a low density scatter between them. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site contains a total of approximately one hundred grey quartzite flakes. The site appears to be in good condition and all artifacts were left *in situ*. There is the potential for additional artifacts beneath the vegetation (Rescan 2013c). Based on the artifacts present the site is determined to have low-moderate archaeological significance.

LfNo-5

Archaeological site LfNo-5 is a lithic workshop with located in a surface exposure on a knoll to the south of a creek that connects two lakes located to the east and west. The site measures 15 m x 35 m and includes over 200 white and grey quartzite flakes. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site appears to be in good condition and all artifacts were left *in situ*. There is the potential for additional artifacts beneath the vegetation (Rescan 2013c). Based on the artifacts present the site is determined to have moderate archaeological significance.

LhNk-4

Archaeological site LhNk-4 is a lithic reduction site located on a rocky terrace overlooking Back River to the east. The site measures 10 m diameter and consists of a lithic scatter with 10 flakes and three pieces of micro debitage of white quartzite. The site appears to be in good condition and all artifacts were left *in situ*. Vegetation at the site consists of mosses, lichens, and ground-covering bushes and there is the potential for additional artifacts beneath the vegetation (Rescan 2013c). Based on the artifacts present the site is determined to have low archaeological significance.

1.5.3 Identification of Mitigation and Management Measures

1.5.3.1 Mitigation by Project Design

Project design features, including the placement of site infrastructure to avoid archaeological sites and the use of temporary winter roads that reduce the disturbance areas on the tundra reduce direct impacts to archaeological sites.

1.5.3.2 Best Management Practices

Avoidance through Project design and redesign is always the preferred option for archaeological sites. Avoidance measures instituted for the Project include conducting thorough archaeological assessments of Project infrastructure to identify archaeological sites prior to construction. Of the 305 known archaeological sites within the RSA and the Tibbitt to Contwoyto Winter Road Connector Assessment Area only 35 archaeological sites are currently anticipated to be directly impacted by the Project developments. The development of a "Chance Find Procedure" will aid in the identification and avoidance of possible archaeological sites not identified prior to construction and operations.

1.5.3.3 Adaptive Management

For the 130 archaeological sites within 1,000 m of the PDAs or the proposed roads the following adaptive management measures will be instituted:

- For the 35 archaeological sites 0 m to 50 m from the PDAs or the proposed roads, direct impact from construction activities is anticipated and mitigation or protective measures will be undertaken prior to construction.
- For the 15 archaeological sites 50 m to 150 m from the PDAs or the proposed roads, indirect impact from construction activities is anticipated and protective measures will be undertaken.

- For the 80 archaeological sites 150 m to 1,000 m from the PDAs or the proposed roads, indirect impact from increased human presence is anticipated. Monitoring and inspection of these sites will be undertaken on a periodic basis to determine that they remain intact and not effected by the Project.
- For the 175 archaeological sites within the RSA that are greater than 1,000 m from the Project footprint, no impact is anticipated.

1.5.3.4 Site-specific Effects, Management, and Mitigation

Sites LfNo-3, LfNo-5, LhNk-4, LjNh-1, LjNh-2, LjNh-4, LjNh-5, LlNk-1, LlNk-2, LlNk-5, LlNk-7, LlNk-8, LlNk-9, LlNk-10, LlNk-11, LlNk-12, LlNk-18, LlNk-20, LlNk-21, McNj-18, MdNl-5, MdNl-6, MdNl-7, MdNl-8, MdNl-9, MdNl-10, MdNl-11, MdNl-12, MdNl-13, MdNl-14, MdNl-16, MdNl-17, MdNl-18, MdNl-19, and MdNl-20

These sites fall within 0 to 50 m of the PDAs or proposed roads and are at risk if direct impacts from construction activities. Site avoidance through Project redesign is the recommended management option. If avoidance is not possible, mitigation of these sites will be conducted prior to construction activities. Mitigation measures will be determined in consultation with the GN-DCH. Mitigation may involve detailed mapping and systematic data recovery though surface collection, detailed site mapping, photography and controlled subsurface excavations of evaluative units if subsurface deposits are present. Once mitigation and associated reporting have been completed development in this area can proceed.

Site LfNo-2, LfNq-3, LgNm-6, LhNk-2, LhNk-3, LhNk-5, LiNj-4, LlNk-22, MaNj-5, MaNj-6, MbNj-7, MbNj-18, McNj-17, McNk-15, and McNk-23

These sites falls within 50 to 150 m of the PDAs or proposed roads and are at risk if indirect impacts from construction activities. These areas will be marked as “No Work Zone” on development maps and will have protective measures put in place prior to construction which will be determined in consultation with the GN-DCH. McNk-15 is an exception to the above. All artifacts at the site have been collected and no features or subsurface deposits are present. The site has been mitigated and no further work is required.

Sites LfNn-1, LfNo-1, LfNo-4, LfNo-6, LfNo-7, LfNo-8, LfNo-9, LfNo-10, LfNo-11, LfNo-12, LfNo-13, LfNo-14, LfNo-15, LfNo-16, LfNp-1, LfNp-2, LfNp-3, LfNp-4, LgNm-1, LgNm-2, LgNm-3, LgNm-4, LgNm-5, LhNk-1, LhNk-6, LhNk-7, LiNj-1, LiNj-3, LiNk-1, LiNj-2, LjNi-3, LjNi-4, LjNh-1, LjNh-2, LjNh-3, LjNj-2, LjNj-3, LjNj-4, LjNj-5, LjNj-6, LjNh-3, LjNi-1, LkNj-1, LlNj-1, LlNk-3, LlNk-4, LlNk-6, LlNk-13, LlNk-14, LlNk-15, LlNk-16, LlNk-17, LlNk-19, LlNl-14, LlNl-15, MaNj-7, MaNl-1, MaNl-2, MaNl-3, MaNl-4, MaNl-5, MaNl-6, MaNl-7, MaNl-8, MaNl-9, MbNj-1, MbNj-2, MbNj-8, MbNj-17, MbNj-19, MbNj-21, McNk-19, McNk-20, McNk-24, MdNk-24, MdNk-25, MdNk-27, MdNk-43, MdNk-44, MdNk-45, MdNk-46, MdNk-47, and MdNk-48

These sites fall within 150 to 1,000 m of the PDAs or proposed roads and are at risk of increased human presence in the area. These areas will be marked as “No Work Zones” on development maps. Efforts will be made to avoid these sites during construction, operations, and closure. Monitoring and inspection of these sites will be undertaken on a periodic basis. MaNl-1 and MaNl-4 are exceptions to the above. All artifacts at these two sites have been collected and features have been documented by photography and mapping and no further work is required.

1.5.3.5 Offsetting or Enhancement Heritage Resources Valued Socio-economic Component

Prior to construction, mitigation will be carried out at archaeological sites that cannot be avoided by Project developments. It is anticipated that the data gathered from these sites during mitigation will be sufficient to offset the disturbance of these sites by the Project.

1.5.4 Characterization of Residual Effects

The assessment of the potential for residual effects for heritage resources is based on an assessment of VSECs with a focus on archaeological sites. Archaeological sites are considered a heritage resources VSEC as they are protected under the legislation of Nunavut (Section 1.1.1). The assessment of potential for residual effects on archaeological sites takes into account that mitigation measures will be conducted prior to disturbance.

1.5.4.1 Disturbance of Archaeological Sites

During the construction, operational and possibly closure phases, excavation, clearing and grading within the PDAs and along the proposed roads may result in irreversible alteration of archaeological sites that have been identified in areas where the PDAs or proposed roads and archaeological sites occupy the same space or are in close proximity. No impacts are anticipated to the archaeological sites within the RSA that are beyond 1,000 m from the Project footprint. There are 35 archaeological sites that could be directly affected by the Project during construction. Where possible, these sites will be avoided. However, if these sites cannot be avoided, impacts will be mitigated by collecting the information contained within the sites. Prior to a site being impacted, a mitigation plan will be developed in cooperation with the GN-DCH and carried out to their satisfaction. Avoidance measures will be put in place to protect sites that will be indirectly affected during construction and operations and unknown sites will be protected through the implementation of a "Chance Find Procedure." Mitigation by data recovery, monitoring, and/or site protection of archaeological sites that will be directly affected by Project-related activities and avoidance of archaeological sites that will be indirectly affected will reduce cumulative and residual effects to not significant.

1.5.5 Significance of Residual Effects

The significance of the residual effects on Heritage Resources VSECs are summarized in Table 1.5-1 and are discussed in more detail below.

1.5.5.1 Residual Effect Descriptors for Archaeological Sites

The magnitude of the residual effect is determined through professional judgment taking into account the types of affected sites, the significance of affected sites, and the number of similar sites in the area. The assessment of magnitude also accounts for Project commitments and the legislative framework in Nunavut. The geographic extent is determined by the size of the expected scope of the change. The duration and frequency are determined by how long and how often the effect will occur. Reversibility is a measure of how quickly the effect can be returned to the baseline condition, and context is a measure of how the effect will change the population of unaffected sites. Probability is a determination of the likelihood of the event occurring and confidence is a measure of the certainty of the preceding analysis of effects.

Table 1.5-1. Summary of Heritage 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)***
Impact to Known Archaeological Sites	Negative	Low	Long	Once	Local	Irreversible	High	High	Not significant
Impact to Unknown Archaeological Sites	Negative	Low	Long	Once	Local	Irreversible	Low	Moderate	Not significant

Notes:
Certainty around the assignment of Likelihood (only applicable to significant effects)
Level of confidence in the Significance Rating

1.5.5.2 Disturbance of Known Archaeological Sites

The magnitude of change to known sites was assessed to be low, as only 35 sites will be directly impacted out of the 305 known archaeological sites within the RSA and within the TCWR Winter Road Connector Assessment Area. Though the direction of the effect is negative, mitigation through data recovery and/or monitoring will acceptably offset any potential loss of archaeological data reducing the magnitude to low. The geographic extent of the effect was determined to be local as the disturbance of an archaeological site has no effect on other archaeological sites in the area. The duration, frequency, and reversibility of the effect is considered to be long, once, and irreversible, as once the site has been mitigated there are no additional effects to the site through Project activity, and it cannot be rebuilt or reconstituted. The context or resiliency of the population has been determined to be neutral as the disturbance to a site will be offset by the data collected during mitigation. Disturbance to archaeological sites is highly likely to occur as there are archaeological sites in direct conflict with the proposed developments, and it is anticipated that archaeological sites discussed in Section 1.5.2.3 will be impacted. The confidence level in the assessment is high as the requirements of the legislation in Nunavut to conduct site investigations provides a rigorous approach to understanding the effect of the Project on archaeological sites.

1.5.5.3 Disturbance of Unknown Archaeological Sites

The magnitude of change to unknown archaeological sites was assessed to be low as the archaeological impact assessments (AIAs) conducted for the Project were exhaustive and covered the moderate to high potential areas within the Project footprint, and any currently unknown sites in direct conflict with the Project are expected to be small, low density lithic scatters with unstratified deposits. The processes outlined in the Project Chance Find Procedure,and any resulting mitigation, will acceptably offset any potential loss of archaeological data reducing the magnitude of the negative effect to low.

The geographic extent of the effect to unknown archaeological sites was determined to be local as the disturbance of an archaeological site has no effect on other archaeological sites in the area. The duration, frequency, and reversibility of the effect is considered to be long, once, and irreversible, as once the site has been mitigated it has been effectively curated, there are no additional effects to the site through Project activity, and it cannot be rebuilt or reconstituted. The context or resiliency of the VSEC archaeological sites has been determined to be neutral as the disturbance to the site will be offset by the data and knowledge collected during mitigation.

The probability of disturbance to unknown archaeological sites is low as AIAs were conducted; however, there is always a possibility that currently unrecorded archaeological sites may be discovered during ground altering activity. There is a moderate level of confidence that there is low probability of any disturbance to significant unknown archaeological sites.

1.5.5.4 Overall Effect on Archaeological Sites

By committing to site avoidance or mitigation through data recovery and/or monitoring, the archaeological sites for which effects are anticipated will be avoided or adequately mitigated. Residual effects of the Project on heritage VSECs are anticipated to be not significant.

1.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

1.6.1 Methodology Overview

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. Since there are no residual effects from the Project a cumulative effects assessment is not required (Volume 9, Chapter 1).

1.6.2 Potential Interactions of Residual Effects with Other Projects

The development of additional projects, both present and future, and other human land use within the region have the potential to disturb or destroy additional archaeological sites. Disturbance of the archaeological sites that will be impacted by the Project are a spatially localized event that will not result in a negative effect on the condition of other archaeological sites in the region. Further due to the legal requirements in place in Nunavut, it is assumed that residual effects from other projects in the area will also be reduced to not significant through appropriated mitigation measures. Mitigation measures developed in consultation with the GN-DCH are designed to offset the disturbance of the archaeological site through the recovery of scientific data that may not otherwise have been gathered. Therefore no cumulative effects are anticipated due to disturbance of the VSEC archaeological sites by the Project or others in the area.

1.6.3 Identification of Mitigation and Management Measures

Residual effects from other projects in the area will be reduced to not significant through mitigation measures developed in consultation with the GN-DCH designed to offset the disturbance through the recovery of scientific data. Therefore no cumulative effects are anticipated due to disturbance of the VSEC archaeological sites by the Project or others in the area.

1.6.4 Characterization of Cumulative Residual Effects

There are no anticipated cumulative residual effects to the VSEC archaeological sites.

1.7 TRANSBOUNDARY EFFECTS

Disturbance of the archaeological sites is a spatially localized event that will not result in a transboundary effect.

1.8 MITIGATION AND ADAPTIVE MANAGEMENT

1.8.1 Archaeological Sites

Where sites fall within 0 to 50 m of the PDAs or proposed roads, the risk of direct impacts from construction activities is high. Typically, site avoidance through Project redesign is the recommended management option. However, if avoidance is not possible, mitigation of such sites will be conducted prior to construction activities. Mitigation measures are determined in consultation with the GN-DCH and carried out by a professional archaeologist. Mitigation may involve detailed mapping, photography, and systematic data recovery through surface collection, and, if subsurface deposits are present, controlled excavations of evaluative units. Once mitigation and associated reporting have been completed and approved by the GN-DCH development in these areas can proceed.

1.8.2 Summary Table of Mitigation and Adaptive Management Measures

Table 1.8-1 summarizes mitigation and adaptive management measures.

Table 1.8-1. Summary Table of Mitigation and Adaptive Management Measures

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	The Project has been designed to employ winter road only access corridors that travel primarily over lakes and rivers to reduce potential impacts to archaeological sites. Where feasible Project infrastructure has been situated in locations that avoid archaeological sites.
2. Best Management Practices	Avoidance is the preferred management practice for archaeological sites. A Chance Find Procedure is in place to identify and protect unknown archaeological sites.
3. Adaptive Management	For archaeological sites 0 m to 50 m from PDAs or proposed roads, direct impact from construction activities is anticipated and mitigation including systematic data recovery or protective measures will be undertaken prior to construction. For archaeological sites 50 m to 150 m from PDAs or proposed roads, indirect impact from construction activities is anticipated and site protection measures will be undertaken. For archaeological sites 150 m to 1,000 m from PDAs or proposed roads, indirect impact from increased human presence is anticipated. Monitoring and inspection of these sites should be undertaken on a periodic basis to determine that they remain intact and not effected by the Project. For archaeological sites greater than 1,000 m from infrastructure, no impact is anticipated.
4. Monitoring	Construction occurring near archaeological sites which are within 150 m of PDAs or proposed roads will have an Environmental Monitor present during construction. Periodic inspection of archaeological sites within 1000 m of infrastructure will be conducted.
5. Offsetting or Enhancement	Systematic data recovery will be used to offset adverse effects on archaeological sites that cannot be avoided.

1.9 PROPOSED MONITORING PROGRAMS

Construction occurring near archaeological sites which are within 50 to 150 m of the Project footprint will monitored and protective measures put in place prior to construction. Development maps will clearly indicate the location of archaeological site boundaries in relation to Project footprint components. The Environmental Monitor will watch for archaeological site impacts or situations where construction activities are occurring less than 50 m from a site. Should impacts be anticipated to occur less than 50 m from a site, the Project archaeologist will be contacted to determine if mitigation measures, which may include systematic data recovery, are required.

The placement of protective measures for marking of archaeological site boundaries will take place prior to construction during snow-free conditions and when the ground is not frozen.

Archaeological sites which are within 150 to 1,000 m of the Project footprint will be checked on a periodic basis to determine that they remain intact and unaffected by the Project.

Should impacts be observed at archaeological sites, the Project archaeologist and the GN-DCH will be contacted and notified of any impacts. Post-impact mitigation plans will be developed in consultation with the GN-DCH on a case-by-case basis

The monitoring of sites will be documented, by means of photographs and field notes, the type of construction and/or disturbance occurring near a site, weather conditions, personnel present, and other pertinent details. It is imperative that detailed field notes are recorded during monitoring.

A data report will be completed following monitoring conducted at each site. The reports will generally include the site's Borden number, a summary of the methods and equipment used, GPS location, a photo log of the photographs taken during monitoring, a map showing the location of the site being monitored in relation to the Project component.

1.9.1 Cultural and Heritage Resources Protection Plan

The Cultural and Heritage Resources Protection Plan (Volume 10) includes the following:

- applicable regulations and guidelines for management of potential impacts to identified cultural and heritage resources;
- results of archaeological investigations and studies;
- inventory of known archaeological resources in Project areas;
- discussion of how the results from the impact assessment have been considered and incorporated into the plan; and
- general and site-specific measures for the protection of archaeological sites and mitigation of potential adverse impacts.

Thorough site-specific mitigation plans for sites that cannot be avoided will be developed in consultation with the GN-DCH prior to construction permitting.

1.10 IMPACT STATEMENT

Both recorded and unrecorded archaeological sites are protected by legislation in Nunavut and may be directly affected during construction, operations and possibly closure. Effects on archaeological sites that cannot be avoided will be mitigated through measures to be developed in consultation with the GN-DCH and will be carried out under a Class 2 archaeologist's permit. With avoidance and/or mitigation implemented, residual effects on known archaeological sites are anticipated to be not significant. The use of the "Chance Find Procedure" during construction and operations will facilitate the protection of any archaeological sites within the Project footprint not identified during the AIAs. If present, they will be avoided and/or mitigated in a similar manner to that described for known archaeological sites and no significant adverse residual effects will result. Due to the spatially localized nature of archaeological sites there are no cumulative effects from the Project on the VSEC archaeological sites.

1.11 SUPPORTING AND SUPPLEMENTAL INFORMATION

All information requested in the EIS Guidelines (NIRB 2013) is provided in the previous sections of this chapter.

2. Paleontology

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2. Paleontology

2.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

The Back River Project (the Project) is located in the Kitikmeot region of Nunavut. The Project includes the Goose Property, the George Property, and a Marine Laydown Area situated in the southern portion of Bathurst Inlet, and connecting winter roads. The mine plan for the Project is a 10 year operating mine life based on currently known resources, though continued exploration may extend projected mine life. A combination of open pit and underground mining methods will be used for mineral extraction. Waste rock will be stored in designated storage areas on the surface or backfilled in mine workings at both properties. Tailings from the mill will be stored in a single Tailings Impoundment Area (TIA) in the area of the mill.

Potential Development Areas (PDAs) have been identified for the Goose Property, the George Property, and the Marine Laydown Area. Since the Project design is at the conceptual phase, the actual footprint of the facilities are likely to shift within these PDAs as further geotechnical investigations are undertaken and the design of the facilities is finalized. The PDAs makes allowances for potential relocation of certain facilities within their boundaries. For paleontology VSECs it is assumed that the entire area of the PDA is lost for the duration of the mine life.

The baseline data used to determine the effects of the Project on the paleonotological resources VSEC are discussed below.

2.1.1 Territorial and Federal Legislation

All paleontological sites in Nunavut are protected under territorial or federal legislation. Archaeological and paleontological sites are protected under Section 51 of the *Nunavut Act* (1993; Nunavut Archaeological and Palaeontological Sites Regulations [SOR/2001-220]).

Permits to conduct paleontological research throughout Nunavut are applied for and issued under the *Nunavut Act* (1993; Nunavut Archaeological and Paleontological Sites Regulations [SOR/2001-220]). In addition, work conducted on Inuit Owned Lands or within the Nunavut Settlement Area should be conducted in accordance with Articles 21 and 33 of the *Nunavut Land Claims Agreement* (1993).

2.1.2 Paleontology Background

The Back River Project paleontological Regional Study Area (RSA) in Nunavut Territory is located in the northeastern corner of the Slave Structural Province (Figure 2.1-1). The RSA is predominantly underlain by folded turbiditic meta-sediments of the Archean (~ 1.8 Ga) Beechey Lake Group, cut by felsic and gabbroic dikes, sills, and small intrusions. Only the sedimentary rocks are of interest from a paleontological perspective, as intrusive igneous rocks have no potential to contain fossils and metamorphosed rocks would not preserve fossils of the size prevalent during this interval of geologic time.

The Local Study Area (LSA) was chosen to be the same as the Project Development Areas (PDAs) as these are the location where Project infrastructure is expected to result in surface and subsurface impacts. (Figure 2.1-1, Table 2.1-1). The Goose and George Property areas are located on rocks of the Beechey Lake Group, part of the Yellowknife Supergroup. The Yellowknife Supergroup represents a heterogenous assemblage consisting of greywacke, pelite; minor quartzite, conglomerate, iron-formation, marble, and volcanics. The turbiditic sequence of the Beechey Lake Group is composed of interbedded greywacke, mudstone, and variably silicified iron formation units (SRK 2012). These are unconformably overlain by sediments of the Lower Proterozoic Epworth Group, exposed on the north

and east margins of the George Property and around Bathurst Inlet. The Epworth Group consists of a succession of deltaic sandstones, stromatolitic carbonates, shallow and deep water mudstones, and fluvial sandstones (Cecile and Campbell 1977).

The Marine Laydown Area is located on rocks of the Lady Nye Formation, a division of the roughly 1.6 to 1.8 Ga Hornby Bay Group that consists of sandstone, conglomerate, siltstone, and dolomite.

2.1.3 Previous Paleontological Research in the Regional Study Area

No paleontological studies appear to have been carried out in the RSA, and as a result records are lacking on the presence of fossil species in the Beechey Lake and Goulburn Groups, though biological structures have been identified in the form of stromatolites (Cecile and Campbell 1977). Lack of fossils is identified as one of the barriers to subdividing and dating the succession of greywacke-mudstone turbidites (Ootes, Bleeker, and Jackson 2009). However, it is possible to suggest the most likely findings, based on the ages of the sediments and their depositional environment.

The dominant sediments in the RSA are Late Archean to Proterozoic in age (~2.6-1.8 Ga). The fossil record during this interval is dominated by the occurrence of stromatolites. These layered, mound-like structures are produced by communities of photosynthetic bacteria. In exceptional circumstances, cells of bacteria can be preserved (Schopf, 2006). Stromatolites have been encountered at the boundary between felsic rocks from the Back River volcanic complex and the Beechey Lake turbidites (Lambert 1998). They have also been found in the Kilohigok Basin around Bathurst Inlet (Pelechaty and Grotzinger 1988), and in the Goulburn Group sediments. Given the clastic nature of these sediments, the fine-scale preservation necessary for the preservation of cellular detail is improbable.

The presence of stromatolites is consistent with a depositional setting of a shallow marine basin. This is also consistent with the tectonic placement of the study area in a back-arc basin associated with the Back River volcanic complex, comparable to the modern-day Sea of Japan between the islands of Japan and mainland China.

This paleoenvironment makes it possible to deduce the types of fossils that may be observed in the Epworth Group. As the units within the Epworth Group are predominantly shallow and deep water marine sediments, Proterozoic marine life forms would likely provide the fossil source. The record for fossil species at this point in the rock record is exclusively microscopic, consisting of some of the earliest multicellular and eukaryotic organisms. As these organisms were unmineralized and microscopic, they had very low preservation potential, their occurrence being typically confined to cherts (Schopf, 2006). Consequently, the potential for encountering paleontological resources in the study area is limited to the discovery of stromatolites.

2.2 INCORPORATION OF TRADITIONAL KNOWLEDGE

The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* was reviewed for information relating to paleontological sites. No information on paleontological sites was found in the NTKP report (KIA 2012).

2.3 VALUED COMPONENTS

2.3.1 Potential Valued Components and Scoping

Paleontological sites were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, paleontological sites were classified as a Subject of Note.

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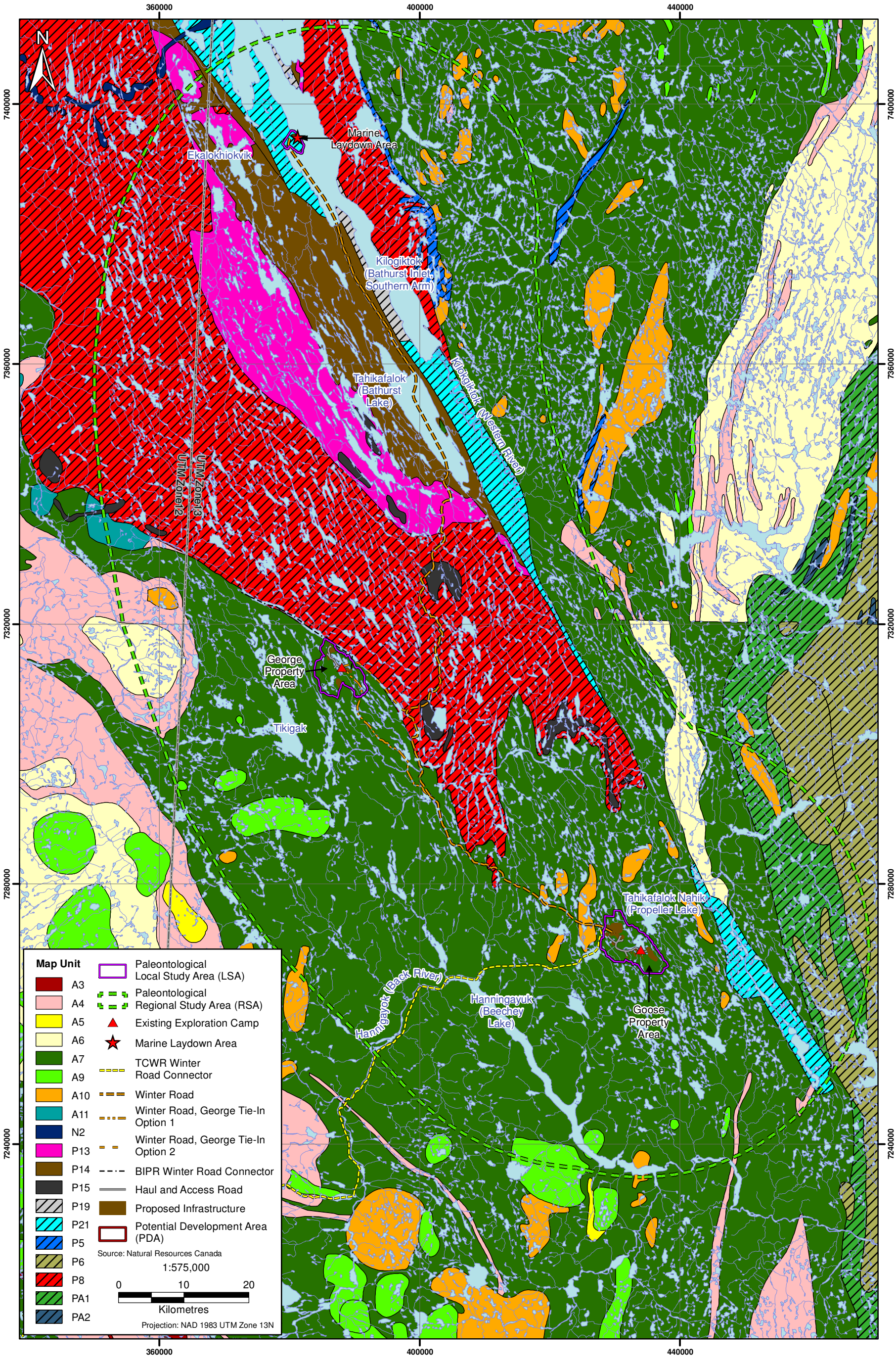


Figure 2.1-1

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Bedrock Geology for the Back River Paleontological Study Areas

Figure 2.1-1

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Table 2.1-1. Bedrock Geology Map Legend

Map Unit	Description
A1	Acasta gneiss complex in Slave craton: granitic, granodioritic, tonalitic and dioritic orthogneiss, minor paragneiss, mafic and ultramafic enclaves (4.0?3.4 Ga).
A2	Point Lake and Sleepy Dragon gneiss complexes in Slave craton: granitic, granodioritic, tonalitic and dioritic orthogneiss, minor paragneiss, mafic and ultramafic enclaves (3.2?2.8 Ga).
A3	Yellowknife Supergroup in Slave craton: mainly basaltic volcanic and related intrusive rocks; minor andesite, rhyodacite, rhyolite; metamorphic equivalents, includes minor pre-Yellowknife Supergroup metavolcanic rocks (2.71?2.68 Ga).
A4	Yellowknife Supergroup in Slave craton: mainly andesitic and dacitic volcanic and related intrusive rocks, derived sediments; minor basalt, rhyodacite, rhyolite; metamorphic equivalents.
A5	Yellowknife Supergroup in Slave craton: mainly rhyodacitic and rhyolitic volcanic and related intrusive rocks, derived sediments; minor basalt, andesite, dacite; metamorphic equivalents (2.69?2.66 Ga).
A6	Deformed granitoids in Slave craton coeval with Yellowknife volcanics: tonalite, granodiorite, quartz diorite, diorite, gabbro, anorthosite (2.69?2.65 Ga).
A7	Beechey Lake Group, Yellowknife Supergroup in Slave craton: greywacke, pelite; minor quartzite, conglomerate, iron-formation, marble, volcanics; metamorphic equivalents; includes minor pre-Yellowknife Supergroup metasedimentary rocks.
A8	Undifferentiated gneiss complexes in Slave craton: paragneiss, orthogneiss, includes possible pre-Yellowknife Supergroup rocks.
A9	Deformed granitoids in Slave craton younger than Yellowknife volcanics: tonalite, granodiorite, granite, quartz diorite, diorite, gabbro (2.63?2.59 Ga).
A10	Undeformed granitoids in Slave craton: granite, granodiorite, tonalite (2.61?2.56 Ga).
A11	Undifferentiated granitoids in Slave craton and deformed equivalents in Wopmay orogen: granite, granodiorite, tonalite, quartz diorite, diorite, gabbro.
M1	LeRoux, Fort Confidence and Dease Lake formations (Dismal Lakes Group) in Coppermine homocline: sandstone, shale, dolomite.
M2	Kendall River, Sulky and Greenhorn Lakes formations (Dismal Lakes Group) in Coppermine homocline; Parry Bay and Kanuyak formations in Bathurst Inlet and Kent Peninsula; Lookout Point Formation in Thelon basin: dolomite.
M3	Muskox Intrusion in Wopmay orogen: serpentinized dunite and peridotite, pyroxenite, gabbro, picritic border phase and feeder dyke, hybrid upper border phase (1.27 Ga).
M4	Fortress cone sheets in Great Slave Lake; unnamed sills in Wopmay orogen and Coppermine homocline: gabbro, diabase (1.27 Ga).
M5	Copper Creek Formation in Coppermine homocline; Ekalulia Formation in Bathurst Inlet and Kent Peninsula: plateau basalt, minor gabbro (1.27 Ga).
M6	Husky Creek Formation in Coppermine homocline; Algak Formation in Bathurst Inlet and Kent Peninsula: red sandstone, siltstone, minor basalt.
MP	Western Channel sheets in Coppermine homocline: diabase, gabbro.
N1	Hottah sheets in Wopmay orogen: gabbro, diabase (0.78 Ga).
N2	Franklin sills in Coppermine homocline: gabbro, diabase (0.72 Ga).
NM	Rae Group in Coppermine homocline: sandstone, siltstone, dolomite, shale; includes undifferentiated Franklin sills.
P1	Big Spruce, Blachford and Booth River intrusive suites in Slave craton: alkaline, peralkaline and subalkaline granite, quartz syenite, diorite, gabbro, foyaite, ijolite, carbonatite (2.19?2.02 Ga).
P2	Snare Group in Wopmay orogen (equivalent to Melville, Epworth and/or Grant groups): quartzite, siltstone, pelite, dolomite, basalt.
P3	Melville Group in Wopmay orogen: basalt, gabbro, dolomite, argillite, siltstone, arkose, conglomerate (2.02 Ga).

(continued)

Table 2.1-1. Bedrock Geology Map Legend (completed)

Map Unit	Description
P4	Union Island Group in Great Slave Lake: dolomite, shale, siltstone, basalt, quartzite, conglomerate.
P5	Kimerot Group in Kilohigok basin: quartzite, dolomite.
P6	Taltson-Thelon magmatic zone: magnetite-series granite, charnockite, granodiorite, tonalite, enderbite, quartz diorite, diorite, gabbro (1.99?1.91 Ga).
P7	Taltson-Thelon magmatic zone: ilmenite-series granite (1.94?1.91 Ga).
P8	Epworth Group in Wopmay orogen; Bear Creek Group in Kilohigok basin; Wilson Island and Sosan groups in Great Slave Lake: arkose, quartzite, siltstone, argillaceous dolomite, dolomite, basalt, rhyolite (1.97?1.89 Ga).
P9	Lower Nonacho Group (Hjalmar and Tronka Chua formations) in Chruchill hinterland: conglomerate, arkose.
P10	Middle Nonacho Group (Chief Nataway and Newshethdezza formations) in Churchill hinterland: siltstone, arkose.
P11	Upper Nonacho Group (Thekulthili and Taltson formations) in Churchill hinterland: conglomerate, arkose.
P12	Akaitcho, Grant and lower Bell Island Bay groups of Hottah terrane in Wopmay orogen: basalt, gabbro, rhyolite, intrusive porphyry, arkose, pelite, marble (1.90?1.89 Ga).
P13	Recluse Group in Wopmay orogen; Peacock Hills and Kuuvik formations in Kilohigok basin; Kahochella and Pethei groups in Great Slave Lake: greywacke, argillite, concretionary argillite, argillaceous limestone, limestone,
P14	Takiyuak Formation in Wopmay orogen; Brown Sound and Amagok formations in Kilohigok basin; Christie Bay Group in Great Slave Lake: red sandstone, siltstone, limestone, dolomite, basalt, halokinetic(?) megabreccia.
P15	Morel sills in Wopmay orogen and Kilohigok basin: gabbro, diabase.
P16	Hepburn intrusive suite in Wopmay orogen; Butte Island intrusive suite in Great Slave Lake: ilmenite-series granite, granodiorite, tonalite, quartz diorite, diorite hornblendite, norite, peridotite (1.89?1.87 Ga).
P17	MacTavish Supergroup in Wopmay orogen: rhyolite, rhyodacite, dacite, andesite, basalt, gabbro, intrusive felsic porphyry, sandstone, conglomerate, siltstone (1.87?1.86 Ga).
P18	Great Bear and Bishop intrusive suites in Wopmay orogen; Compton laccoliths in Great Slave Lake: magnetite-series granite, granodiorite, quartz, monzonite, quartz diorite, diorite (1.87?1.84 Ga).
P19	Tinney Cove Formation in Bathurst Inlet; Et-then Group in Great Slave Lake: conglomerate, sandstone.
P20	Bigbear and Fault River formations (Hornby Bay Group) in Coppermine homocline and Wopmay orogen: sandstone, conglomerate.
P21	Lady Nye Formation (Hornby Bay Group) in Coppermine homocline; Ellice Formation in Bathurst Inlet and Kent Peninsula; Thelon Formation in Thelon basin: sandstone, conglomerate, siltstone, dolomite.
P22	East River Formation (Hornby Bay Group) in Coppermine homocline: dolomite, minor quartzite, mudstone.
P23	Kaertok Formation (Hornby Bay Group) in Coppermine homocline: sandstone, mudstone, dolomite.
P24	Narakay volcanic complex (Hornby Bay Group) in Coppermine homocline: mafic and felsic tuffs, flows and plugs, sandstone, shale, dolomite (1.66 Ga).
PA1	Gneiss complexes in Churchill hinterland: granitic, granodioritic, tonalitic and dioritic orthogneisses, in part hypersthene-bearing, minor paragneiss, mafic and ultramafic enclaves.
PA2	Metamorphic suites in Churchill hinterland: paragneiss, quartzite, marble, amphibolite, iron-formation.
PA3	Mafic intrusive suites in Churchill hinterland: gabbro, diorite, peridotite.
PA4	Felsic intrusive suites in Churchill hinterland: granite, granodiorite, quartz diorite.
PA5	Undersaturated intrusive suites in Churchill hinterland: nepheline syenite, syenite.
PA6	Holly Lake metamorphic suite of Hottah terrane in Wopmay orogen: quartzite, siltstone, pelite, mafic and intermediate volcanic rocks, amphibolite.
PA7	Intrusive suites of Hottah terrane (conjectural south of latitude 65?N) in Wopmay orogen: granite, granodiorite, tonalite, quartz diorite, amphibolite.

2.3.2 Valued Components Included in Assessment

Paleontological effects have been scoped out as there are no known paleontological sites protected by legislation that may be affected by development of the Project. (Section 2.1.1).

2.3.3 Supporting and Supplemental Information

There is no additional information requested in the NIRB-issued EIS guidelines on paleontology.

3. Socio-economics

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3. Socio-economics

The potential effects of the Back River Project (the Project) on social and economic conditions are assessed in this chapter. This includes consideration of predicted effects on employment, education and training, economic development, business opportunities, and health and community well-being (CWB). Social and economic effects are predicted and evaluated at the local, regional, territorial, and nation level, where relevant.

3.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

This section provides a summary of the methods and results of the socio-economic baseline information collected for the proposed Project. Research studies were carried out in the fall and winter of 2012. Detailed information on the methods and results for socio-economic studies is provided in the 2013 Back River Socio-economic and Land Use Baseline Report (Appendix V8-3A; Rescan 2012).

3.1.1 Method

The collection of baseline information focused on the need to generate a profile of key socio-economic characteristics for the Kitikmeot Region. Information from Statistics Canada, the Nunavut Bureau of Statistics, the Government of Nunavut (GN), and other sources were compiled and analyzed, and a literature review of the relevant published material was conducted. Information is provided at the regional and community levels. Regional-level information is presented for the Kitikmeot Region of Nunavut, while community-level information is presented for individual Kitikmeot communities: Bathurst Inlet (also known as Kingaok), Omingmaktok (also known as Bay Chimo), Cambridge Bay (also known as Iqaluktuuttiaq), Kugluktuk (previously known as Coppermine), Gjoa Haven (also known as Uqsuqtuuq), Taloyoak (previously known as Spence Bay), and Kugaaruk (previously known as Pelly Bay). The communities of Omingmaktok and Bathurst Inlet are no longer occupied year round and do not offer typical municipal services such as health and education services. As such, this research focused on the five Kitikmeot communities that are populated year round.

Desk-based research consisted of reviewing documents and databases to identify and compile available information. Initially, an internet and bibliographic search was completed to identify potential information sources. The identified sources were then reviewed and applicable information extracted. Sources that were accessed included publically available statistics from government agencies, government reports, private sector and non-governmental organization reports, academic literature, and internet publications.

Socio-economic fieldwork was completed in September and October of 2012 and included 60 key knowledge holder interviews with Kitikmeot Region service providers from government administration, health services, wellness and social services, safety and protection services, business and economic development, and education and training.

3.1.2 Results

The following sections include socio-economic baseline study results at the regional and community level. Comprehensive data are provided in the 2013 Back River Socio-Economic and Land Use Baseline Report (Appendix V8-3A; Rescan 2012).

3.1.2.1 Demographics

Within the Kitikmeot Region there are seven communities-Bathurst Inlet, Omingmaktok, Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk. Cambridge Bay, a traditional hunting and fishing location, is the largest community, acting as a regional hub for government and business, as well as transportation to and from the region. Kugluktuk and Gjoa Haven have slightly smaller but growing populations, with growth primarily attributed to opportunities in the government and mining sectors. Gjoa Haven, Taloyoak, and Kugaaruk have economies that are mainly based on the public sector and traditional subsistence land-based activities (Statistics Canada 2007c). Bathurst Inlet and Omingmaktok have seasonal populations related to traditional land-based activities and, to a lesser extent, eco-tourism operations.

Population

The population of the Kitikmeot Region has grown steadily from 2001 to 2006, from approximately 4,816 to 5,361 individuals, an increase of 11.3% (Statistics Canada 2007b). The population of the Kitikmeot Region increased again between 2006 to 2011, from approximately 5,361 to 6,012, an additional 12.1% increase (Statistics Canada 2012a). The 2011 Census of Canada indicated the Kitikmeot communities range in size, from Cambridge Bay, the largest, with approximately 1,608 individuals, to Kugaaruk, the smallest, with approximately 771 individuals.[1] Kugluktuk and Gjoa Haven had populations of 1,450 and 1,279, respectively, while Taloyoak, the second smallest community, had a population of 899. For Nunavut as a whole, a strong natural increase and net in-migration from other areas of Canada are the main factors that contributed to population growth (Statistics Canada 2012a).

The Kitikmeot communities (Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk) have experienced immense population growth over this time period (1981 to 2011), having at least doubled in size (with the exception of Kugluktuk, which has experienced a comparatively smaller population increase of approximately 79%). The populations of Nunavut and the Kitikmeot Region have also experienced a doubling over this time period, with increases of 104.9 and 104.1%, respectively. The largest population increases in the Kitikmeot Region took place in Kugaaruk (200.0%) and Gjoa Haven (144.6%).

Residents of Bathurst Inlet and Omingmaktok have been historically underrepresented in Statistics Canada data. For example, Statistics Canada recorded the population of Bathurst Inlet as five in 2001 and zero in 2006. The underrepresentation is likely a result of small size of the communities and other difficulties associated with collecting data. The Nunavut Bureau of Statistics has also counted the populations of these two settlements as zero each year from 2006 to 2012. Community research indicates that residents of Bathurst Inlet relocated to Cambridge Bay approximately five years ago and residents of Omingmaktok relocated to Cambridge Bay in the fall of 2011. Both groups return to their home communities at select times throughout the year (Back River Project Research Program 2012). As a result, there is no statistical data for these two settlements and the following discussion focuses on the five Kitikmeot communities.

Aboriginal Population

A high proportion of the population in the communities is Aboriginal, primarily Inuit. The Aboriginal population in the Kitikmeot Region was approximately 4,800 (90% of the total population) in 2006, of which 4,725 were Inuit. For Cambridge Bay, approximately 83% of residents self-identified as Aboriginal. This proportion was higher in all the other Kitikmeot communities, with 92% or more identifying as Aboriginal.

[1] Bathurst Inlet and Omingmaktok are the smallest Kitikmeot communities, and because of their small size, do not have secondary statistical information available. See Appendix V8-3A for community profile.

Age Distribution

All communities have exceptionally young populations as compared to the rest of Canada. In 2011, the median age ranged from 27.4 years in Cambridge Bay to 18.4 years in Kugaaruk. The Kitikmeot Region has a median age of 23.0 years, slightly younger than Nunavut's median age of 24.1 years and much younger than the Canadian median age of 40.6 years (Statistics Canada 2012a).

In 2011, the proportion of the population under the age of 15 in the Kitikmeot communities ranged from a low of approximately 29% in Cambridge Bay to a high of approximately 42% in Kugaaruk (Nunavut Bureau of Statistics 2011b). The Government of Nunavut's (GN's) population projections predict the population will age moderately by 2036, although it will remain a substantially younger population as compared to Canada (Nunavut Bureau of Statistics 2010a).

Gender

The Kitikmeot communities tend to have a slightly higher proportion of males to females, with the most notable differences in Gjoa Haven and Kugaaruk with a male population of 52% (Statistics Canada 2012a).

Family Structure

Family structure in Nunavut differs from that of the general Canadian population. Within the Kitikmeot communities and the three Nunavut regions, families typically consist of approximately 70 to 75% family couples (married and common-law) and 25 to 30% lone-parent families, whereas in Canada approximately 84% are family couples and 16% are lone-parent families. The most notable difference in family structure is seen in the proportion of married couples in Nunavut (48.3%) as compared to the average for Canada as a whole (80.1%).

Language

Sixty-one percent of people in Nunavut reported an Inuit language as their mother tongue. The majority of residents in Taloyoak and Kugaaruk indicated Inuktitut was their mother tongue. However in the eastern Kitikmeot and Gjoa Haven, the majority indicated English was their mother tongue. More Kitikmeot residents reported English as the language spoken most often at home rather than one of the Inuit languages. Further, a majority of Kitikmeot residents speak English at home, including those in the eastern Kitikmeot where Inuktitut was the most commonly reported mother tongue. Inuinnaqtun speakers are mainly located in Kugluktuk, although a small number reside in Cambridge Bay (Nunavut Bureau of Statistics 2012b).

3.1.2.2 Employment

Labour Force

The potential labour force (i.e., 15 years of age and older) within the Kitikmeot communities (excluding Bathurst Inlet and Omingmaktok) was approximately 3,475 in 2006. The active labour force among these same communities was approximately 2,185 individuals, indicating an average participation rate (i.e., percentage of the potential labour force that is active) of 62.9%. This level of participation is lower than the Nunavut average of 65.3% and the Canadian average of 66.8% (Statistics Canada 2007b).

Participation rates among the communities ranged from approximately 70.6% in Cambridge Bay to 57.6% in Taloyoak, with Gjoa Haven, Kugluktuk, and Kugaaruk having participation rates of 61.4, 60.3, and 58.0%, respectively. Employment rates varied by more than 23%; from 40.4% in Taloyoak to 63.7% in Cambridge Bay. The unemployment rate in all communities was relatively high compared to

the national average of 6.6% and the Nunavut average of 15.6%, except for Cambridge Bay, which reported an unemployment rate of 9.7%. Approximately one-fifth of the Kitikmeot labour force are unemployed; resulting in the highest unemployment rate regionally (20.2%), notably higher as compared to the Baffin (14.0%) and Kivalliq (15.7%) regions, which more closely reflect the territorial rate (15.6%; Statistics Canada 2007b).

A portion of the non-Inuit population residing in the Kitikmeot Region have relocated from southern communities for the purpose of employment. However, the majority of the population in the Kitikmeot communities are Inuit and this segment of the population is experiencing rapid growth, meaning that Inuit comprise the large majority of the labour force. Participation rates among the Aboriginal identity population[2] in the Kitikmeot communities vary from a high of 64.4% in Cambridge Bay to a low of 56.0% in Taloyoak, resulting in an overall rate for the region (59.5%) that is similar to the rate for Nunavut (59.1%) and moderately lower than the rate for the Aboriginal population of Canada (63.0%; Table 3.1-1). Employment rates in the region vary by community, from a low of 38.5% in Gjoa Haven to a high of 55.6% in Cambridge Bay. Notably, the employment rate in Cambridge Bay is higher than the rates for both Nunavut and Canada. Unemployment rates were considerably higher in Gjoa Haven and Taloyoak (31.9% and 31.4%, respectively) as compared to the rate for the Canadian Aboriginal population (14.8%; Table 3.1-1). This focused account of Aboriginal labour force characteristics shows greater balance in participation rates between the Kitikmeot, Kivalliq, and Baffin Regions (59.5%, 57.5%, and 59.9%, respectively). In terms of unemployment among the Aboriginal identity population, the Kitikmeot remains highest of the three regions (23.5%), but more closely reflects the territorial average (20.1%).

Table 3.1-1. Labour Force Activity Characteristics of the Aboriginal Identity Population (2006)

	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk	Kitikmeot Region	Kivalliq Region[2]	Baffin Region	Nunavut	Canada
Aboriginal identity population 15 years and over[1]	800	800	605	455	365	3,040	4,570	7,900	15,510	823,890
In the labour force	515 (64.4%)	460 (57.5%)	360 (59.5%)	255 (56.0%)	210 (57.5%)	1,810 (59.3%)	2,630 (57.5%)	4,730 (59.9%)	9,170 (59.1%)	519,250 (63.0%)
Employed	445 (55.6%)	340 (42.5%)	245 (40.5%)	175 (38.5%)	165 (45.2%)	1,385 (45.6%)	2,135 (46.7%)	3,800 (48.1%)	7,325 (47.2%)	442,395 (53.7%)
Unemployed	70 (8.8%)	120 (15.0%)	115 (19.0%)	80 (17.6%)	45 (12.3%)	425 (14.0%)	495 (10.8%)	930 (11.8%)	1,845 (11.9%)	76,860 (9.3%)
Not in the labour force	285 (35.6%)	340 (42.5%)	245 (40.5%)	200 (44.0%)	155 (42.5%)	1,230 (40.5%)	1,940 (42.5%)	3,165 (40.1%)	6,340 (40.9%)	304,635 (36.9%)
Participation rate	64.4%	57.5%	59.5%	56.0%	57.5%	59.5%	57.5%	59.9%	59.1%	63.0%
Employment rate	55.6%	42.5%	40.5%	38.5%	45.2%	45.6%	46.7%	48.1%	47.2%	53.7%
Unemployment rate	13.6%	26.1%	31.9%	31.4%	21.4%	23.5%	18.8%	19.7%	20.1%	14.8%

Source: Statistics Canada (2007a).
[1] Aboriginal identity population 15 years and over refers to the total number of people who identify as Aboriginal and indicate they were in the labour force or not in the labour force the week prior to the Census Day (May 16, 2006).
[2] Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.

[2] Statistics Canada uses the term Aboriginal identity population to refer to all persons who reported identifying with at least one Aboriginal group, that is North American Indian, Métis, or Inuit, and/or those who reported being a Treaty Indian or a Registered Indian, as defined by the *Indian Act* of Canada.

Labour Force Experience

The majority of Kitikmeot residents in the workforce were employed in service-based activities. In 2006, the largest proportion of the labour force worked in sales and service occupations, ranging from 23% (Cambridge Bay) to 36% (Kugaaruk). In the majority of the communities, the second largest portion of the labour force was employed in 'trade, transport, and equipment operations' occupations. Cambridge Bay was the exception where 'business, finance, and administration' was the second largest portion of the labour force, which can be expected given Cambridge Bay's role as a service centre in the Kitikmeot Region. 'Social science, education, government, and religion' was the third most common occupational category, engaging around 15% of the labour force in all communities. Management was of particular importance in Cambridge Bay, accounting for more than 14% of the labour force. 'Occupations unique to primary industries', including mining, accounted for less than 5% of the local workforce within each community, ranging from less than 2% in Cambridge Bay (approximately 10 people) to 5% in Gjoa Haven and Kugaaruk (approximately 10 people).

All Kitikmeot communities exhibit high participation in the education, business, retail, and other services sectors. Retail trade is particularly important in Kugaaruk and Gjoa Haven (16 and 15% of the labour force, respectively). These labour trends are typical for small, relatively isolated northern communities (Statistics Canada 2007b). The GN is also a notable employer in the Kitikmeot Region, as it is committed to a decentralized model of government, with the goal of benefitting all Nunavummiut through the sharing of government employment and training among communities.

Income

Cambridge Bay had a substantially higher median individual income ($26,061) than the territorial average ($20,982) in 2005. Other Kitikmeot communities reported median individual incomes below the Nunavut average. Cambridge Bay also reported the highest median household income among the Kitikmeot communities ($71,936), which is approximately 22% more than the community with the second highest household income (Kugaaruk at $58,624) and almost 20% more than the Nunavut average. Regionally, median household income in the Kitikmeot falls between that of the Kivalliq and Baffin Regions ($49,835 and $66,517, respectively). With the exceptions of Cambridge Bay and Kugluktuk, all communities sourced a relatively large amount of household income from government transfers, compared to the average for Nunavut as a whole (11.2%; (Statistics Canada 2007b).

In general, all communities reported high proportions of part-time or seasonal work, ranging from approximately 58% in Cambridge Bay to 87% in Gjoa Haven. In Kugluktuk, 72% of work was part-time or seasonal and 74% of work in each Taloyoak and Kugaaruk was part-time or seasonal (Statistics Canada 2007b). This has the overall effect of greatly lowering total annual earnings compared to what would be achieved with more full-time employment.

On the whole, the Kitikmeot Region has the lowest earnings in comparison to the other two regions of Nunavut (Statistics Canada 2007b). In addition, in the Kitikmeot communities, women earn significantly less than men. The largest gender disparities in terms of full-time earnings were observed in Taloyoak, where male earnings were more than double female earnings. In general, the Kitikmeot communities have the highest salary disparity between genders than any other region in Nunavut (Nunavut Bureau of Statistics 2008).

3.1.2.3 Education and Training

Each of the study communities, with the exception of Bathurst Inlet and Omingmaktok, is provided with kindergarten, elementary, and secondary schooling. There are separate secondary and elementary schools in the larger communities (i.e., Cambridge Bay, Kugluktuk, and Gjoa Haven); while in the

smaller communities (i.e., Taloyoak and Kugaaruk) there is a single school for all grade levels. Students are provided with the opportunity to obtain their high school certificate (or equivalent) within their home community. The operation of public schools in the region is overseen by the GN through the Kitikmeot School Operations' office based in Kugluktuk. Schools in the Kitikmeot Region typically provide English, math, science, art, physical education, health, and language classes (either Inuinnaqtun and Inuktitut), as well as career and program planning.

Western education has been controversial for the Inuit as a result of residential schools, social issues around the settlement of communities in the 1960s, and intercultural differences related to culturally appropriate and accessible education. Issues related to these events continue to be relevant today, and for some Inuit who have lived through these changes, obtaining a Western education is not seen as relevant or highly valued (Pauktuutit Inuit Women of Canada 2006; Inuit Tapiriit Kanatami 2007; Back River Project Research Program 2012).

Educational Attainment

Attainment levels for apprenticeship and trade certifications ranged from almost one-quarter of the population in Kugaaruk (22%) to just over one-tenth (12%) of the population in Cambridge Bay. The two most common levels of education in the Kitikmeot Region were trades certificates and college or non-university diplomas. In the western communities, the percentage of individuals who obtained college or other non-university diplomas was higher than trades certificates, while in Gjoa Haven, the proportions were equal, and in the remaining two Kitikmeot communities (Taloyoak and Kugaaruk), trades certificates were more common as compared to college and other non-university diplomas.

In general, high school completion rates remain low in all communities. Gjoa Haven residents exhibited the lowest level of educational attainment in the region, with over 59% of the population aged 25 to 64 lacking high school or other certificates/diplomas. In contrast, Cambridge Bay residents had the highest level of educational attainment among the communities, with approximately 36% of residents aged 25 to 64 without high school or other certificates/diplomas. However, for all Kitikmeot communities, the proportion of the population without high school or other certificates/diplomas is well above the Canadian average of 15.4% (Statistics Canada 2007b).

Among the Kitikmeot communities, Cambridge Bay had a relatively high proportion of the population with a university certificate/diploma (16%) or a college degree or diploma (24%) compared with the other communities.

Enrolment and Graduation Levels

Public school enrolment in Kitikmeot schools decreased between 2003 and 2011 for all communities with the exception of Taloyoak, which experienced a slight increase. Truancy rates increased in all Kitikmeot communities between 2001/2002 and 2010/2011, with the largest increases taking place in Cambridge Bay and Kugluktuk, with approximate 5 and 10% increases, respectively. Truancy is often cited as one of the biggest challenges facing educators in Kitikmeot schools (Back River Project Research Program 2012).

The number of high school graduates varied by community size between 2001 and 2011. For example, the eastern Kitikmeot communities have consistently lower numbers of graduates as compared to the two larger, more populous, western Kitikmeot communities (Back River Project Research Program 2012).

Post-secondary Education

Post-secondary education is offered through the Nunavut Arctic College (NAC). The college serves Kitikmeot communities through its central campus in Cambridge Bay, which is responsible for all college programming in the region (NAC 2008). Programs offered through the NAC include trade programs, certificate and diploma programs, career development programs, academic studies programs, and continuing education programs. Enrolment at the NAC has increased over the past five years, from approximately 1,242 in 2007 to 1,335 in 2011. Over the past four years, the Nunavut Teachers Education Program has expanded from four to eleven communities in Nunavut (Opportunities North 2012). In 2010, the NAC student population comprised more female students (65%) than male students (35%); however, program administrators anticipate an increase in the male student population as program offerings increase (35%; Association of Canadian Community Colleges 2010). NAC completion rates in the Kitikmeot Region are higher for certificate and diploma programs (approximately 75% completion rate) as compared to literacy level programs such as Adult Basic Education (Back River Project Research Program 2012).

NAC also provides training programs to support employment in the mining sector. The Pre-Trades Program prepares high school students for the entrance exam to the Nunavut Trades Training Centre in Rankin Inlet. The Pre-Trades program can be described as a combination of high school and college education, allowing part of the coursework to count toward high school credits to help students meet graduation requirements. The camp cook program provides students with the basic knowledge and skills required to obtain employment in the food industry, mainly at mining camps and other institutional camp settings (Back River Research Program 2012; NAC 2013).

3.1.2.4 Economic Development

The Kitikmeot communities are governed by hamlet governments that are typically responsible for public works, operations and maintenance, water, sewer, waste management, fire protection, wellness, justice, and economic development. Hamlet governments also lead community planning with the assistance of the GN. At the community level, economic development and hamlet services are supported by the GN Department of Economic Development and Transportation and the GN Department of Community and Government Services, respectively. The Department of Economic Development and Transportation provides funding to small businesses, individuals, organizations, and municipal governments, while the Department of Community and Government Services supports municipal operation, infrastructure development and land development (GN Department of Community and Government Services 2013); (GN Department of Economic Development and Transportation 2013).

Regional Economy

The Kitikmeot Region has a mixed economy, focusing on public sector services, private sector market economies, and traditional activities. Formal economic sectors of particular importance include: government administration, health care and social services, education, retail, construction, transportation, tourism services, arts and crafts, and mineral exploration and development (Statistics Canada 2007b). The traditional economy is largely focused on subsistence land use. Inuit people in the region often participate in the market economy to supplement their traditional livelihoods. The seasonality of subsistence harvesting and the availability of wage employment influence the timing and consistency of Inuit participation in the market economy.

> *A balance between traditional and wage economies has yet to be achieved in many Inuit communities, as individuals and communities struggle to adapt to the demands of industrial employment in a boom-and-bust economy, while retaining their connection to the land and their traditional way of life* (Thompson 2005).

The service sector is the base of the Kitikmeot economy, providing employment to around 80% of the employed labour force. Services in the region are related to business, education, retail trade, health, and social services. In contrast, primary and secondary industries-including resource-based industries and construction-account for about 20% of local employment (Statistics Canada 2007b). Renewable and non-renewable resource sectors are also important to the regional economy, while tourism is an emerging industry. Opportunities to develop mineral-based deposits are expected over the next 25 years, leading to continued economic growth in the region and its communities. Nunavummiut are expected to benefit from this growth.

Real GDP and Economic Sectors in Nunavut

Nunavut's Gross Domestic Product (GDP) experienced an overall increase of approximately 26.5%, from $1,357 million to $1,716 million between 2007 and 2011. Despite a small decrease between 2008 and 2009, Nunavut GDP has increased each year over the specified time period (Statistics Canada 2012a).

In Nunavut, a number of factors shape the economy: the public sector is responsible for a notable portion of economic activity, private business is limited, and the retail industry is hindered by a lack of intra-regional transportation networks and cost-effective shipping. Overall, there is a heavy economic reliance on government funded sectors in Nunavut. The four largest contributors to real GDP in Nunavut were consistent between 2007 and 2011 and included the following industry sectors: construction; education services; health and social assistance; and public administration. However, large increases in the contribution from the mining, quarrying, and oil and gas exploration sector places the industry among the four top contributors in 2010 and 2011.

Annual growth in real GDP varied between 2007 and 2011 in Nunavut. Table 3.1-2 shows a decrease in real GDP between 2008 and 2009, associated with the global economic slowdown of 2008-09. Real GDP more then recovered in 2010, increasing by 16.6%, and continued to increase in 2011 (Nunavut Bureau of Statistics 2012).

Table 3.1-2. Annual Growth in Real Gross Domestic Product in Nunavut (2007 to 2011)

	2007	2008	2009	2010	2011
Real GDP – All Industries (millions of chained 2007 dollars)	$1,315.9	$1,469.4	$1,362.4	$1,589.2	$1,666.1
Annual Growth (%)	Na	11.7%	-7.3%	16.6%	4.8%

Source: Nunavut Bureau of Statistics (2012a)

The Centre for the North's Territorial Outlook report predicted a reduction in Nunavut's growth prospects for 2012 due to the closure of the Hope Bay mine site, lower than expected gold production at the Meadowbank mine, and cutbacks to exploration and development budgets. The report also predicts that construction on the Mary River and Meliadine mines will cause real GDP in Nunavut to surge by 17% in 2013 and 14.2% in 2014. Further, the construction industry is expected to continue to grow between 2012 and 2016 (Centre for the North 2012).

Nunavut Import and Exports

Nunavut imports almost three times as much as it exports, with virtually all exports and imports beginning or ending in other Canadian provinces. Overall, there was an increase in imports and exports in Nunavut between 2007 and 2011, of 41.1% and 271.6% respectively. There was also a notable decrease of exports to other countries (59.1%) coupled with a dramatic increase in exports to other provinces (425.4%). In terms of imports, both imports from other countries and from other provinces increased (14.7 and 47.7%, respectively). The largest increase occurred for import of services from

other provinces, which may be linked to the 2010 commencement of operations of the Meadowbank mine (Nunavut Bureau of Statistics 2012a).

GDP Expenditure Account and Household Consumption in Nunavut and Canada

Comparatively, Nunavut and Canada are polar opposites in terms of private and public spending. In Nunavut, approximately one-third of consumption contributing to GDP is private while two-thirds is public. In Canada, approximately two-thirds of total consumption is private while just over one-quarter is public. In Nunavut, final consumption expenditure, or the total of public and private consumption, increased by approximately 25% between 2007 and 2011. Government consumption in Nunavut accounted for approximately 66% throughout this time period, while household consumption routinely accounted for approximately 32%. Comparatively, general government consumption expenditure in Canada routinely accounted for between 20 to 22% of GDP between 2008 and 2011 (specifically 21% in 2011; The World Bank 2013).

Household final consumption expenditure has experienced a notable increase in Nunavut between 2007 and 2011 at 23.0%, increasing only 7.5% nationally. In Nunavut, the most notable increase was in non-durable consumer goods (36.7%), while in Canada the household consumption of non-durable goods experienced a proportional decrease (from 53.5% in 2007 to 52.4% in 2011).

3.1.2.5 Business Opportunities

Industries are growing steadily in Nunavut and there are many business opportunities and advantages to operating a business in Nunavut. For example, there is no territorial sales tax and the corporate tax rate is the second lowest in Canada. Government incentives foster economic development and encourage investment by providing generous financing, loans, and wage subsidy programs for certain investors that partner with Inuit or Nunavut businesses (Government of Canada 2012). Private sector businesses prominently include accommodation and retail, as well as a range of smaller-scale goods and service providers in each community. Cambridge Bay, and to a lesser extent Kugluktuk, stands out as a community where the private sector has a more important role in the economy.

The co-operative (co-op) business model is active in Nunavut. Co-ops operate the Inns North hotel chain and also hold a number of other service provision contracts in Kitikmeot communities. A co-op retail store that sells food, clothing, and a broad range of household items can be found in each Kitikmeot community. These communities, with the exception of Kugaaruk, also have a Northern Store (formerly Hudson Bay Company-owned stores in the North), which is in competition with the co-ops.

Private Sector Development and Local Employment Opportunities

The GN dominates the service sector and is the major economic driver of the Kitikmeot communities. Government employment and income support provides the main source of income for residents and this, in turn, supports the presence of the private sector in each community. Dependence on the public sector results from multiple conditions, such as the harsh climate, geographic remoteness, small population, and underdeveloped infrastructure systems, as these conditions have constrained private sector economic development.

There are approximately 600 new housing units constructed in Nunavut each year across the territory. This generates work and business for foreign manufacturers and also locally for construction companies (Government of Canada 2012). Each Kitikmeot community also has at least one prominent construction and contracting firm, due in large part to the opportunities afforded by government spending on housing and infrastructure. Expertise within the firms ranges from housing and building construction, heavy equipment operation and excavation, and road construction and maintenance. These firms provide significant employment opportunities, particularly during the summer construction season. In smaller

communities, these firms typically provide the majority of employment opportunities outside of the public sector. Construction firms include Inuksuk Enterprises (Cambridge Bay), Kikiak Contracting (Kugluktuk), CAP Enterprises (Gjoa Haven), Lyall Construction Ltd. (Taloyoak), and Koomiut Co-operative Association (Kugaaruk), among others (Back River Project Research Program 2012).

Challenges to Local Business and Community Economic Development

Many of the challenges to local businesses and community economic development are the same elements that shape the Kitikmeot economy, for example, the lack of economies of scale, isolated location, and lack of infrastructure and transportation networks. As noted in interviews with local business owners and operators, the main challenges to local businesses in the Kitikmeot Region include the cost of freight, lack of skilled employees, and the exclusionary policies of local organizations and governments. Additionally, the increasing presence of southern construction and contracting companies were also noted as a challenge, as these companies do not have the same operating costs as those physically located in the region.

In the western Kitikmeot, the demand for skilled and semi-skilled workers has increased and is reportedly higher than the available labour. At the same time, local residents have expressed frustration at the type of jobs perceived to be available to Inuit people (i.e., lower skill-level positions). Inuit Impact and Benefit Agreements (IIBAs), typically required for larger projects needing regulatory approval, usually define a specific target for the level of Inuit employment. However, if local skills do not meet job requirements, it can be difficult for companies to meet targets. Those who facilitate training initiatives in the Kitikmeot Region noted there may be misunderstanding among the public related the amount of training or education required to obtain different types of employment (Back River Project Research Program 2012). In addition, the limited number of jobs in communities does not inspire local people to complete education or other training, as the benefit is perceived to be unclear (S. Novak, pers. comm.; L. Flynn, pers. comm.).

Overall, perhaps the biggest challenges to any business and economic growth are the lack of economies of scale (i.e., servicing a small population) and the lack of income-generating private sector activity that is independent of government spending. Approximately 51% of individuals in the region receive social assistance and the majority reside in subsidized housing, meaning spending power is limited and government dependent. In addition, there is limited local demand for goods and services due to the small population of communities and many people wait to shop in southern centres such as Yellowknife or Edmonton as the cost is much less.

Business Development Support

There are multiple investment support programs offered by the GN to encourage the development of local business. Funding to small businesses, individuals, organizations, and municipal governments is provided by the Nunavut Department of Economic Development and Transportation and is administered by the regional office based in Kugluktuk. The four main funding programs include: the Small Business Support Program, Arts and Crafts Program, Strategic Investment Program, and Policy on Program Partnership (NDEDT 2011). Other business development support is available from the Nunavut Business Credit Corporation in the form of venture debt financing. Nunavut Business Credit Corporation programming is focused on small and medium-sized enterprises and offers loans, loan guarantees, bid security, and investment support (NBCC 2011). The Atuqtuarvik Corporation, which is governed by NTI, also offers loans, loan guarantees, bid security, and investment placement to small and medium-sized enterprises that are Inuit-owned (Atuqtuarvik Corporation 2011).

3.1.2.6 Infrastructure and Services

Recreation Programs

Community recreation facilities and recreation programs are operated by the Kitikmeot Region hamlets. Recreation coordinators are responsible for the delivery of programs that respond to community identified needs, as well as the management of facilities (i.e., ice arena and community hall). The recreational programs available vary by community in response to local demands, infrastructure, funding, and staff available to support the programs (Back River Project Research Program 2012).

Regional Transportation

As there are no roads between the Kitikmeot communities, aircraft are the main method of travel in the region. Other types of traffic include marine vessel and all-terrain vehicle in the summer months, and snowmobile during winter months. Cruise ships also operate in the area, especially through the renowned Northwest Passage. Barges (the sealift) deliver annual provisions to communities during the ice-free period. The sealift includes food, household items, construction supplies, heavy equipment, and fuel, among other supplies. Most communities have a barge dock facility that receives barge service from the Northern Transportation Company Ltd. (NTCL) or Nunavut Sealift and Supply Inc. each year. The western Kitikmeot communities, including Bathurst Inlet and Omingmaktok (NTCL 2013), are usually serviced by NTCL and the eastern communities by Nunavut Sealift and Supply Inc.; however, both companies may provide shipping services to all Kitikmeot communities (NSSI 2011).

In 2009, NTCL began using shipping routes starting near Vancouver, British Columbia and extending north along the coast. NTCL's shipping route for the Western Arctic travels north along the coast from Delta, British Columbia, around Point Barrow and east to the Kitikmeot communities of Kugluktuk, Cambridge Bay, Gjoa Haven, and Taloyoak. However, in mid-2011, NTCL cancelled shipping along the British Columbia coast route due to loss of a major mining-related contract with Newmont Mining (CBC News 2011).

All Kitikmeot communities, with the exception of Bathurst Inlet and Omingmaktok, are accessible by scheduled air travel provided by First Air and Canadian North. Air travel is used for cargo deliveries as well as passenger travel. All communities are also serviced by chartered air travel by a number of companies based in Yellowknife and Edmonton. There is a weekly charter flight from Yellowknife that travels to Bathurst Inlet during the operating season of the Bathurst Inlet Lodge (usually a six-week period in the early summer).

Infrastructure Challenges

Hamlet governments in the Kitikmeot Region face a number of challenges. As is evident from the interview results with hamlet staff, one of the primary challenges is staff hiring and retention. Funded positions can go unstaffed for months and turnover is high in many positions. This is typical of many isolated Arctic communities in Nunavut. In Taloyoak, an under-funded contribution agreement resulted in the loss of employment positions within the Hamlet, for example, the income support position (C. Dickson, pers. comm.).

Infrastructure, resources, and school materials can be a challenge for schools in the Kitikmeot Region. Two of the five schools are at or over capacity and require new, larger structures to accommodate the local student population. Facilities such as woodworking shops, science labs, and home economic labs require maintenance, which can, at times, be costly and/or unavailable. Resources such as specialized teachers (e.g., computer science, woodworking, or other trades) can be difficult to attract and retain.

In some communities, it can be difficult to obtain teachers due to the lack of available staff housing (Back River Project Research Program 2012).

Locating space for programs and activities can be a challenge as many buildings are older and require repair. Lack of suitable infrastructure in the Kitikmeot communities is an ongoing issue related to staff housing, community services, and recreation. GN buildings face similar challenges. However, these issues are being addressed; for example, new hamlet office buildings and new arenas/recreation facilities have been constructed in both Kugluktuk and Taloyoak (Back River Project Research Program 2012).

Communication, Utilities, and Waste Management

In the Kitikmeot communities, water and sewer services are provided by the hamlet and include water delivery and sewage pump-out by truck. In addition to trucked water and sewer services, Cambridge Bay has a 'utilidor' system connecting a few municipal buildings. The system runs above ground to transport water and sewage (GN Department of Health and Social Services n.d.). Qulliq Energy Corporation provides electricity to all communities in Nunavut. Electricity needs are met by imported fossil fuel supplies distributed through an independent electricity generation and distribution system in each community (Quilliq Energy Corporation 2008).

Communication services in the Kitikmeot Region include internet and phone services; both are provided via satellite. High-speed internet services are available in all Kitikmeot communities through Qiniq, Netkaster, and NorthwesTel. Qiniq is an Inuit-owned service provider offering wireless broadband internet via satellite in 25 Nunavut communities. Qiniq and NorthwesTel both introduced improved broadband internet services in early 2013. NorthwesTel, who previously also provided internet services via satellite, announced new DSL services in Cambridge Bay (Nunatsiaq News 2013) and Qiniq introduced two new service options that include download speeds equal to that of DSL services in all Nunavut communities (Qiniq 2013).

Housing

The availability of suitable housing is an important issue for all Kitikmeot communities and "the overcrowding of housing is a clear non-medical health indicator for Inuit" (Inuit Tapiriit Kanatami 2007). Insufficient availability of quality housing leads to a number of health-related challenges in Inuit communities, including family violence, depression, stress, and a higher incidence of infectious diseases (Inuit Tapiriit Kanatami 2007; NTI 2008). Community-based research indicates that individuals in the Kitikmeot Region who are part of a nuclear family residing with the nuclear unit of extended family members consider themselves homeless (Back River Project Research Program 2012).

A large number of dwellings in the Kitikmeot Region are crowded according to the National Occupancy Standard. The problem is particularly prevalent in the eastern Kitikmeot communities of Taloyoak, Gjoa Haven, and Kugaaruk, where approximately 57%, 56%, and 50% of dwellings are crowded, respectively. Kugluktuk has the lowest percentage of crowded dwellings (34%), slightly below Cambridge Bay (35%). The incidence of overcrowded dwellings in the eastern Kitikmeot communities is higher as compared to the Nunavut average of approximately 35%.

Recent census data further highlights overcrowded conditions in the Kitikmeot communities. In the eastern Kitikmeot communities of Gjoa Haven, Taloyoak, and Kugaaruk, more than 50% of households have four or more persons per household and approximately 20% are two-or-more family households. Approximately 46% of households in Kugluktuk and 38% of households in Cambridge Bay have four or more persons per household (Statistics Canada 2012a). Overall, there are more households in the Kitikmeot Region with four or more persons (52%) as compared to the territorial average (47%), and

there is also has a higher percentage of two-or-more family households (13%) as compared to the territorial average (10%; Statistics Canada 2012a).

Total dwelling counts in the Kitikmeot range from approximately 170 in Kugaaruk to 540 in Cambridge Bay. The vast majority of these are occupied by residents, with only 4 to 17% either occupied by temporary residents or unoccupied. The most common types of dwellings are single detached houses (59%) and row houses with three or more units (28%). The majority of dwellings are rented—approximately three out of every four dwellings across the region. Rented housing includes public housing, government staff housing (GN and Government of Canada), non-government employer-provided staff housing, and private market rental units. Public housing units are subsidized rented dwellings under the Nunavut Housing Corporation (NHC) and are available to Nunavummiut who meet certain eligibility requirements. Private market rental units are owned by private individuals, corporations, or other organizations and are made available on the rental market (Nunavut Bureau of Statistics 2011a).

Public housing is the most common type of housing tenure in the region. Cambridge Bay has a slightly lower percentage of public housing (49%) than the other communities (ranging from 64 to 77%). Prevalence of owner-occupied dwellings ranges from approximately 13% in Taloyoak to 30% in Cambridge Bay. Staff housing and private market rental units form less substantial proportions of available housing in the communities. Gjoa Haven, which had 40 owner-occupied dwellings in 2009/2010, experienced a number of foreclosures and evictions in 2011 (C. Cahill, pers. comm.).

Even though public housing is common, it is in high demand; there is currently a shortage of public housing with relatively large waiting lists for applicants. Again, the issue is more prevalent in the eastern Kitikmeot communities where the percentage of the population (15 years old or older) on the waiting list for public housing ranges from approximately 23% in Kugaaruk to a high of 33% in Taloyoak. In contrast, only about 12% of the population in Cambridge Bay is on a waiting list.

The NHC is responsible for public and GN staff housing units. The NHC's annual budget increased from approximately $138 million in 2009/2010 to $151 million in 2010/2011. This budget increase was primarily for the addition of new public housing units in Nunavut (NHC 2011). There are two programs under which new housing is constructed, the Nunavut Housing Trust and Canada's Economic Action Plan. The federal government provided $200 million for the Nunavut Housing Trust, which was created in 2006 to build new affordable housing for Nunavummiut (NHC 2006). Projected housing needs range from approximately 100 additional units in both Gjoa Haven and Kugluktuk by 2020 to an additional 325 units in Cambridge Bay by 2026. Taloyoak and Kugaaruk also require a number of additional units, approximately 216 by 2030 and 170 by 2028, respectively. In addition, these estimates are likely conservative, as the population growth estimates on which these housing needs were based are out-dated and are lower than more recent growth estimates.

Other Infrastructure

Women's Shelters

Women's shelters in both Cambridge Bay and Kugluktuk provide accommodation for women and children who are victims of domestic violence and is continuously staffed (24/7) when occupied (C. Hogaluk, pers. comm.). Although Kugaaruk does not have a women's shelter, a safe house is currently operating in an old trailer (previously a Royal Canadian Mounted Police [RCMP] facility). The safe house provides food and shelter to victims of domestic violence (Back River Project Research Program 2012). Gjoa Haven does not have an emergency shelter; however, service providers indicate there is a need to provide emergency accommodation for individuals who are homeless or affected by

domestic violence (S. Bucknor, pers. comm.). Taloyoak has a facility previously used as an emergency shelter, but the program is no longer operating. As such, in the event of a crisis situation related to domestic violence, the victim and her children are typically flown to a shelter outside the community for up to six weeks (Back River Project Research Program 2012).

Addictions Treatment Centre

Funding for a 28-day residential (in-patient) treatment centre in Cambridge Bay was announced early in 2012 and is known as the Mobile Addictions Treatment Pilot Program. The program will operate as an extension of the wellness centre and incorporates aftercare and family involvement as services included in patient care. Plans to open the addictions treatment centre have since been delayed and are currently on hold (George 2012). Residents currently have to travel south to obtain treatment.

3.1.2.7 Health and Community Well-being

Factors that contribute to Inuit well-being include health status, food security, housing and infrastructure, community and family, economy and governance, knowledge and learning, culture and language, health behaviours, and access to health services (Inuit Qaujisarvingat Knowedge Centre n.d.). Well-being is a broad concept that approximates the overall wellness or quality of life in communities based on the complex interactions between existing social, economic, and cultural conditions.

Health Status

Although updated data specific to the Kitikmeot Region were not available at the time of writing, a number of health status indicators have been calculated for Nunavut as a whole. In 2010, fewer Nunavummiut (45.9%) perceived their overall health condition as very good or excellent as compared to Canadians (60.3%) (Statistics Canada 2012b). Overall, Nunavummiut experience lower rates of arthritis, diabetes, asthma, and high blood pressure as compared to Canadians. However, more Nunavummiut are overweight and obese, and have a higher incidence of cancer (512.1 per 100,000) as compared to Canadians generally (404.9 per 100,000). The incidence of lung cancer (206.8 per 100,000) is particularly high for Nunavummiut, at approximately four times the rate in Canada (56.9 per 100,000).

Residents of Nunavut can expect a much shorter lifespan than the average Canadian (DHSS 2004; NTI 2008). On average, Nunavut residents have a life expectancy of 71.6 years at birth and 15.2 years at age 65 (2007/2009 average). These values are strikingly lower than the Canadian average life expectancies for the same period (i.e., approximately 81.1 years at birth and 20.2 years at age 65). The lifespan for Nunavut males is almost 10 years shorter than the average Canadian male at birth and almost five years shorter at age 65. It has been estimated that Inuit people have the lowest life expectancy among all of Canada's Aboriginal groups; Inuit currently live as long as the average Canadian in the 1940s (Spicer 2008). Comparisons of the two-year averages indicate that, for Nunavummiut, life expectancy at birth is not only lower than that of Canadians, but is decreasing over time, while Canadian residents continue to experience small gains in their life expectancy at birth. Lastly, although Nunavut residents have experienced greater gains in life expectancy at age 65 over time, Canadians continues to live longer (Statistics Canada 2012b).

Nunavut has a much higher average infant mortality rate than Canada as a whole (Statistics Canada 2012b). In 2007, Nunavut's infant mortality rate was nearly three times that of Canada and the proportion of low birth weight babies is typically higher in Nunavut than in Canada. Although there have been specific years (1996 and 2007) during which Nunavut and Canada's infant mortality rates were comparable, the rate for Nunavut's remained approximately three times higher as compared to the Canadian average between 2006 and 2009. Birth weight is another indication on the general health

and well-being status of the population – in general terms, the heavier newborns are, the least likely it is that they are malnourished. The proportion of babies born in Nunavut that are considered to have a low birth weight has effectively remained unchanged between 2006 and 2010. Although the percentage of low birth weight babies born in Nunavut and in Canada has both increased and decreased over time, the percentage of low birth weight babies in Nunavut (7.6%) remained higher than the Canadian average (6.2%) in 2010, the last date for which data is available.

Health Centres and Services

Each of the Kitikmeot communities has a health centre that provides access to health professionals and various health programs. Health centres in the region coordinate with the Stanton Hospital in Yellowknife, which is the nearest full service hospital. Stanton doctors work closely with Kitikmeot Region nurses, travel to the communities on a rotational basis, and are on call for emergencies (C. Evalik, pers. comm.). Patients can be transported via Medevac either to Yellowknife or Edmonton when in need of medical services unavailable in the community (Back River Project Research Program 2012).

Physicians visit the communities to see patients for one week every six to eight weeks (excluding Cambridge Bay, as the health centre has a doctor on duty throughout the year). Typically, health centre nurses see patients in the morning and run clinics/health programs in the afternoons. Community health nurses assess, triage, diagnose, treat, and refer patients (E. Garneau, pers. comm.). Health programs include Well Woman, Well Man, Well Child, a prenatal clinic, and a communicable disease clinic (Back River Project Research Program 2012). The health centres are generally open during office hours Monday to Friday and have a nurse on call after hours and overnight.

Each of the Kitikmeot health centres are equipped with a telehealth machine, which enables patients to meet with health specialists in the south through audio-visual communication. Telehealth also facilitates specialized counselling sessions and enables communication between patients and mental health counsellors or physicians residing in southern facilities. The use of telehealth in Kitikmeot health centres has resulted in a notable reduction in the number of Medevac transports as well as related cost savings (Back River Project Research Program 2012).

In addition to providing medical services, the Kitikmeot health centres also provide access to mental health counsellors, social workers, home care, and a variety of community-based programs. There are a wide range of services available in health centres in the Kitikmeot communities. Programs offered through Kitikmeot health centres include the Canadian Pre-natal Program and the chronic disease clinic, among others (Back River Project Research Program 2012). Many service providers in the Kitikmeot Region also note a decrease in clients in the summer months and a subsequent increase in clients during the winter months. Many families leave the communities in the spring and summer to spend time on the land hunting and fishing (Back River Project Research Program 2012).

Health Services and Programs

Typically, each community has a Community Health Representative who is responsible for health promotion and prevention through the delivery of educational health and wellness programming. Educational programs include nutrition, dental health, suicide prevention, diabetes, sexual health, and smoking cessation. Kitikmeot communities that have developed wellness programs also typically have an alcohol and drug counsellor who works with individuals suffering from addiction or substance abuse and promotes community education and awareness of those issues (Back River Project Research Program 2012).

Each community in the Kitikmeot Region employs an individual responsible for home care who provides support to the elderly, disabled, and people recovering from major surgery. Recent community health

profiles indicate there are approximately 113 people receiving home care and seven people receiving palliative care in the Kitikmeot communities (Evalik 2012). In 2009, a 10-bed extended care facility was established in Gjoa Haven that provides palliative, acute, and respite care to Kitikmeot residents. In the past, people requiring long-term care were relocated to facilities outside of Nunavut (C. Evalik, pers. comm.).

Each Kitikmeot community employs at least one social worker to provide child and family, as well as social services such as child and adult protection. Social workers also provide crisis intervention, support services, and family counselling. The most prominent challenges faced by social workers include the lack of external facilities and support agencies (e.g., emergency shelter, in-patient addictions treatment programs). In southern communities, organizations external to a government department of social work provide a great deal of support to social workers and their clients, whereas in the Kitikmeot Region communities have a limited number of social workers tasked with providing or facilitating all services and accommodations required by clients (Back River Project Research Program 2012). Regionally, there were approximately 38 children in care (C. Evalik, pers. comm; Back River Project Research Program 2012).

Emergency Response

Medical emergency response is provided at each community health centre. Emergency transportation in the Kitikmeot communities is provided by the RCMP or personal vehicles with the exception of Cambridge Bay, which has a Hamlet-operated ambulance service. There is an RCMP detachment in each community to provide policing services, as well as a volunteer fire department to provide fire protection services.

Mental Health and Suicide

Suicide is a multifaceted issue in Nunavut, with high rates attributed to recent and rapidly occurring social change, which has led to a general sense of discontinuity and a loss of self-reliance among Nunavummiut. The GN has identified the following factors contributing to risk of suicide:

- personal characteristics of depression, deficits in problem-solving skills, and substance abuse;
- situational factors of living in a troubled family, physical or sexual abuse, loss of a parent or caregiver, and exposure to suicidal acts of family or friends;
- social network, including loss of relationships, isolation, and inter-personal problems; and
- socio-cultural factors of poverty, social disorganization, and loss of tradition.

Factors reducing suicide risk include having a stable home life, being educated, being employed, and receiving mental health care as required (GN et al. 2010).

The majority of mental health patients in the Kitikmeot Region are women, with the exception of Gjoa Haven. Counsellors believe there continues to be a stigma associated with seeking assistance for mental health issues, particularly among men (J. Glasgow, pers. comm.). One of the main challenges associated with mental health and counselling services has been the ability to develop trusting relationships between the counsellor and patient, as there has been high staff turnover in this position in the past. Mental health counsellors throughout the region link increases in substance abuse to increases in domestic violence. A separate segment of mental health patients include individuals damaged by residential schools (Back River Project Research Program 2012).

Mental health counsellors in a number of communities link mental health issues to housing circumstances, stating that individuals residing in overcrowded homes are more likely to have negative

experiences such as stress, depression, anxiety, and panic attacks, which may result in contact with mental health counsellors, social workers, or the RCMP (R. Bilta, pers. comm.; Back River Project Research Program 2012). Overall, mental health in the Kitikmeot communities is described as improving (Back River Project Research Program 2012).

Suicide is a prominent social issue and health concern in Nunavut communities. The number of deaths by suicide and the degree of suicide-related trauma are higher in Nunavut than in other Canadian jurisdictions. In 2009, the RCMP responded to approximately 983 calls where persons were threatening or attempting suicide in Nunavut (GN et al. 2010). In a recent survey, 43.6% of respondents reported suicide ideation (i.e., thoughts of committing suicide) over the course of a week and 30% reported attempting suicide over a six-month period, 16% on multiple occasions. Suicide-related deaths are highest among young Inuit males (GN et al. 2010).

Acculturation

Prior to the 1950s, most Inuit lived on the land in extended family groups, following the migration of wildlife across the Arctic. During this time men and women had very specific roles as hunters and care-givers that were tied to the land and linked to a way of life based on survival in harsh climatic conditions. During the 1950s, the Canadian government actively encouraged Inuit to settle in permanent communities and provided low-cost housing, medical facilities, and modern services. Although traditional land use activities still persist, the change from a traditional subsistence-based economy to a wage economy has disrupted Inuit life and has, in a number of ways, negatively affected Inuit well-being. The impact of residential schools on Inuit includes disconnection from traditional familial, communal, and socio-cultural relationship and has disrupted the inter-generational exchange of knowledge, cultural values, parenting skills, and language that forms the basis of Inuit identity. The trauma of residential schools and disruption to the exchange of knowledge and culture continues to affect Inuit health and mental well-being today (Inuit Tapiriit Kanatami 2007).

Community Health and Wellness Issues

Overall, food security and poverty were the two most commonly reported issues facing Kitikmeot communities (Back River Project Research Program 2012). Results of the 2012 research program indicate the health and wellness issues facing the communities include:

- *Addictions* – drugs, alcohol, tobacco use, and gambling. Service providers link substance abuse to high levels of domestic violence (C. Evalik, pers. comm.). Solvent abuse was noted as an issue for residents of Kugluktuk (C. Lee, pers. comm.).
- *Suicide* – a number of individuals described suicide as an important issue and stated that communities are focusing on prevention and education (J. Glasgow, pers. comm.).
- *Overcrowding* - the lack of housing in all Kitikmeot communities was noted as a main issue and was linked to poor outcomes in education, health, and mental health, and was also linked domestic violence (Back River Project Research Program 2012).
- *Domestic violence* – violence and abuse were described as very problematic for all segments of the population (children, teens, adults, and Elders) and has been connected to the legacy of residential schools, which is thought to have caused dysfunction within the family unit. Drug and alcohol use have been linked to other issues such as domestic violence (E. Fredlund, pers. comm.).
- *Food security* – the high cost of food and availability of nutritious foods were noted as issues during recent focus group sessions.

- *Respiratory disease* – was the most commonly mentioned community health issue for children, teen's, adults and Elders (Back River Project Research Program 2012).

Community Well-being Index

Community well-being is a broad concept that approximates the overall wellness or quality of life in communities based on the complex interactions between existing social, economic, and cultural conditions. Aboriginal Affairs and Northern Development Canada (AANDC) calculates an index of community well-being based on four components: education, labour force, income, and housing. Although it is likely that additional components contribute to overall well-being, using these four components to estimate well-being is reasonable given what is known about the existing conditions in the communities and current data gaps. The community well-being scores can then be used to compare well-being, at least as measured by the index, across Aboriginal and other Canadian communities and over time (INAC 2010).

For 2006, the most recent data available, Nunavut had an overall community well-being index score of 65.1, the lowest of all the Canadian provinces and territories. The next lowest score was Newfoundland and Labrador (75.4), while the Province of Alberta had the highest score (84.3) and the Northwest Territory's (NWT's) score was between that of Newfoundland and Labour and Alberta (79) (INAC 2010). Overall, the Kitikmeot communities also ranked low on the community well-being index. Taloyoak, Kugaaruk, and Gjoa Haven scored very low (53, 55, and 56, respectively). Kugluktuk scored near the average for Nunavut as a whole, while Cambridge Bay fared somewhat better at 73, although still below the scores of other Canadian provinces and territories.

A review of trends in the well-being of Inuit in Canada concluded that, on average, Inuit community well-being scores were 15 points lower as compared to non-Aboriginal communities in 2006. There were 34 Inuit communities among the "bottom 500" Canadian communities, and no Inuit communities ranked among the "top 500" Canadian communities. The review noted a decrease in the gap between Inuit and non-Aboriginal communities between 1981 and 1991. However, between 2001 and 2006 the gap widened. Of the four components analyzed, the largest gap between Inuit and non-Aboriginal communities was in housing (AANDC n.d.).

Country Foods

Country foods are an important foundation within Inuit culture that link and perpetuate traditional harvesting activities, social relationships, and family and community, as well as sharing and informal networks. Access to and use of country foods is extremely important to well-being. Kitikmeot Region residents harvest food from the land for themselves, their families, and their neighbours. Country foods are shared with those who are unable to harvest country food themselves; this typically includes Elders, widows, and women (Cambridge Bay Hunter Focus Group 2012). Animals consumed by Kitikmeot Region residents include caribou, muskox, rabbit, ptarmigan, fish, and berries, among others. In Inuit tradition, country food belongs to everyone and is shared as an inherent part of Inuit culture (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Individuals who harvest country food know their community including who is able to harvest and who is not. These individuals are part of larger social networks that ensure people have food to eat and are cared for. The sharing of country food is intrinsic within the process of obtaining food from the land. At times sharing takes place between communities (Cambridge Bay Hunter Focus Group 2012).

The 2006 Aboriginal Peoples Survey (Statistics Canada 2008) surveyed Inuit in the Nunatsiavut, Nunavik, Nunavut, and Inuvialuit regions. Together these areas constitute the Inuit Nunaat, or the "Inuit homeland." Portions of the survey included questions related to country foods and harvesting. For the majority of Nunavut residents (66%), at least half of the meat and fish they consume is obtained through

traditional harvesting methods. Another 38% of Nunavut residents obtain more than half of the meat and fish they consume from harvesting activities as compared to the amount that is purchased in stores.

In 2006, over two-thirds of Nunavut residents harvested country foods in the previous year, with a higher portion of males participating in harvesting (74%) as compared to females (59%). The portion of the population harvesting country food was slightly lower for those aged 15 to 24, but remained relatively stable for both males and females. The 2006 Aboriginal Peoples Survey also reported that approximately 57% of Nunavut children, ages 6 to 14, ate wild meat, caribou, walrus, and/or muktuk three or more days per week (Inuit Qaujisarvingat Knowedge Centre n.d.).

Although food subsidy programs such as Nutrition North and Food Mail aim to provide an affordable healthy diet for Inuit people, the composition of this diet is quite different from the foods Inuit have traditionally consumed to sustain themselves for generations. Fruit and vegetables thought to be an essential part of healthy diet are not naturally available in Nunavut and must be flown into the community at costs that make fresh produce often inaccessible to the majority of community members. The length of time to transport fresh food into the north usually results in short shelf lives and less appealing produce than is available from southern retailers (National Aboriginal Health Organization 2004). The appropriateness of a traditional diet is characterized by the following:

> *When one eats meat, it warms your body very quickly. But when one eats fruit or other imported food, it doesn't help you keep very warm. With imported food… you're warm just a short period of time. But [our] meat is different; it keeps you warm. It doesn't matter if it's raw meat or frozen meat… it has the same effect* (Freeman et al. 1998).

There has been a recent focus on the issue of food security in Nunavut (Statistics Canada 2010; De Schutter 2012; Northern Public Affairs 2012). This issue is expected to be further highlighted in coming years, as the UN's Special Rapporteur's final report discussing the right to food in Canada will be presented to the United Nations Human Rights Council in Geneva in March 2014. The report reviews findings related to food insecurity in First Nations and Inuit communities and ranks food security in the Canadian North in comparison to other developed and under-developed counties (Hicks 2012).

In the recent roundtable discussion "Issues and Ideas for Change," Kitikmeot residents described hunger, poverty, food security, nutrition, and access to country foods as key issues (Nunavut Roundtable for Poverty Reduction 2011). In Cambridge Bay, the Wellness Center operates a food bank where families can shop once per month (if assessed as being in need) and also provides coffee, toast, and cereal on a drop-in basis (C. Hogaluk, pers. comm.).

The International Polar Year Inuit Child Health Survey (Egeland 2010) was conducted by the Qanuippitali Steering Committee and McGill University and included participants from each of Nunavut's 25 communities. The goal of the survey was to obtain an overview of the health status and living conditions of Nunavummiut living in Nunavut. The study concluded that food insecurity is a problem in Nunavut homes. The survey indicated that 35.1% of homes were severely food insecure (defined as disrupted eating patterns and reduced food intake among adults and/or children), and another 35.1% of homes were moderately food insecure. Homes with children were more likely to be food insecure as compared to homes without children. Specifically, the survey indicated that 38.4% of homes with children were severely food insecure and another 33.0% were moderately food insecure (Egeland 2010). This suggests that over two-thirds of Nunavummiut homes with children struggle with food security.

The Canadian Community Health Survey 2007/2008 reported that Canada's national average for food insecurity was approximately 7.8%. In comparison, Nunavut's rate of food insecurity (31.9%) was more than four times the national average (Statistics Canada 2010).

The Cost of Food and Household Items

In the Kitikmeot Region, food is shipped from Yellowknife and subsidized as part of the Food Mail Program. Although Edmonton is a supply centre, it is not an entry point for Kitikmeot communities. Through AANDC's program called the Northern Food Basket (now called the Revised Northern Food Basket [RNFB]) Program, food price surveys were conducted in each of the Kitikmeot communities from 2005 to 2009. The program aims to estimate the cost of a typical basket of groceries and other household items for a family of four by comparing similar products and brands in a northern community to the cost of the same products in the most appropriate southern communities. The basket includes both perishable and non-perishable goods (approximately two thirds of the basket are perishable goods). Costs were estimated for both Edmonton and Yellowknife. In 2008, surveys were conducted in March and September in Edmonton, Yellowknife, Gjoa Haven, and Kugaaruk to account for any seasonal variation in food prices.

Overall, the cost of food is increasing in both northern and southern communities. However, the cost difference between southern centres and the Kitikmeot communities is substantial. In 2009, the weekly cost of the RNFB in Taloyoak was almost double the cost in Yellowknife. Although Cambridge Bay had the lowest RNFB cost of the Kitikmeot communities in 2009, the weekly cost of food and household items remained almost $200 higher than the weekly cost in Yellowknife and $171 higher than Edmonton. For Kitikmeot families (of four people) calculating a monthly household budget, this equates to anywhere between an additional $680 and $800 per month.

Crime

Total numbers of police-reported incidences of crime are highest in Cambridge Bay, which also has the highest overall crime rate. Non-violent crimes (e.g., breaking and entering, possession of stolen property, theft, and fraud) account for the highest rate among all types of crime, with Cambridge Bay again having the highest rate, followed by Kugluktuk, and Gjoa Haven. The rate of violent crime (e.g., homicide, attempted murder, assault, sexual assault, and robbery) is also greatest in Cambridge Bay and Kugluktuk, followed closely by Gjoa Haven. Comparatively, crime rates were substantially lower in Kugaaruk and, to a lesser extent, Taloyoak (Nunavut Bureau of Statistics 2010b).

Violent and non-violent crime rates generally increased from 1999 to 2011 across the Kitikmeot Region, peaking in 2003 and 2004 and then declining. The notable exceptions were the 2008 and 2009 increase in violent crime and the persistence of a relatively high rate of non-violent crime in Cambridge Bay, the sharp increase in violent crime in Gjoa Haven in 2009, the sharp increase in violent crime in Taloyoak in 2011, and the increase in the non-violent crime rate in Gjoa Haven. Over time, Kugaaruk stands out as consistently having the lowest rates of violent and non-violent crime within the Kitikmeot Region (RCMP 2012b).

The number of calls for service is also an important indicator of the level of demand on policing services in each community, as a call for service may not necessarily result in a police-reported incidence of crime. For each community in the Kitikmeot Region, the number of calls for service has increased between 2010 and 2012, most notably in Kugaaruk where the increase was approximately 186% over the two years. The overall increase over that period was lowest in Taloyoak (14%, although there was a 37% increase from 2010 to 2011), followed by Cambridge Bay (22%), Gjoa Haven (35%), and Kugluktuk (47%).

Law Enforcement

RCMP in the Kitikmeot Region provide basic policing services and, when possible, hold educational sessions that aim to reduce substance abuse. The RCMP also participate in the Junior Rangers program and facilitate the Aboriginal Shield Program, which is a youth-driven program that provides substance abuse prevention and healthy lifestyle coaching (Back River Project Research Program 2012; RCMP 2012a). The RCMP also deliver the Drug Abuse Resistance Education program in certain Kitikmeot communities and plan to offer the program in additional communities in the future (Back River Project Research Program 2012). The RCMP is also responsible for issuance of driver's licences, commissioning of oaths, and provide emergency transportation on an as needed bases (L. Morrison, pers. comm.).

RCMP in the Kitikmeot Region characterize the majority of crime in the communities as related to substance abuse and violence, while property crime and vehicles theft are also common. The RCMP in Cambridge Bay have recently established a successful Crime Stoppers hotline through which community members can call in to report a crime and remain anonymous (K. Wood, pers. comm.). RCMP in the Kitikmeot Region estimate a lower number of emergency calls in communities where alcohol is prohibited or restricted (L. Morrison, pers. comm.). The number of police officers per community range from two in the smaller eastern communities to five in the larger communities (Back River Project Research Program 2012).

3.1.2.8 Summary

The Kitikmeot communities have experienced immense population growth over the past 30 years. The Kitikmeot Region has a median age of 23.0 years, which is slightly lower than Nunavut's median age of 24.1 years and much younger than the Canadian median age of 40.6 years (Statistics Canada 2012a). A high proportion of the population in the Kitikmeot communities is Aboriginal, primarily Inuit. In 2006, approximately 83% of Cambridge Bay residents self-identified as Aboriginal. This proportion was higher in all the other Kitikmeot communities, with 92% or more identifying as Aboriginal. The Kitikmeot communities tend to have a slightly higher proportion of males as compared to females. Within the Kitikmeot communities there is a notable difference in family structure as compared to the general Canadian population. This difference is seen in the lower proportion of married couples in the Kitikmeot Region (48.3%) as compared to Canada (80.1%). In 2011, the majority of Taloyoak and Kugaaruk residence reported an Inuit language as their mother tongue, while in Gjoa Haven and the western Kitikmeot communities, the majority of residents reported English as their mother tongue.

Formal education levels are low in the Kitikmeot communities when compared to Canadian averages. The proportion of the population with formal education is slightly higher in Cambridge Bay, but is still well below the Canadian average. Kitikmeot communities have high rates of unemployment among men and women. In 2006, the potential labour for the region was approximately 3,490 people, with an active labour force of 2,200 people, indicating a 63% participation rate, which is lower than the Nunavut average of approximately 65% (Statistics Canada 2007c). In Kitikmeot communities, unemployment rates are also higher than the Nunavut average (15.6%), ranging from 29.6% in Gjoa Haven to 21.3% in Kugaaruk, with the exception of Cambridge Bay, where the unemployment rate was 9.7%. Approximately one-fifth of the Kitikmeot population are unemployed, resulting in the highest unemployment rate within the territory (20.2%). In comparison, the Baffin (14.0%) and Kivalliq (15.7%) Regions more closely reflect the territorial rate (15.6%; (Statistics Canada 2007b).

In Cambridge Bay, individual and household income are typically higher and employment-based (derived in greater proportions from employment) as compared to the other Kitikmeot communities. The proportion of income from government transfers in Kitikmeot communities, other than Cambridge Bay, is typically higher than the Nunavut average. On the whole, the Kitikmeot Region has the lowest earnings in within the Territory (Statistics Canada 2007b).

As evidenced by typical health indicators, such as infant mortality and life expectancy, the health status of Kitikmeot residents requires further improvement to be on par with that of the general Canadian population. Despite the relatively small populations, there are a wide range of health services and programs available in Kitikmeot communities. Although Cambridge Bay is the only community that provides full-time physician services, visiting doctors see patients in the other communities on a rotational basis. With respect to community health within Kitikmeot communities, relatively high suicide rates are a concern. This has been attributed to recent rapid social change, resulting in a loss of self-reliance and a sense of discontinuity (GN et al. 2010).

General community well-being, as described by AANDC's community well-being indicator, was relatively low within Kitikmeot communities. Cambridge Bay and Kugluktuk scored somewhat higher, on or above the Nunavut average. Taloyoak, Kugaaruk, and Gjoa Haven scored exceptionally low (53, 55, and 56, respectively), particularly on the housing component of the index (27, 29, and 26, respectively). Crime and housing contribute to community health and well-being. Crime rates among Kitikmeot communities are highest in Cambridge Bay, Kugluktuk, and Gjoa Haven. Kugaaruk typically has low crime rates in relation to other Kitikmeot communities. Although housing challenges exist in all Kitikmeot communities, there are a notably high proportion of crowded homes in Gjoa Haven, Taloyoak, and Kugaaruk (57, 56, and 50%, respectively). Public housing is the most common type of tenure, and dependence on the public sector for housing is likely to continue given severe economic, climatic, and geographic constraints on private sector involvement.

Annual growth in Nunavut's real GDP varied between 2007 and 2011. There was a decrease in real GDP between 2008 and 2009, likely associated with the global economic slowdown of 2008-09. Real GDP more than recovered in 2010, increasing by 16.6%, and then continued to increase in 2011, by 4.8% (Nunavut Bureau of Statistics 2012a). Nunavut imports almost three times as much as it exports, with virtually all exports and imports coming from or ending in other Canadian provinces. Overall, between 2007 and 2011, Nunavut's exports increased by 271.6% and imports increased by 41.1%. In Nunavut, final consumption expenditure, or the total of public and private consumption, increased by approximately 25% between 2007 and 2011. This routinely included approximately 66% government consumption and 32% household consumption.

Overall, the Kitikmeot economy is characterized as mixed and is focused across three major sectors - public, private, and traditional. The public sector dominates and acts as a major economic driver for local communities. Cambridge Bay has a more diversified economy than the other communities, and is increasingly expanding into the private sector. Regional economic development is constrained by a lack of skilled labour, lack of infrastructure, and difficulties with transportation and distance from outside markets. The traditional subsistence economy is of great importance to livelihoods in the Kitikmeot Region and is based in Inuit culture. Harvesting activities underpin the social fabric of communities and perpetuate traditional forms of social relationships and networks among Inuit.

3.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Information on Traditional Knowledge (TK) was accessed and used to inform the selection of Valued Socio-economic Components (VSECs), as well as the spatial and temporal boundaries for the assessment of potential Project socio-economic effects. TK was also used in the effects assessment itself, and in the development of mitigation and adaptive management to minimize potential adverse effects of the Project.

In Nunavut, TK is encompassed by the concept of Inuit Qaujimajatuqangit, which is described as "[t]he traditional, current, and evolving body of Inuit values, beliefs, experience, perceptions, and knowledge

regarding the environment, including land, water, wildlife and people, to the extent that people are part of the environment" (Qikiqtani Inuit Association 2009) or literally translates to 'that which the Inuit know and have always known'. Because TK provides a foundational understanding of the events and activities that have shaped Inuit society (e.g., social and gender roles, parental roles, and others) and Inuit people's relationships to each other and their communities, the review of TK material was an integral aspect of the assessment of the potential effects of the Project on VSECs.

3.2.1 Incorporation of TK for Existing Environment and Baseline Information

While the information provided in the Back River Project TK report (KIA 2012) provides contextual information that promotes a deeper understanding of the socio-economic environment, the information is not directly applicable to the characterization of the current socio-economic environment. Rather, this information provides a context that informs an understanding of current trends.

3.2.2 Incorporation of TK for VSEC Selection

The TK report (KIA 2012) illustrates the socio-cultural values of the Kitikmeot Inuit which identified elements for consideration for the scoping of VSECs for the Project. Other sources that inform that process included consultation with local communities, regional Inuit organizations, and other stakeholders. The TK report (KIA 2012) informed the discussion and scoping of VSECs by providing context to the current socio-economic characteristics of the region and identifying topics of importance for further consideration (see Volume 9, Chapter 1).

Situating current socio-economic values within their traditional context enables a more informed analysis of baseline study trends as well as a more rigorous effects assessment. The Kitikmeot Inuit Association (KIA; 2012) report presents information that speaks to past social and gender roles, economic means, methods of education and skills development, as well as values associated with community well-being. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were incorporated in the VSECs selected.

3.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The spatial and temporal boundaries of the Project have been defined by the location of the Project and the predicted distribution of the benefits and effects of the Project. While the TK report (KIA 2012) provides valuable contextual information including the relative distribution of Inuit prior to settlement in communities, this information is not directly applicable to the characterization of spatial and temporal boundaries used to the assess the potential socio-economic effects of the Project.

3.2.4 Incorporation of TK for Effects Assessment

The effects assessment relies on the information collected and analyzed during baseline studies. The inclusion of TK as related to the selection of VSECs facilitates the production of a more accurate and relevant effects assessment. The TK report (KIA 2012) provided valuable contextual information that informed understanding of the current socio-economic environment. While historic events are not directly application to the assessment of Project effects, this knowledge informs discussion as well as current trends identified and used to predict the effects of the Project.

3.2.5 Incorporation of TK for Mitigation and Adaptive Management

Mitigation and adaptive management measures relevant for socio-economics include those established to enhance Project benefits while mitigating or managing any adverse effects of the Project. Information provided in the TK report (KIA 2012) was used to guide the development of mitigation and adaptive management measures and was coupled with other sources of information, for example, reports describing the current experiences of Inuit engaged in mine work elsewhere in Nunavut.

3.3 VALUED COMPONENTS

3.3.1 Potential Valued Components and Scoping

The scoping of potential valued components followed the process outlined in the Assessment Methodology (Volume 9, Chapter 1). VSECs are the aspects of the socio-economic environment considered to be of vital importance including components related 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 2013a). VSECs to be examined in the assessment of the effects of the Project on the socio-economic environment were selected based on the potential interaction with Project activities and informed through consultation with communities, regulatory agencies, and available TK, and was further informed by professional expertise (Volume 9, Chapter 1).

The potential interaction with VSECs is ultimately due to Project employment and expenditures in the Kitikmeot Region, across Nunavut, and elsewhere. As indicated in the Preliminary Economic Assessment (SRK Consulting 2012), the Project involves a total capital investment of approximately $447.2 million in the initial two-year construction phase ($207.4 million in the first year of construction, and $240.2 million in the second year of construction). In addition, capital expenditures during operation (sustaining capital and capital investments associated with expansion of the mining operations, estimated to occur over ten years) total an additional $391.0 million, for a total capital expenditure of approximately $838.6 million. Operating expenditures for the Project are estimated to be a total of approximately $1,798.5 million or an average of about $179.9 million annually over approximately 10 years. Direct employment during construction is estimated to total approximately 1,200 person-years. The direct employment during operation totals an estimated 4,442 person-years over approximately 10 years of operation, or an average of approximately 444 workers each year (full-time equivalent, standardized to a 2,080-hour work year).

The determination of VSECs and potential effects for inclusion in the assessment considered and was informed by:

- the Environmental Impact Statement (EIS) guidelines (NIRB 2013a);
- meetings with regional Inuit groups (for example, the KIA);
- GN policy documents (e.g., The Makimaniq Plan: A Shared Approach to Poverty Reduction; GN 2011);
- community research including interviews with local service providers;
- Kitikmeot Community Advisory Group (CAG) meetings; and
- The public, during public consultation and open house meetings held in the Kitikmeot communities.

A number of additional key data sources also provided context to inform the selection of VSECs and effects to be assessed including the 2012 Socio-economic and Land Use Baseline Report (Appendix V8-3A; Rescan 2012), the Draft Nunavut Land Use Plan (NPC 2012), Nunavut Impact Review Board (NIRB) reference and guidance documents (NIRB 2013b, 2013c), and the TK report (KIA 2012). Topics discussed during community meetings, focus groups, interviews, and other meetings with the KIA and relevant government bodies were integrated within specific VSECs for further examination in the assessment process.

Each VSEC was considered in relation to the 2012 Socio-economic and Land Use Baseline Report (Appendix V8-3A). Information and results from other DEIS chapters were integrated to further inform

the assessment of the potential socio-economic effects of the Project, including Public Consultation and Government Engagement (Volume 3), and the Country Foods Assessment (Volume 8, Chapter 5). Specific chapters and sections of these volumes are referenced, where appropriate, as they are considered in the socio-economic effects assessment.

Multiple scoping sessions held with NIRB, local stakeholders, and community members (i.e., the public) facilitated discussion to identify local values as related to the socio-economic context of the Kitikmeot Region. Comments made during these sessions were compiled and analysed as part of VSEC scoping. All comments were considered during VSEC selection. A number of comments are highlighted below to showcase content considered:

> *I'm witnessing ways of living that I've never seen before. Our young people have to learn so that they can be qualified to work in a mine. We need to make them employable and they're increasing in numbers. The other worry is that the mining companies can affect the environment, but there are a number of unemployed people* (Volume 3).
>
> *The most important things in a community are health and food. It doesn't matter about how much money that the community gets in the end, because it gets siphoned out. It's the land, the food, the animals, the people* (Volume 3).
>
> *There are many people that are going through poverty. Because of high cost of living, many people are trying to seek employment and training* (Volume 3).
>
> *There are more workers from the south and only like two from the north. We have too many families living on social assistance. We have lots of people asking for food, especially the grandchildren* (Volume 3).
>
> *A lot of Inuit don't make good wages because they don't have certificates/education. We are more or less laborers because of this. People from down south make good wages. Inuit work very hard, but their wages are very minimal. The different races should be treated equal. We need to get the skills to move into positions with more responsibility* (Volume 3).

Consideration was given also to topics and issues highlighted during public consultation meetings in the Kitikmeot Region. For example, numerous individuals spoke about the current lack of jobs and high cost of living in the north and indicated that employment is much needed.

> *For us Kitikmeotmiut I suppose there are some of us are in support to see our youth being employed. There will be other companies locally that will benefit. DFO will help us protect our environment. The fact that they will be shipping the ore, it will benefit us because of the high unemployment rate. And other local businesses will benefit as well* (Volume 3).
>
> *Employment opportunities are being talked about in the community. Work is hard to find. We thank you for making these opportunities available to our young people. In Gjoa Haven, Taloyoak, and Kugaaruk jobs are hard to come by* (Volume 3).

Others spoke about the need to manage the benefits of Project employment and contracting opportunities. Most notably, concerns around how Projects employees might choose to spend their

increased income were discussed in all five Kitikmeot community meetings, highlighting the need for the Project to compliment employment with counselling and other supports.

> *Even if family gets jobs, the money will just be used for drugs and alcohol and not go to family. Maybe they need to learn how to use money* (Volume 3).

> *The youth that gets jobs they spend it on drugs and alcohol. What could go to big ticket items is being wasted on drugs and alcohol. The mining companies have to consider training on how to manage your money. They should provide a course on how to manage your money and not to blow it all at once* (Volume 3).

> *Drugs and alcohol may cause social problems; the money being made from the mines would go to drugs and alcohol* (Volume 3).

The need to coordinate education and training programs and the provision of Project employment was also discussed. Specifically, Kitikmeot residents noted that in order to benefit from the Project local people need to obtain the skills required for Project employment. Communication of specific opportunities and qualifications required was noted as key for both adults and potentially even more so for youth.

> *Will you be able to help encourage the youth to embrace employment opportunities? Maybe there are barriers for people that are not well educated that are stopping them from moving forward. We need the youth to feel better about themselves moving forward, and let them know that there are lots of opportunities out there* (Volume 3).

Community research, specifically interviews with hamlet officials, business owners, and numerous health, education, housing, and social service providers in study area communities also informed to the selection of VSECs. Further details describing the results of community research and the fieldwork program are provided in Section 3.1 and Appendix V8-3A. The results of community research as well as community and public consultation and scoping sessions collectively informed the selection of VSECs to assess the potential effects of the Project.

3.3.2 Valued Components Included in Assessment

This section responds to the socio-economic environment and impact assessment sections of the NIRB guidelines (NIRB 2013a). The guidelines call for consideration of valued components that include 'Economic Development and Opportunities', 'Employment', 'Education and Training', 'Contracting and Business Opportunities', 'Population Demographics', 'Health and Well-being', and 'Community Infrastructure and Services'. These proposed valued components, as well as the potential effects identified that correspond to each of the valued components, were considered in the selection of the VSECs included in the assessment.

Rational for the inclusion or exclusion of each potential effect identified is provided. The review of potential socio-economic interactions identified whether or not a Project activity may interact with either one or more of the identified VSECs, causing an effect. If there is no potential for interaction between Project component and a VSEC, the effect was not further assessed.

The following section first reviews the VSECs selected for inclusion in the effects assessment and provides a rational for VSECs not included in the assessment. Second, the potential socio-economic effects of the Project that will be included in the socio-economic effects assessment are identified. This is followed by a section that details potential socio-economic Project effects that have been

excluded from this assessment. In both cases, rationale for the decision and direction to further information supporting the decision is provided.

The VSECs selected to assess the potential socio-economic effects of the Project include:

1. Economic Development;
2. Business Opportunities;
3. Employment;
4. Education and Training; and
5. Health and Community Well-being.

These VSECs have been selected to represent the interests of Kitikmeot residents as they relate to the Project. Regional interests were identified in public and community meetings held in the Kitikmeot communities.

The Project is expected to affect regional economic development as a result of the provision of employment and business opportunities. Education and training are valued as they enhance the ability of local residents to secure employment and/or business contracts, and to generate and take advantage of economic development opportunities. Participation in education and training, employment, and Project-related contracts is expected to have implication for health and community well-being.

More specifically, the Project will contribute to the VSEC Economic Development through expenditures and employment that result in tax gains for regional and territorial government and contributions to GDP. Project employment and related incomes also generate indirect and induced employment and incomes. Business opportunities associated with the Project also contribute to economic development and consider the direct, indirect, and induced opportunities associated with the Project.

Education and training may be affected by the Project as local residents have expressed interest in Project employment that requires specified education and skill levels. Education institutions in the Region have expressed an interest in understanding the Project's specific staffing and skill-level requirements in order to establish program delivery that further enables local hiring.

Finally, the Project has the potential to impact health and community well-being in the Kitikmeot. For the purpose of this environment assessment, health and community well-being is inclusive of issues identified by Kitikmeot residents during public consultation and community research as well as in GN policy documents and as indicated by the Kitikmeot Region Socio-economic Monitoring Committee (SEMC). Further, within the assessment the concept 'health' has been included to reflect the broader implications of changes to well-being. The inclusion of 'health' enables consideration for the physical outcomes that can be associated with well-being. Examples of this include: respiratory issues that are exacerbated by housing that is overcrowded; the numerous health implications (liver damage, cancer, or injury) that can result from substance abuse; or the sexual health implications (e.g., sexually transmitted infections, or STIs) of risky sexual behaviour.

3.3.2.1 Valued Socio-economic Components Excluded from the Assessment

In addition to the VSECs included in the assessment, there are two VSECs proposed in the EIS guidelines (NIRB 2013a) that are excluded from the assessment as interaction with the Project is not anticipated, including:

- Population Demographics; and
- Community Infrastructure and Public Services.

The potential effects related to each of these VSECs are considered below and linked to either a rationale for their exclusion or direction to where the information is located within this broader effects assessment. In some instances, potential effects have been excluded from further evaluation as they relate to the above two excluded VCESs and instead are considered as part of other effects that have the potential to interact with the VCESs included in the assessment (Section 3.3.2.2).

Population Demographics

The proposed VSEC Population Demographics is excluded from this socio-economic effects assessment as the Project is not anticipated to contribute to changes in population size due to the fly-in/fly-out operation of the Project as well as the provision of worker camps at the Project site. That is, Project employees are not expected to relocate to the Kitikmeot Region from southern areas. Further, local employees are not expected to relocated within the region as pick up points are established at the main points of hire and additional pick up points may be added as necessary to facilitate the transportation of workers to and from their home communities. Population demographics data relative to population, age, gender, social structure and others is provided in Section 3.1. This data provides valuable context relative to the socio-economic environment in the Kitikmeot Region and Nunavut. Project effects linked to the VSEC Population Demographics, as well as the rationale for exclusion of each are shown in Table 3.3-1.

Table 3.3-1. Potential Effects to Population Demographics and Rationale for Exclusion

Potential Effect	Rationale for Exclusion
Potential for Project-induced demographic changes in population and migration (including in-migration from outside Nunavut).	The Project is not anticipated to cause in-migration from outside Nunavut as Project employees who are non-residents will be housed in camps at the Project site and will be flown into and out of the region from designated pick up points in the south (e.g., Edmonton).
Population re-distribution or movement of Nunavummiut between communities and the effects of those changes. Details on potential interactions between local residents and non-residents.	Nunavummiut are not expected to relocate as a result of Project work. Cambridge Bay and Kugluktuk will act as pick up points for Inuit employees. Should a number of employees be hired from the eastern Kitikmeot communities, there is potential to develop additional pick-up points. Interaction between local residents and non-residents are anticipated to be minimal as the Project has been designed as a fly-in/fly-out operation.
Potential effects of the fly-in/fly-out employment on population demographics.	The fly-in/fly-out operation of the Project will be assessed as related to the VSEC Health and Community Well-being and is not anticipated to alter population demographics (see Sections 3.5.3 and 3.5.5).
Potential effects from various Project phases, including unemployment as a result of temporary suspension of operations or mine closure.	This effect is assessed as related to the VSEC employment for all stages of the Project.

Community Infrastructure and Public Services

The proposed VSEC Community Infrastructure and Public Services is excluded from this assessment. Information describing community infrastructure and public services has been included in Section 3.1 (see also Appendix V8-3A), including:

- community, cultural, and recreational programs;
- existing transportation modes and travel routes/roads and associated costs;

- existing communication systems, services and utilities, community and regional waste management systems;
- cost, conditions, supply of, and demand for housing (public, private, and rental);
- descriptive of the extent and current capacity of the local transportation systems and associated infrastructure;
- the cost to build infrastructure (housing and other); and
- existing public services and associated facilities (e.g., including law enforcement, health care, emergency response, dependency assistance, welfare utilities, temporary accommodation and foods services).

The Project is not anticipated to affect Community Infrastructure and Public Services as Project employees will be housed in one of three camps at the Project site and will be provided with duplicative infrastructure and services. That is, Project employees will be transported to and from the Project via their home community and, therefore, will continue to access infrastructure and services either in their home community, where services are currently accessed, or at the Project site. Project employees obtained from southern communities will continue to access services such as dental care, standard health care (e.g., general practitioner or family doctor), mental health care, and other services in their home communities. Health services, such as nursing, emergency care, and others, will be available for all employees at the Project site. In the event of an emergency, the Project will provide emergency and medevac services that are in addition to services utilized by the Kitikmeot communities and therefore, is predicted to place no additional strain on the current health systems in place.

Similarly, increases to the current level of demand on community infrastructure and public services in the Kitikmeot communities are not anticipated. Project employees obtained from the Kitikmeot communities will continue to access health services within their home community and additionally have access to some services at the Project site. There is potential for the Project to decrease demand on specific services, for example, nursing care for minor issues, if Inuit employees choose to access these services through Project-provided services rather than in their home communities. Overall, current demand for health and social services are expected to be maintained as Project employees resident in the Kitikmeot will continue to rely on these services during time off work. Any other potential indirect effects of the Project due to changes in demand on community health and social services, such as due to changes in spending habits, are considered as part of the VSEC Health and Community Well-being.

There will be a minimum of two pick-up points in the Kitikmeot Region (Kugluktuk and Cambridge Bay), as well as additional pick-up points in the eastern Kitikmeot communities should a number of individuals be hired from those communities. For example, during exploration, six individuals from Kugaaruk were hired and transportation was provided to the Project site directly from Kugaaruk. Employees that are resident in the Kitikmeot Region are not expected to relocate as a result of the Project.

Each effect linked to community infrastructure and services has also been considered. Table 3.3-2 below summarizes effects of concern as indicated by the EIS guidelines (NIRB 2013a) and the rational for their exclusion from this assessment.

Table 3.3-2. Potential Effects to Community Infrastructure and Services and Rational for Exclusion

Potential Effect to Community Infrastructure and Services	Rationale for Exclusion
Discussion of demand for community infrastructure and public services from the Project directly and indirectly.	The Project is not anticipated to effect community infrastructure and services as Project employees will be housed at the Project site. Any indirect effects of the Project on facilities and services are considered within their representative VSEC. For example, changes to the demand for education and training are considered as an effect on Education and Training.
Assessment of the effects on services and/or infrastructure (including housing) in public and private sectors, due to the potential use by the Project directly or indirectly, include those caused by Project related demographic changes.	Effects to the supply of housing and other infrastructure and services are not anticipated as Project employees will be housed and provided with additional facilities and services at the Project site. Any indirect effects of the Project due to changes in demand on community health and social services are considered as part of the VSEC Health and Community Well-being.
An assessment of potential increased demand on local and regional health care systems, including the standard medical system, emergency response and emergency medical care, medevac services, and challenges raised by increased demand.	Project inducted demographic changes are not expected as Project employees will be housed in camps at the Project site. Emergency and standard health care services will be provided at the Project site. As such, Project employees who do not presently access health care services including medevac in the Kitikmeot communities will access those services at the Project site. Therefore, changes to demand on local, regional, emergency, and medevac services are not anticipated to change as a result of the Project.
Discussion of building new and updating existing structures including weather shields and outposts beyond the boundaries of communities and along hunting/travel routes and/or at hunting grounds which may facilitate local hunting activities/traveling in Project areas.	The Project has not proposed to develop infrastructure (weather shields or outpost) that would facilitate access to hunting areas for local or external hunters with the view of maintaining current levels of harvesting and not increasing pressure on wildlife, bird, and fish populations near the Project area.
Assessment of incremental costs imposed by the needs from the Project directly or indirectly on public infrastructure, services, including those caused by Project-induced demographic changes.	Project inducted demographic changes are not expected as Project employees will be housed in camps at the Project site.
A discussion of community access to Project infrastructure upon Project closure, including proposed road options.	The Project will rely on winter roads and will not establish any all-weather roads. Access to infrastructure upon closure of the Project will be detailed in a Project Closure Plan.
A discussion of the potential to bring in freight for communities by return shipping and likelihood to share shipping costs with local communities.	This topic will be discussed as part of Inuit Impact and Benefit Agreement (IIBA) negotiations and may be included in the forthcoming IIBA.
Assessment of public health and environmental health needs and implications to the Proponents community initiatives.	The effects of the Project for public health and environmental health are detailed in the Human Health and Environmental Health Risk Assessment in Chapter 6.
Potential impact on availability and adequacy of existing health infrastructure and services includes medical, dental, vision, social, mental (including addictions), environmental health officers, social workers, registered nurses, medical directors, and access to medical travel and interventions.	Project employees who do not presently access these services in the Kitikmeot communities will continue to access health and social services in their home communities, and may access some services at the Project site. Therefore, changes to current demand for these services within the Kitikmeot communities are not anticipated to change as a direct result of the Project. Any indirect effects of the Project due to changes in demand on community health and social services are considered as part of the VSEC Health and Community Well-being.

3.3.2.2 Potential Socio-economic Effects Included in the Assessment

Examination of the potential effects of the Project resulted in the identification of effects that interact with the VSECs to be carried forward for further consideration and assessment. The effects have been defined in a way that enables the reader to understand the direct effect of the Project (e.g., direct employment, direct business opportunities) and the implications of these effects for the socio-economic context of the Kitikmeot Region. Each potential effect selected for inclusion in this assessment is linked to one of the VSECs and may be either positive or negative. As noted earlier, all potential socio-economic effects ultimately stem from direct Project employment and expenditures in the Kitikmeot Region. Table 3.3-3 summarizes the potential effects as related to each Project VSEC that are included in the effect assessment.

Table 3.3-3. Potential Socio-economic Effects of the Back River Project

VSEC	Potential Effect
Economic Development	• Changes to economic growth, diversity, and performance
Business Opportunities	• Changes to the growth and diversity of Inuit and Northern businesses
Employment	• Changes to employment and income levels • Changes to the capacity of the labour force • Changes to competition for local labour
Education and Training	• Changes to the demand for education and training • Changes to youth attitudes and behaviours toward education and training
Health and Community Well-being	• Changes to life skills of individuals • Changes to individual and family spending • Changes to family/household structure

The review of potential effects in some instances refined the effect to enable a more focused analysis or scoped out an aspect of the effect for which there is not expected to be an interaction with a VSEC. The aim of this approach was to clearly define one effect, how the effect is linked to the Project, and how the Project-induced effect is expected to interact with a VSEC. The rationale for the inclusion of each potential effect is provided below.

Economic Development

Changes to Economic Growth, Diversity, and Performance - this effect is defined as growth to the production and capacity of the economy. This effect will consider changes to Nunavut's GDP, as well as changes to the economy that result from the development and eventual closure of the Project. This effect also considers changes to number of businesses and industries that together comprise the economy. Components include the type, size, capacity, and number of permanent businesses.

Business Opportunities

Changes in the growth and diversity of Inuit and northern businesses – this effect is defined as the potential for new businesses and the ability of existing businesses to expand or diversify and as a result of local Project expenditures and the expenditure of Project related income.

Employment

Changes to employment and income levels - this effect is a result of direct Project employment and procurement and is anticipated to change individual and family income, and purchasing power of workers and their families.

Changes to the capacity of the labour force - this effect is a result of Project employment and procurement and is defined as the potential for changes to the skills and experience the Kitikmeot labour force. This effect considers the resulting increase to human capital within the Region.

Changes to competition for local labour - this effect is a result of Project employment and procurement and is defined as the potential for individuals currently employed in the Kitikmeot Region to leave their current employment for mine-related employment. Consideration is given to any increase or decrease in the number of vacant non-mine related jobs by industry sector and changes to expectations of salary or compensation. This effect considers the retention of local employees (e.g., hamlet and Government of Nunavut employees).

Education and Training

Changes to the demand for education and training programs – this effect is defined as increased local demand for accredited education and training programs that results from the provision of employment opportunities associated with the Project.

Changes to youth attitudes towards education and training – the effect is defined by youth perceptions of the link between education and employment and considers the motives of youth and their participation in education.

Health and Community Well-being

Changes to the life skills[3] of individuals – this effect is defined as Project-induced changes to abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life and is focused on individuals that obtain Project employment.

Changes to individual and family spending - this effect is defined as the expected implications of increased income from Project employment including productive spending (e.g., education, housing, equipment, etc.) and unproductive spending (e.g., gambling, drugs, and alcohol). Increased income as related to family consumption and housing subsidy eligibility as well as the linkages between increased levels of substance abuse, domestic violence, family violence, and sexually transmitted infections (STIs) are also considered.

Changes to family/household structure – the effect is defined as the potential for changes to the family and household structure of those engaged in mine employment as a result of the fly-in/fly-out worker rotation schedule. This effect considers the implications of Project employment on families (e.g., one or two parents away from home, gender roles) and relationships (e.g., marital and parental).

3.3.2.3 Potential Socio-economic Effects Excluded from Further Assessment

Where interactions have been identified and potential effects are likely but not substantial these items have not been carried forward for further assessment. In a number of instances, potential effects that have been excluded are considered as part of one of the included potential effects noted above. An explanation for the exclusion of specific socio-economic effects is provided and the reader is encouraged to review additional content supporting the conclusion. Identified potential effects or changes caused by the Project that are excluded from the assessment are detailed in Table 3.3-4.

[3] Life Skills are defined as the abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life. Adaptive means a person is flexible in approach and able to adjust in different circumstances. Positive behavior implies a person is forward looking and seeks solutions to problems (WHO. 1999. *Partners in Life Skills Education*.

Table 3.3-4. Potential Socio-economic Effects Excluded from the Assessment

VSEC	Potential Socio-Economic Effect	Rationale for Exclusion
Economic Development	Potential impact on the traditional economic activities including hunting, fishing, and sport hunting/guiding, etc.	This effect is considered as part of the Land Use EA (Volume 8, Chapter 4).
	Potential impacts related to accessibility and the removal of barriers for travelling fishing, hunting/trapping and other activities by local communities as a result of the construction and operation of the all-weather road.	This effect is considered as part of the Land Use EA (Volume 8, Chapter 4).
	Effects of the Project on import/export and trade balance of goods and impacts of the Project on household consumption and own source tax revenues.	Trade balance of goods, import/export, household consumption, and own source tax revenues are economic measures that characterize the state of the economy. The actual effects of the Project that may lead to changes in these measures are captured by assessing, for example, changes to the demand for goods and services or changes to economic diversity. It is Project expenditure and procurement that influence changes in the economy that can later be measured using these economic descriptors. The terms do not, however, represent any independent change apart from those described. As such, and to avoid redundancy, a separate assessment is not carried out for these specific measures.
	Effects of the Project on CPI	The Project is not expected to have an effect on the cost of goods in communities as a result of the fly-in/fly-out nature of the Project.
Business Opportunities	The contributions made to public, communities and Inuit form the Project.	The process for financial and other contributions made by Sabina is highlighted in Volume 10, Chapter 26, Community Involvement Plan and will be detailed in the forthcoming IIBA.
	Assessment of Project related procurement, and potential capacity to meet Project needs.	Benefit enhancement through Project-related contracting and procurement is detailed in the Business Development Plan (Volume 10, Chapter 24 and Section 3.8.1.1). The potential capacity of Inuit Businesses to obtain contract opportunities with the Project and methods through which Sabina will enhance these opportunities are also detailed in Volume 10, Chapter 24 and Section 3.8.1.1 (The Business Development Plan).
	Discussion of barriers to local business capacity building.	Barriers to local business development are described in Appendix V8-3A and are also highlighted in Section 3.1, Existing Environment. These barriers are considered in the assessment of the potential effects of the Project on Business Opportunities because of a 'changes to the growth and diversity of Inuit and Northern businesses'.
	Assessment of existing country foods supply sources from the Project region and Nunavut, and opportunities to supply country food sources for Inuit workers at the Project.	Existing country food supply sources are described in the Socio-economic and Land Use Baseline Report (see Appendix V8-3A). The project approach for the provision of country food for Inuit Project employees is detailed in the Human Resources Plan (Volume 10, Chapter 28).

(continued)

Table 3.3-4. Potential Socio-economic Effects Excluded from the Assessment (continued)

VSEC	Potential Socio-Economic Effect	Rationale for Exclusion
Employment	Discussion of culturally sensitive workforce management practices that meet both the Project's immediate needs and the region's longer-term economic development needs.	Measures that established a culturally sensitive workforce are detailed in the Human Resources Plan (Volume 10, Chapter 28).
Education and Training	Projects effects to class sizes, infrastructure, and administration	Project employees are not expected to relocate to Kitikmeot communities and their families will not accompany workers to the Project site. Changes to NAC class sizes, infrastructure and administration is included as part of the potential effect 'changes to the capacity of education and training institutions'.
	Discussion of the potential need of local labour force training to meet the needs of the Project. The types of training can be those specifically required by the Project, or others geared towards universally applicable skills that might improve worker's opportunities in other sectors of the local economy.	Measures aimed to match training efforts with the labour force needs of the Project, as well as providing the first opportunity for employment to Inuit, are detailed in the Human Resources Plan (Volume 10, Chapter 28). This is not an anticipated effect of the Project. However, universally applicable skills training as related to the Project is discussed as part of the Human Resources Plan (Volume 10, Chapter 28) and Section 3.8 (Mitigation and Adaptive Management) and will be further detailed in the forthcoming IIBA. The types of training and skill levels required for Project employment are available online at www.BackRiverProject.com.
	Requirements for education levels, skills and experience of labour force from the Project in short term, medium term and foreseeable future, taking account the vision of expansion for the Project lifespan, and regional economic development.	While measures are planned to enhance Inuit participation in Project training and employment, this is not an effect of the Project. The types of training and skill levels required for Project employment are available online at www.BackRiverProject.com. Plans to enhance Inuit participation in Project training and employment are provide in the Human Resources Plan(Volume 10, Chapter 28) and Section 3.8 (Mitigation and Adaptive Management).
	Evaluation of training programs planned by the Proponent, the associated challenges and likelihood of success of trainees to satisfy the Project needs and regional economy development with consideration of cultural and language barrier.	While the evaluation of training programs is planned in order to enhance Inuit participation in Project training and employment, this is not an effect of the Project. Plans in place to monitor the outcomes of the Project, including the success of training programs, are provided in the Human Resources Plan (Volume 10, Chapter 28) and are summarized in Section 3.9 (Proposed Monitoring Program).
	Discussion of the potential for longer term community capacity building programs, if any have been planned or will be planned and are anticipated to be implemented throughout the Project's lifetime, regarding how mine training plans can enhance the transferability of skills after mine closure (e.g., management and HR skills, computer skills, heavy equipment experience, finance skills, etc.)	Longer term community capacity building and plans to assist Project employees find new employment upon closure of the Project are planned; they are not an effect of the Project and are discussed in the Human Resources Plan (Volume 10, Chapter 28) and are summarized in Section 3.8.1.1.

(continued)

Table 3.3-4. Potential Socio-economic Effects Excluded from the Assessment (continued)

VSEC	Potential Socio-Economic Effect	Rationale for Exclusion
Education and Training *(cont'd)*	Discussion of other possible solutions to fill up the gap between requirements of Project needs and education level and qualifications of local labour force.	Aside from measures defined by the Human Resources Plan (Volume 10, Chapter 28), this discussion is underway as part of the IIBA negotiations but is not an effect of the Project.
Health and Community Well-being	Potential impacts to human health associated with traditional lifestyles where large amounts of country foods are consumed, considering the bioaccumulation of contaminants loadings in country foods (e.g., terrestrial and marine wildlife, fish, birds, and vegetation consumed by humans).	See the Country Foods EA (Volume 8, Chapter 5), which concludes the Project will not cause risks to human health in either adults or toddlers due to incidental metal consumption, and that the Project will not cause changes to country food quality (due to metal content).
	Changes to the community safety and security, including crime incidents, as a result of the potential influx of Project personnel into local communities during the life of the Project.	Project personnel will be housed in camps at the Project site and will be transported to and from their home communities (see Main Volume, Chapter 3). As such, Project personnel are not expected to affect community security or cause changes to the frequency or type of crime indictments. Potential indirect effects due to the actions of Kitikmeot residents are considered as they relate to 'changes to individual and family spending' as it has the potential to affect the VSEC Health and Community Well-being.
	Description of barriers to current financial management programs and any incentives that would be provided by the proponent for health financial management.	Financial management programs are not consistently available in the Kitikmeot Region. Measures to enhance the financial management skills of Project employees are detailed in the Human Resources Plan (Volume 10, Chapter 28).
	Potential effects on individual, family, and community health and well-being from workplace and community cross-cultural tensions, conflict, and/or racism.	Intercultural awareness training will be provided to all Project employees and managers. As such effects to well-being as a result of cultural conflict and racism are not anticipated. Further details on intercultural awareness training are provided in the Human Resources Plan (Volume 10, Chapter 28).
	Changes in access to alcohol or other controlled substances resulting from the potential movement of these items through the Project site or via project related activities (e.g., stopovers or layovers). Impacts of the Project on alcohol/prohibited substance consumption and import/export.	The Human Resources Plan (Volume 10, Chapter 28) includes measures to: 1) maintain an alcohol and drug free environment at the Project site, 2) prevent the transfer of drugs and alcohol to and from the Project site (e.g., luggage searches), and 3) establish and maintain the zero tolerance regulation for all Project employees and managers. Potential indirect effects due to the actions of Kitikmeot residents are considered as they relate to 'changes to individual and family spending' as it has the potential to affect the VSEC Health and Community Well-being.

(continued)

Table 3.3-4. Potential Socio-economic Effects Excluded from the Assessment (completed)

VSEC	Potential Socio-Economic Effect	Rationale for Exclusion
Health and Community Well-being *(cont'd)*	Changes to physical health – this effect considers the implications of the potential spread of communicable diseases and STIs from the Project site, changes to the mental health of Project employees, and changes to the longevity of Project employees and their families.	Changes to physical health are considered as part of the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). The Project is not expected to have an effect on community levels of STIs or other communicable diseases due to the fly-in/fly-out operation of the Project. That is, there will be no influx of workers into the Kitikmeot Region and a very minimal level of contact, if any, between southern Project employees and the Kitikmeot communities. It is acknowledge that domestic violence, STIs, and communicable diseases are important issues of concern to communities. The regular provision of health services at the Project site is considered as a preventative measure that guards against the spread of disease within the Kitikmeot communities, as is other mitigation as defined by the Human Resources Plan (Volume 8, Chapter 28).

3.3.3 Supporting and Supplemental Information

Socio-economics was included in the scoping and refining process with all other potential Valued Ecosystem Components/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation (Volume 3), the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations.

Supporting and supplemental information is provided for 'topics for discussion', or topics that have been given further consideration within the discussion of a particular VSEC. These topics are issues that were raised during scoping meetings, community research activities, or during community consultation. While topics for discussion are not thought to be directly linked to the Project and do not represent effects of the Project, these topics are further explored to establish a deeper understanding of the socio-economic conditions and cultural context of communities in Nunavut's Kitikmeot Region. Understanding local and regional social and cultural contexts furthers the extent to which the success of the Project can be inherently linked, through design of management plans and mitigation, to the increased economic successes and enhanced community well-being of the Kitikmeot Region.

As required by the NIRB (2013a), 'topics of discussion' are included as context for the following assessment and may be related to specific mitigation measures developed to address a potential Project effect. 'Topics of discussion' are considered and addressed where possible rather than resolved, as these topics speak to existing socio-economic conditions in the Kitikmeot Region and demonstrates an understanding that facilitates the overall assessment of potential Project effects.

3.4 SPATIAL AND TEMPORAL BOUNDARIES

3.4.1 Spatial Boundaries

For the purposes of this socio-economic effects assessment, local and regional levels of data are considered. Regional-level data is considered for the Kitikmeot Region of Nunavut, while community-level data is presented for each of the Kitikmeot Region communities: Bathurst Inlet (also known as Kingaok), Omingmaktok (also known as Bay Chimo), Cambridge Bay (also known as Iqaluktuuttiaq), Kugluktuk (previously known as Coppermine), Gjoa Haven (also known as Uqsuqtuuq), Taloyoak (previously known as Spence Bay), and Kugaaruk (previously known as Pelly Bay). In some cases, depending on information availability, Nunavut-wide information is presented.

The communities of Omingmaktok and Bathurst Inlet are no longer occupied year round and do not offer typical municipal services such as health and education services. As such, this social and economic effects assessment focuses on the five Kitikmeot communities populated year round. Additional consideration is given to Yellowknife, NWT, due the likely socio-economic linkages between the Project and this community. However, the focus of this social and economic assessment is on those communities within the Kitikmeot Region.

The assessment of the potential effects of the Project on social and economic conditions considers two distinct sub-regional areas of interest – the west and east Kitikmeot regions. The west Kitikmeot Region defines the LSA and includes the communities of Bathurst Inlet, Omingmaktok, Cambridge Bay, and Kugluktuk. In addition to the west Kitikmeot Region, the RSA is expanded to include the east Kitikmeot Region, specifically including Gjoa Haven, Taloyoak, and Kugaaruk. The city of Yellowknife is also included within the RSA. The LSA and RSA are shown in Figure 3.4-1.

3.4.2 Temporal Boundaries

The temporal boundaries for each VSEC are defined in relation to planned activities over the lifetime of the Project within which a reasonable expectation of interaction can be predicted. The temporal boundaries for the Project phases are defined as follows:

- Site Preparation: 2 years
- Construction Phase: 2 years
- Operational Phase: 10 years
- Reclamation and Closure Phase: 10 years
- Post-Closure Phase: 5 years
- Other Phases:
  - Temporary Closure: less than 2 years
  - Care and Maintenance Phase: 2 to 10 years

3.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

This assessment of effects was informed by a methodology used to identify and assess the potential socio-economic effects of the Project and is consistent with the requirements of Section 12.5.2 of the Nunavut Land Claim Agreement and the EIS guidelines (NIRB 2013a).

3.5.1 Methodology Overview

Effects are changes to current aspects of the environment or human activities that occur as a result of the Project. This effects assessment involved a process of identifying the effects of the Project that would result in changes to the socio-economic characteristics of the Kitikmeot communities.

This assessment follows the general methodology provided in Volume 9, Chapter 1. This analysis of effect considered the information provided in the following sources:

- 2012 Socio-economic and Land Use Baseline Report (Appendix V8-3A);
- Inuit TK (Usher 1976; Thorpe 2001; Blower 2003; KIA 2012);
- community research and fieldwork program;
- Kitikmeot CAG meetings; and
- The EIS guidelines (NIRB 2013a).

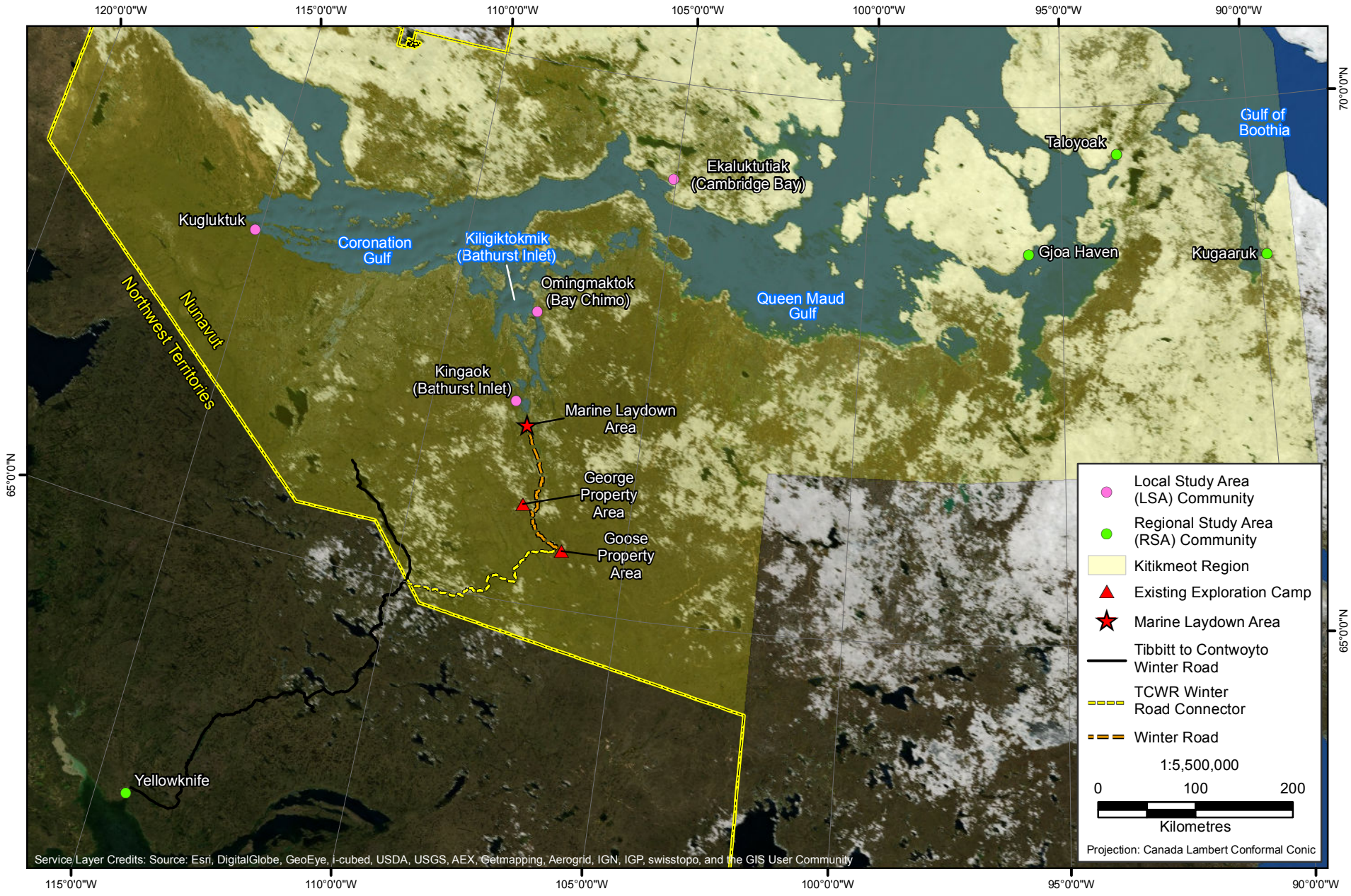


Figure 3.4-1

Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area Communities for Socio-economics

Figure 3.4-1

Rescan an ERM company

This assessment was further informed by regional planning and policy documents, the results of public consultation and open house meetings held in the Kitikmeot communities, and professional judgement.

3.5.1.1 Identification of Residual Effects and Significance

The effects assessment process comprises a step-wise method to assess potential effects of the Project on the socio-economic environment, as follows:

1. Identification of potential interactions between the Project and VSECs, which include: Economic Development, Business Opportunities, Employment, Education and Training, and Health and Community Well-being;
2. Characterization of the potential effects that could result from these interactions;
3. Identification and description of mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. Assessment of defined attributes to rate the significance of residual effects, including: direction, magnitude, geographic extent, equity, frequency, duration, reversibility, and probability (Volume 9, Chapter 1).

Each Project component is evaluated for the defined project phases: Site Preparation, Construction, Operation, Reclamation and Closure, Post-closure, Temporary Closure, and Care and Maintenance. For each potential socio-economic effect, the nature of the effect is characterized. First, the direction of a residual effect is determined to be positive or negative. All effects were then assessed according to several criteria. The magnitude of the effect, duration, and geographic extent were used as the primary criteria, followed by the reversibility and frequency of the effect as secondary criteria. Consideration is then given to equity or the predicted distribution of an effect across different social groups, with the intent of identifying potentially affected vulnerable groups. The probability of the effect was then evaluated to indicate whether or not the effect is likely to occur and the significance of the effect was rated as positive, negative and not significant, or negative and significant. Finally, the level of confidence (certainty) in the rating was provided as a qualifier. The rating of residual socio-economic effects is based on the attributes summarized in Table 3.5-1 below. In considering the magnitude of each residual effect on the VSECs, definitions are referenced to designate each effect as having either a low, moderate, or high magnitude, as defined in Table 3.5-2.

Overall significance of a residual effect is derived from the available information and the experience and professional judgement of the practitioners who prepared the assessment and considering the ratings of the attributes that contribute to significance (Tables 3.5-1 and 3.5-2). Both quantitative and qualitative evaluations of the degree to which residual effects are predicted to cause changes to VSECs were used to determine the ratings for each attribute. Again, residual effects to the VSECs were characterized as positive, negative and significant, or negative and not significant as guided by the definitions provided in Table 3.5-3. For example, an effect receives a rating of “negative and not significant” if it is evaluated as one more the following: low in magnitude, confined mainly to the Proposed Development Area (PDA) or the LSA, or of short duration.

Table 3.5-1. Summary of Attributes to Inform the Significance Rating of Effects

Attribute	Definition
Direction	The direction of an effect can be positive, negative, or variable. The determination of the direction of an effect is based on information provided and values expressed during community research, in TK, and through existing documentation (e.g., past experience with resource development projects).
Geographic Extent	The geographic extent of an effect designates whether the effect will be experienced in the socio-economic LSA, RSA, or beyond.
Magnitude	The magnitude of an effect is the level of change relative to the baseline condition, and is rated as 'low', 'moderate', or 'high' (see Table 3.5-2).
Equity	Equity considers the distribution and evenness of the effect across different social groups, and identifies those most likely to experience the 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, particularly as it may affect vulnerable groups.
Frequency	The frequency of an effect provides an indication of how commonly the effect will occur during the Project, and is rated as 'low' (infrequent, occurring only occasionally), 'sporadic' (intermittent or occurring only at periodic points in the Project), or 'continuous' (occurring throughout the phase of the Project).
Duration	The duration of an effect indicates how long an effect will continue to affect those who experience it and is rated as 'short term' (over a period of four years), 'medium term' (greater than four years and up to 25 years, the combined duration of Site Preparation, Construction, Operation, and Closure), or 'long term' (beyond the life of the Project).
Reversibility	The reversibility criterion considers the likelihood of recovery from an effect, specifically, considering the application of adaptive management and active management interventions that may be required to bring to the effect to an acceptable level. The reversibility ratings are defined as follows: Immediately reversible - effect reverses within an acceptable time frame and with no intervention. Reversible with a cost/effect, management required - active intervention is required to bring the effect to an acceptable level. Irreversible - effect will not be reversed.

Table 3.5-2. Definitions of Magnitude Ratings for Socio-economic Effects

Magnitude	Descriptor of Magnitude
Low	Effect is expected to result in slight changes from baseline conditions, causing minimal disturbance to a small number of households.
Moderate	Effect is expected to result in a notable change from baseline conditions, similar to historic changes or variability that has occurred previously without the Project and impacts a substantial number of households.
High	Effect is expected to result in extreme changes as compared to baseline conditions, beyond historic changes that have occurred previously without the Project, that are relevant to the majority of the population and/or region.

Table 3.5-3. Definitions of Significance Ratings for Socio-economic Effects

Significance	Descriptor of Significance
Positive	Effect could result in improvements to socio-economic conditions relative to the baseline within the LSA or RSA into the foreseeable future.
Negative and Significant	Effect is expected to produce negative socio-economic outcomes that would be detrimental to livelihood or quality of life at the household and/or community level in the long term within the RSA.
Negative and Not Significant	Effects limited to a small number of households, mainly within the LSA, are reversible and do not result in long term reductions in livelihood or quality of life.

The following sections present the socio-economic effects assessment of the Project. First the potential for interactions between Project components or activities with current socio-economic activities are discussed and characterized. Second, the mitigation measures applicable to each effect are presented. This is followed by an analysis and examination of effects that remain following mitigation, which are characterized as residual effects to be rated for significance.

Finally and with the exception of population data, 2011 Census of Canada data is largely not relied upon for this effects assessment. Changes to legislation requiring response to the Census resulted in higher than acceptable rates of non-response which can introduce sampling or selection bias. That is, for smaller remote communities, such as those located in the Kitikmeot Region, issues related to non-response are thought to have resulted in a biased, non-representative illustration of community conditions.

3.5.2 Economic Impact Model

3.5.2.1 Method

An economic impact model based on the construction and operation expenditure estimates from the Preliminary Economic Assessment (SRK Consulting 2012) was used to estimate the direct and spin-off (indirect and induced) economic benefits of the Project:

- direct impacts are associated with employment and expenditures directly by the Project, and the resulting effects on industries directly contracted to supply the goods and services used by the Project;
- indirect impacts are associated with all industries that are ultimately supplying the goods and services used by the industries directly supplying the Project, and include all transactions to the beginning of the supply chain; and
- induced impacts are impacts associated with workers spending their incomes on goods and services, including those directly and indirectly employed because of the Project.

The model used, DYNATEC, is based on Statistics Canada's Input-Output Model of the economies of Canada, the provinces and territories, but incorporates dynamic and non-linear simulations of the likely effects. The current version of the DYNATEC model uses the 2008 dataset of Statistics Canada's Input-Output Model, enhanced with data from various sources dating from 2008 to 2011. The core of the model operates at a level of aggregation consisting of 476 commodities and 117 industries. For the Project, both open and closed versions of the model were run. The open model is used to estimate indirect effects (effects from inter-industry purchases of goods and services), while the closed version is used to estimate induced effects (effects from spending resulting after-tax household income, primarily from wages and salaries).

In addition to the model's ability to simulate the dynamic nature of the economy, a key characteristic is its ability to provide estimates of the distribution of the effects at the national, territorial, and regional level (i.e., for the three regions of Nunavut, including the Kitikmeot Region). The model does this through a mathematical allocation that takes into account the characteristics of existing industries and businesses, current economic structures and supplier relationships, and employment and skill-base profiles.

The economic modelling was conducted for each year of construction (expected years 2015 and 2016) and for all of Operation (estimated 10 year duration, from 2017 to 2026). The output statistics of the economic impact modelling include:

- employment;

- personal income;
- GDP; and
- government tax revenues.

Economic input-output models are one of the best ways to meaningfully estimate regional, territorial and national level impacts of a project. However, the model necessarily is based on the structure and function of the economy as it has been in the recent past (i.e., largely as it was in 2008, the most recent year for which input-output data are available). The model is not able to take into account the changes that may occur in the economy over time, nor is it able to account for the effect of Project mitigation or benefit enhancement measures as they have been defined with respect to business development, human resources, or community investment. Thus, the output statistics of the model (employment, personal income, GDP, and government tax revenues) used to estimate the economic impacts of the Project may be conservative – that is, they provide a picture of what is expected based on the status quo performance of the economy. Actual economic benefits realized from the Project, particularly within the LSA and RSA, may be greater than predicted once mitigation and benefit enhancement measures are applied.

The detailed results of the economic impact modelling are provided in Appendix V8-3B, *Back River Project 2013 Economic Impact Model Report*.

3.5.2.2 Summary of Results

The Project is predicted to result in employment, income, GDP, and government tax revenue benefits to the Kitikmeot Region, Nunavut and Canada as a whole. The following is a summary of the direct, indirect and induced impacts as estimated by the economic model.

For the construction phase, key economic benefits of the Project include the following:

- direct Project employment of approximately 180 person-years for Nunavut (assumed mainly within the Kitikmeot Region) and 1,200 person-years for all of Canada;
- total employment (direct, indirect, and induced) of approximately 483 person-years for the Kitikmeot Region, 1,086 person-years for Nunavut, and 6,245 person-years for all of Canada;
- total GDP (direct, indirect, and induced) contributions of approximately $47.3 million in the Kitikmeot Region, $96.6 million in Nunavut, and $597.5 million in all of Canada; and
- total tax revenue (federal and provincial/territorial) contributions of approximately $6.7 million from economic activity in the Kitikmeot Region, $12.5 million in Nunavut, and $97.2 million for all of Canada.

Within Nunavut, the Kitikmeot, Kivalliq and Qikiqtaaluk Regions are all expected to derive benefits from the construction of the mine; however, the Kitikmeot Region is expected to receive the largest share of total employment, personal income and GDP benefits (direct, indirect and induced). During construction, the Kitikmeot Region is expected to benefit most from direct employment and expenditures, the Kivalliq Region most from indirect activities, and the Qikiqttaluk Region most from induced activities.

For the operation phase, key economic benefits of the Project include the following:

- direct employment of approximately 1,111 person-years for the Nunavut (assumed mainly within the Kitikmeot Region) and 4,442 person-years for all of Canada;

- total employment (direct, indirect, and induced) of approximately 2,191 person-years for the Kitikmeot Region, 4,266 person years for Nunavut, and 28,041 person-years for all of Canada;
- total GDP (direct, indirect, and induced) contributions of approximately $355.7 million in the Kitikmeot Region, $532.5 million in Nunavut, and $2,857.2 million in all of Canada; and
- total tax revenue (federal and provincial/territorial) contributions of approximately $106.5 million from economic activity in the Kitikmeot Region, $124.5 million in Nunavut, and $519.1 million for all of Canada.

In Nunavut, the Kitikmeot, Kivalliq and Qikiqtaaluk Regions are all expected to derive benefits from operation of the mine; however, the Kitikmeot will be the leading region in terms of employment, personal income and GDP benefits (direct, indirect and induced). In addition to direct benefits, the Kitikmeot will also benefit most from indirect activities related to operation (followed by the Qikiqtaaluk Region); whereas the benefits resulting from induced activities will be spread out over the three regions.

3.5.3 Potential Interactions with Project and Characterization

This section describes the nature of potential interactions between Project component or activities and the VSECs. Potential effects of the Project on VSECs were identified and defined through scoping (Section 3.3.1.2). Table 3.5-4 lists the VSECs and potential socio-economic effects selected to assess the impacts of the Project. The interaction between each VSEC and effect is detailed below.

Table 3.5-4. Potential Socio-economic Effects of the Back River Project

VSEC	Potential Effect
Economic Development	• Changes to economic growth, diversity, and performance
Business Opportunities	• Changes to the growth and diversity of Inuit and Northern businesses
Employment	• Changes to employment and income levels • Changes to the capacity of the labour force • Changes to competition for local labour
Education and Training	• Changes to the demand for education and training • Changes to youth attitudes and behaviours toward education and training
Health and Community Well-being	• Changes to life skills of individuals • Changes to individual and family spending • Changes to family/household structure

3.5.3.1 Economic Development

This section describes the potential effect of the Project on Economic Development for each phase of the Project. Specifically, the Project may result in:

- Changes to economic growth, diversity, and performance.

The economic impacts of the Project are a result of direct procurement and workforce employment which are expected to also have indirect and induced effects to employment, personal income, GDP, and government revenues. The indirect and induced effects of the Project are based on an economic model described in detail in Section 3.5.2 and Appendix V8-3B. All monetary measures provided are in constant 2012 Canadian dollars.

Changes to Economic Growth, Diversity, and Performance

The Project is anticipated to cause changes to economic growth, diversity, and performance mainly during the Construction and Operation phases of the Project. Changes to economic growth, diversity, and performance during Reclamation and Closure and Post-closure phases are expected to be notably lower as compared to the Operation phase.

Site Preparation

Notable changes to economic growth, diversity, and performance are not anticipated during the Site Preparation phase (2013 to 2015).

Construction

A positive change in economic growth is predicted as a result of the construction of the Project. This is primarily expected to be expressed through changes to GDP and government tax revenues. Additional contributors to economic growth during this phase are expected to be derived from Project-related employment and income, which are discussed in Section 3.5.3.3 (Employment).

Construction activities include drilling the open-pit and underground mines at the Goose and George Properties, building the winter roads connecting the properties each December, and also building supporting infrastructure like camps, processing facilities, and the Marine Laydown Area (MLA) in southern Bathurst Inlet. Project expenditures and employment are anticipated to contribute to economic growth during this phase.

Construction of the Project would contribute to tax revenues and GDP at the national, territorial/provincial, and regional levels. Each of these aspects is summarized as follows:

- GDP contributions are based on direct, indirect, and induced expenditures and employment generated by construction of the Project; and
- Tax revenues are derived from personal income tax, corporate profit tax, and sales tax.

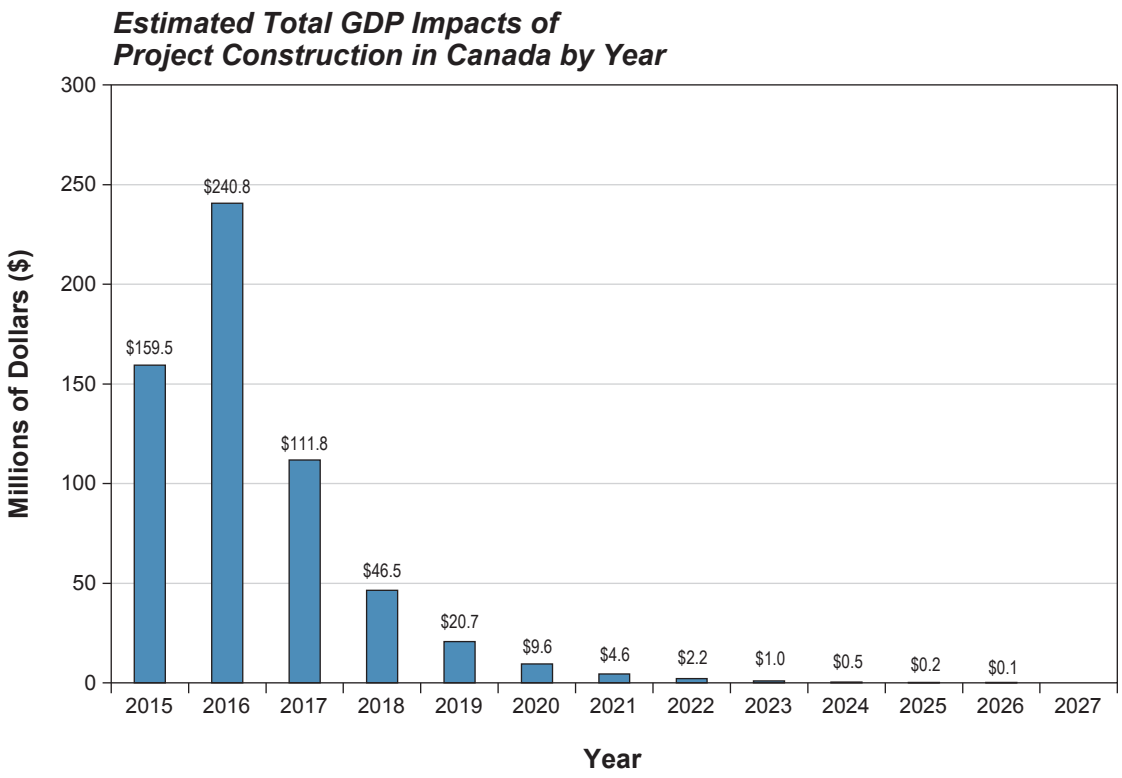
The economic model estimates GDP impacts of approximately $597.5 million in Canada (representing 0.4% of Canada's GDP in 2011) with the highest contributions occurring in the first two years of Construction ($159.5 and $240.8 million). Total GDP impacts of approximately $96.1 million are expected in Nunavut, which would represent 5.8% of Nunavut's 2011 GDP (Table 3.5-5).

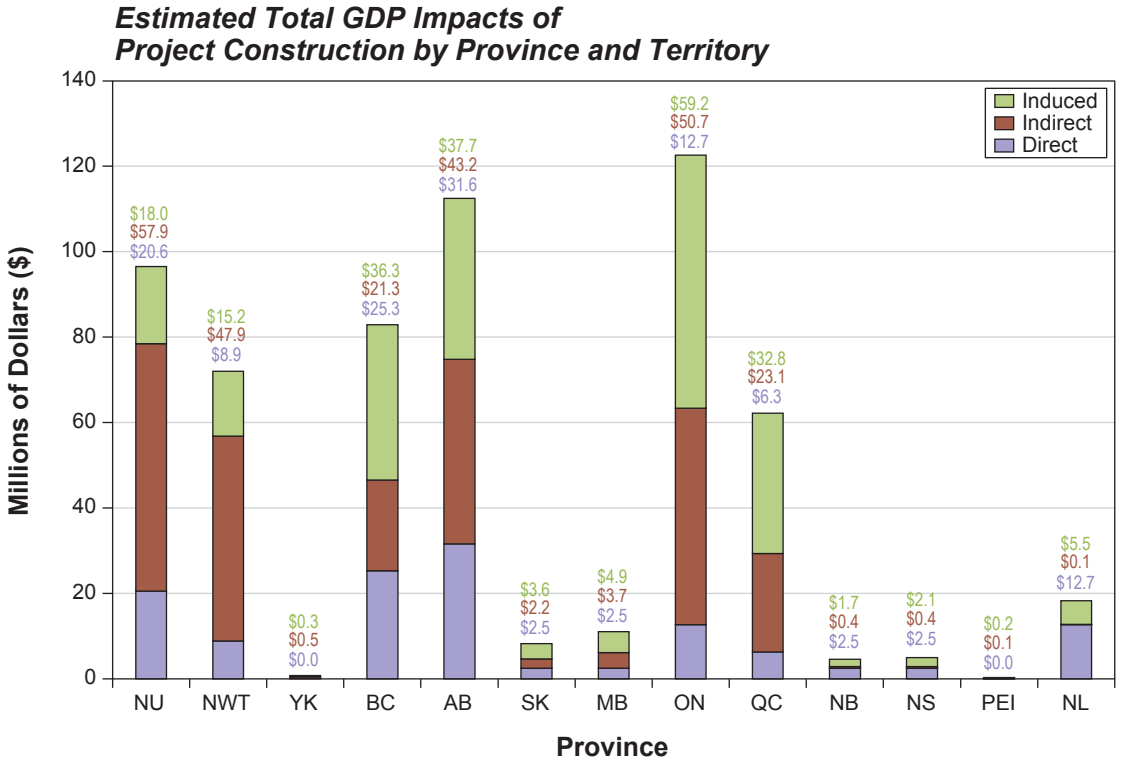
Contributions to GDP as a result of the Project are anticipated to begin to accumulate during the first year of construction (2015) through to 2026 as a result of the indirect and induced effects of direct Project expenditures, contracting, and employment. The economic impacts of Project construction have the potential to occur in all provinces and territories (Figure 3.5-1).

Table 3.5-5. GDP Contributions of the Back River Project for Construction

		Project Contribution to GDP	
	Current 2011 GDP (millions of chained 2007 dollars)	Total GDP (millions of current 2012 dollars)	Proportion of Current 2011 GDP (%)
Nunavut	$1,666.1	$96.1	5.8%
Canada	$1,525,279	$597.5	0.04%

Source: Rescan (2013)





Source: Rescan (2013).

Figure 3.5-1

Predicted Economic Impacts of Construction on GDP in Canada by Year and by Province and Territory

Benefits in Nunavut are predicted to be substantial including total contributions to territorial GDP of approximately $96.1 million. Overall, total GDP contributions as a result of the construction of the Project are highest in Ontario ($122.6 million) and Alberta ($112.7 million). Nunavut would receive the third highest contribution to GDP as a result of the construction phase of the Project, followed by British Columbia ($82.9), the NWT ($71.9), and Quebec ($62.3). Other provinces are likely to receive higher contributions to GDP during the construction phase of the Project as a result of the role of other provinces and territories in supplying the Project with construction workers and goods and services.

Total contributions to GDP from the construction of the Project consist of direct, indirect, and induced effects. As shown in Figure 3.5-1, **direct** GDP benefits across the provinces and territories total $128.2 million and are expected to be highest in Alberta ($31.6 million), British Columbia ($25.3 million) and Nunavut ($20.6 million). **Indirect** GDP benefits would total $251.8 million across Canada and are expected to be highest in Nunavut ($57.9 million). Finally, **induced** GDP benefits from the construction of the Project total $217.5 million nationally with the highest accumulation of benefits occurring in Ontario ($59.2 million), Alberta ($37.7 million), British Columbia ($36.3 million), Quebec ($32.8 million), and Nunavut ($18.0 million).

Effects to GDP within Nunavut as a result of construction are largest (or highest) in 2015 and 2016 and will include contributions of $38.8 and $46.6 million dollars, respectively. Contributions to GDP as a result of construction will continue through to 2020. As shown in Table 3.5-6, the direct contributions to GDP as a result of Construction are predicted to be retained within the Kitikmeot Region and would amount to $20.6 million, serving to increase the territories own source tax revenues. The Kivalliq Region is expected to experience the highest indirect contribution to GDP ($25.2 million) as a result of construction, predicted by the economic model because of the current strength of the mining service and construction sector in that region. Total contribution to GDP as a result of construction would be $47.1 million in the Kitikmeot Region and $96.1 million in Nunavut (Table 3.5-6). In comparison, between 2010 and 2011, Nunavut's GDP increased by $76.9 million (chained 2007 dollars) from $1,589.2 to $1,666.1 million.

Table 3.5-6. Direct, Indirect, and Induced Contributions to GDP during Construction for Nunavut

Region	Project Contribution to GDP (Millions of Dollars) during Construction			
	Direct	Indirect	Induced	Total
Kitikmeot	$20.6	$20.2	$6.2	$47.1
Kivalliq	$0.0	$25.2	$5.3	$30.5
Qikiqtaaluk (Baffin)	$0.0	$12.5	$6.0	$18.5
Nunavut	$20.6	$57.9	$17.5	$96.1

Source: Rescan (2013)

Data reporting the GDP of Nunavut's three administrative districts (the Kitikmeot, Kivalliq, and Baffin Regions) is unavailable and as a result the estimated annual contributions of the Project to Regional GDP cannot be discussed for comparison. However, the economic model report (see Appendix V8-3B) estimates the construction phase of the Project would generate the following contributions to GDP within Nunavut:

- $47.1 million to the GDP of the Kitikmeot Region;
- $30.5 million to the GDP of the Kivalliq Region; and
- $18.5 million to the GDP of the Baffin Region (Table 3.5-6; Appendix V8-3B).

Changes to economic growth in Nunavut result, in part, from contributions to GDP during Project Construction. Specifically, Nunavut GDP would grow due to the Project by approximately $96.1 million

in total, beginning with $38.8 million in 2015, increasing to $46.6 million in 2016, dropping the following year (2017) to $9.5 million, and dissipating completely by 2021.

In addition to contributions to GDP, tax revenues generated by the Project are also anticipated to cause changes to economic growth, and federal and territorial money becomes available for community investment and development by governments. In total, the Project is estimated to generate government tax revenues in the amounts of approximately $52.8 million federally and $44.4 million provincially and territorially (Section 3.5.2 and Appendix V8-3B).

The largest tax revenue effect is expected to occur during the Construction phase (2015 and 2016; Figure 3.5-2) and within that time period will include combined tax revenues of $33.9 million to the federal government, and $28.5 million to provincial and territorial governments. Project procurement and expenditures are expected to continue to generate tax revenues through to 2024 for a total of approximately $97.2 million.

As shown in Table 3.5-7, tax revenue to the GN is estimated to be approximately $5.7 million during Construction, with an additional $52.8 million to the federal government due to Project-generated economic activity across Canada. Within Nunavut, tax revenues generated during Construction would be highest in the Kitikmeot Region at an estimated $3.1 million (Table 3.5-7). Increased tax revenues may alter public spending and while these changes are difficult to measure, it is reasonable to suggest that changes to government spending may include, for example, increased funding and/or resources for mine related education and training initiatives (particularly initiatives undertaken as part of a joint partnership or updates to existing community infrastructure), or other priority community issues, such as housing and municipal infrastructure.

Table 3.5-7. Project-induced Tax Revenues during Project Construction for Nunavut by Region

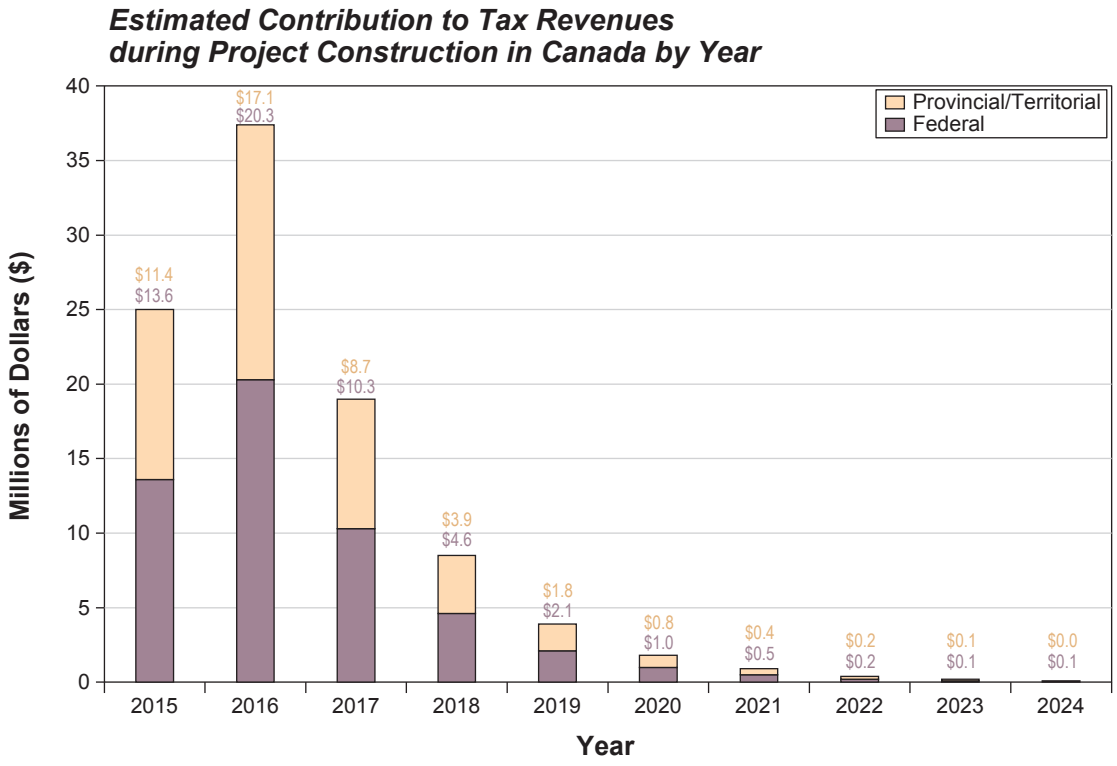
Region	Tax Revenue (Millions of Dollars)		
	Federal	Territorial	Total
Kitikmeot	$3.7	$3.1	$6.7
Kivalliq	$2.0	$1.7	$3.6
Qikiqtaaluk (Baffin)	$1.2	$0.9	$2.1
Nunavut	$6.8	$5.7	$12.5
Canada	$52.8	$44.4	$97.2

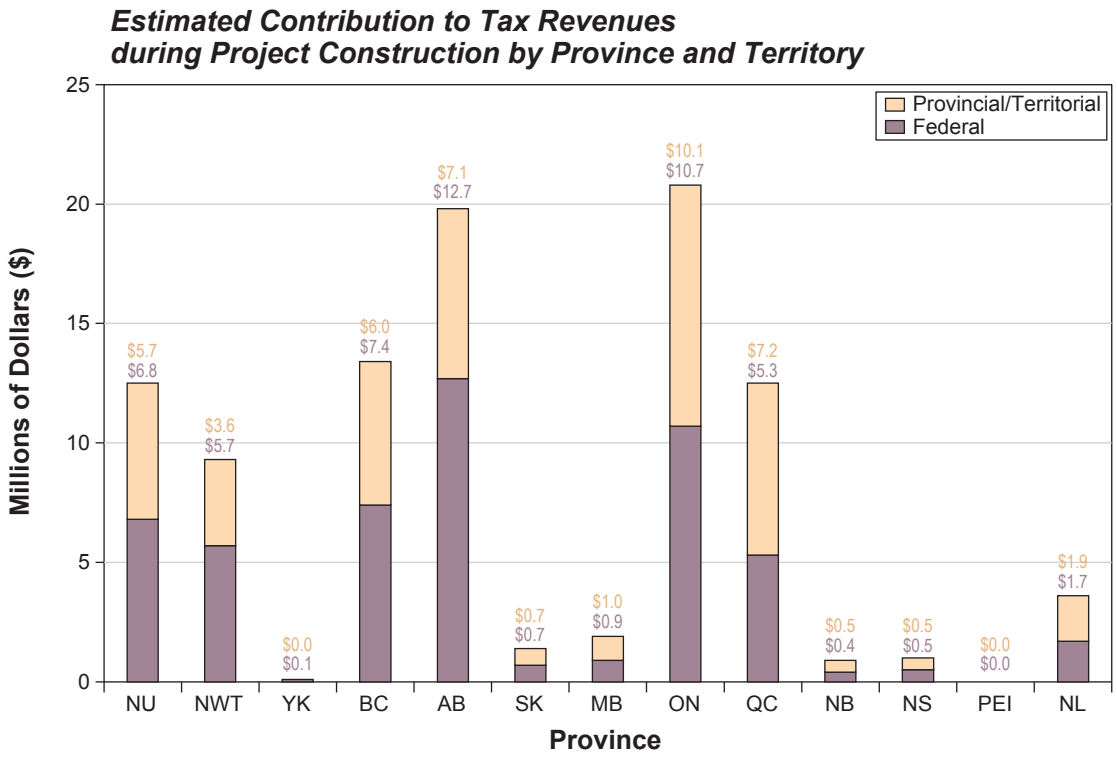
Source: Rescan (2013)

The Project is also estimated to generate provincial tax revenues across Canada during Construction, most notably in Ontario ($10.1 million), Alberta ($7.1 million), Quebec ($7.2 million), and British Columbia ($6.0 million). Figure 3.5-2 provides a summary of government tax revenues generation by the construction of the Project for all Canadian provinces and territories.

Finally, the Project may contribute to economic diversity during the Construction phase as a result of Project related employment, contracting, and business opportunities. Increases to economic diversity are anticipated as a result of the Project and are characterized by:

- Increased local employment, increased incomes, and spending;
- Project-related expenditures (locally, regionally) with existing businesses located in the Kitikmeot and across Nunavut, increasing the financial resources available to existing businesses;
- The addition of new businesses or expansion of existing businesses within the Kitikmeot Region that provide goods or services previously unavailable; and/or
- The development of, or additional investment in, Inuit-owned businesses.





Source: Rescan (2013).

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Estimated Contribution to Federal and Provincial/Territorial Tax Revenues during Project Construction in Canada by Year and by Province and Territory

Figure 3.5-2

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Increased economic diversity is expected as a result of the provision of Project employment and contracting opportunities, which may have induced effects on local businesses.

Changes to economic diversity may also result from employment opportunities available during construction as there will be not only an increased number of jobs, but also a wider variety of jobs available in the Kitikmeot Region. The employment available as a result of the Project will be related to Project employment but will include a variety of industry classifications. For example, the construction of the Project will require labourers and engineers, health and safety officers, employment counsellors or liaisons, administrative staff, catering staff, cleaning and janitorial staff, environmental monitors, team managers or foremen, as well as variety of other positions. A detailed listing of potential Project employment can be found at www.BackRiverProject.com.

Business opportunities thought to further diversify the local economic base include those that become available that are unrelated to mine work. This might include new businesses established in response to changes in the demand for specific goods and services. For example, if a number of people in Kugluktuk become employed in Project work, there may be increased demand for an additional restaurant. The new restaurant would represent a new business and would require employees. This type of induced business opportunities and employment are thought to further increase the diversity of the local and regional economies of the Kitikmeot.

Positive changes to economic performance are expected during Project Construction. Economic performance is defined as the success of a market in producing benefits for society through innovation and efficiency in the use of available resources. The Project is anticipated to increase economic performance during Construction due to the potential for new businesses and employment regionally and locally, and what these changes are expected to mean in terms of local and regional investment and business activity. Changes to economic growth coupled with the changes to economic diversity are anticipated to define an increased ability of local and regional economies to produce societal benefits, resulting in overall increases to the performance and capacity of the economy.

Operation

The Project has the potential to cause further economic growth during the Operation phase primarily associated with continued contributions to GDP and government tax revenues. Additional contributions to economic growth are anticipated as a result of employment and income and are discussed in Section 3.5.3.3: Employment.

The Operation phase of the Project is expected to be characterized by routine employment and related activities, the processing of ore, and export of gold doré bars. As similar to the Construction phase, the Operation phase is expected to result in changes to economic growth regionally, territorially, and nationally. Direct, indirect, and induced business expenditures and employment generated by the Operation of the Project are also expected to contribute to GDP across Canada.

The Project is predicted to be in operation for approximately 10 years, beginning in 2017 and ending in 2026. Operating expenditures are estimated to be $1,798.5 million or about $179.9 million annually. During the Operation phase, changes to economic growth are estimated to include a total GDP impact of approximately $2,857.2 million in Canada and $532.5 million in Nunavut. The operation of the Project would also result in total contributions that represent of 1.9% of the 2011 GDP in Canada and 32.0% of the 2011 GDP in Nunavut (Table 3.5-8).

Table 3.5-8. GDP Contributions of the Back River Project for Operation

	Current 2011 GDP (millions of chained 2007 dollars)	Project Contribution to GDP	
		Total GDP Contribution (millions of current 2012 dollars)	Proportion of Current 2011 GDP (%)
Nunavut	$1,666.1	$532.5	32.0%
Canada	$1,525,279	$2,857.2	1.9%

Source: Rescan (2013)

Although the Operation phase is anticipated to be 10 years (2017 to 2026), the injection of capital into territorial and national economies is anticipated to have effects on GDP that continue through 2036 because of time lags associated with indirect and induced impacts. GDP contributions that result from the operation of the Project would peak in 2026 at $285.6 million. Changes to economic growth as measured by contribution to GDP during Operation would occur in all Canadian provinces and territories but would be greatest in Ontario ($623.6 million), Nunavut ($532.5 million), and Alberta ($493.5 million). The largest portion of direct benefits would be retained within Nunavut ($218.6 million), with Alberta ($94.9 million), British Columbia ($71.2 million), and Ontario ($47.4 million) also experiencing notable benefits via contribution to GDP.

The indirect impact of Project operation on GDP would be slightly higher in Ontario ($294.5 million) than in Nunavut ($243.5 million), with other notable impacts occurring in Alberta ($238.9 million), Quebec ($184.8 million), and NWT ($156.2 million) as sources of goods and services for the Project. Details describing GDP contribution to each province and territory during the Operation phase of the Project are provided in Section 3.5.2 and Appendix V8-3B (2013 Economic Impact Model Report).

Changes to economic growth during the Operation would include a total contribution of $532.5 million to Nunavut's GDP, beginning with an estimated $46.5 million in 2017, reaching a maximum of $53.3 million in 2022, and remaining at that level until the end of Operation (Table 3.5-9). Operation of the Project is expected to cause economic growth within the Kitikmeot Region, as evidenced by the direct contribution of $354.7 million to GDP within the Kitikmeot, which notably represents 66.8% of all Project contributions to GDP in Nunavut. Indirect contributions to GDP are also highest in the Kitikmeot ($108.3 million); however, operation of the Project would also have indirect benefits in the Kivalliq and Baffin Regions, further contributing to the economic growth of the Territory.

Table 3.5-9. Direct, Indirect, and Induced Contributions to GDP during Operation for Nunavut

Region	Project Contribution to GDP (Millions of Dollars)			
	Direct	Indirect	Induced	Total
Kitikmeot	$218.6	$108.3	$27.9	$355.7
Kivalliq	$0.0	$58.7	$16.1	$74.8
Qikiqtaaluk (Baffin)	$0.0	$76.5	$25.0	$102.2
Nunavut	$218.6	$243.5	$69.0	$532.5

Source: Rescan (2013)

In additional to contribution to GDP, Operation of the Project is expected to generate tax revenues that would further increase economic growth at the local, regional, territorial, and national levels. Over the 10 years of Operation, the total tax revenue is estimated at $519.1 million, including $263.7 million to the federal government and $255.4 million to provincial/territorial governments. In 2026, tax revenues peak both federally and provincially at an estimated $26.4 and $25.5 million, respectively.

Changes to economic growth at the territorial level during the Operation phase would be characterized by tax revenues of approximately $71.1 million to the GN, representing the highest contribution of the Project to tax revenues among the provinces and territories. Within Nunavut, tax revenues generated during Operation would be highest in the Kitikmeot Region (Table 3.5-10).

Table 3.5-10. Project-induced Tax Revenues during Project Operation for Nunavut by Region

Region	Tax Revenue (Millions of Dollars)		
	Federal	Territorial	Total
Kitikmeot	$43.9	$62.7	$106.5
Kivalliq	$4.0	$3.8	$7.8
Qikiqtaaluk (Baffin)	$5.5	$4.6	$10.2
Nunavut	$53.4	$71.1	$124.5
Canada	$263.7	$255.4	$519.1

Source: Rescan (2013)

In Nunavut, increased economic growth is also expected to result from tax revenues of approximately $6.7 million in the first year of Operation. Tax revenues are then expected to remain constant at approximately $7.1 million per year between through the duration of the Operation phase (through to 2026). Notably, tax revenues generated in the Kitikmeot Region would account for approximately 85.5% of revenues generated within the Territory, with contributions of $43.9 million to the federal government and $62.7 million to the GN.

The Project is also expected to have a positive change in economic diversity during the Operation phase of the Project. This is anticipated to result from a combination of direct Project employment and expenditures, which creates additional local business opportunities and also increases the amount of capital available in the region. Contributions to territorial GDP and government tax revenues peak during the Operation phase of the Project (Figure 3.5-3). This injection of business activity and monetary capital may serve to further diversify the economy.

The benefits of the Project are anticipated to be felt is most provinces and territories within Canada. In Nunavut, the estimated contributions of Project Operation to GDP and government tax revenues total approximately $96.6 and $12.5 million, respectively (Table 3.5-11). This infusion of capital and opportunity will be at its highest during Operation and is anticipated to result in new businesses and business expansions within Kitikmeot communities. New businesses may come into existence in order to provide goods and services to the Project, or alternatively to meet new community demand that has developed in response to the increase purchasing power of Project employees, contractors, and sub-contracts. Existing businesses may expand the scope of their operations to serve the Project or to meet new community demand.

Table 3.5-11. Total GDP and Tax Impacts of the Operation of the Back River Project in Nunavut

Region	GDP (Millions of Dollars)	Tax Revenues (Millions of Dollars)		
		Federal	Territorial	Total
Kitikmeot	$47.3	$3.7	$3.1	$6.7
Kivalliq	$30.7	$2.0	$1.7	$3.6
Baffin	$18.6	$1.2	$0.9	$2.1
Total Nunavut	$96.6	$6.8	$5.7	$12.5

Source: Rescan (2013)

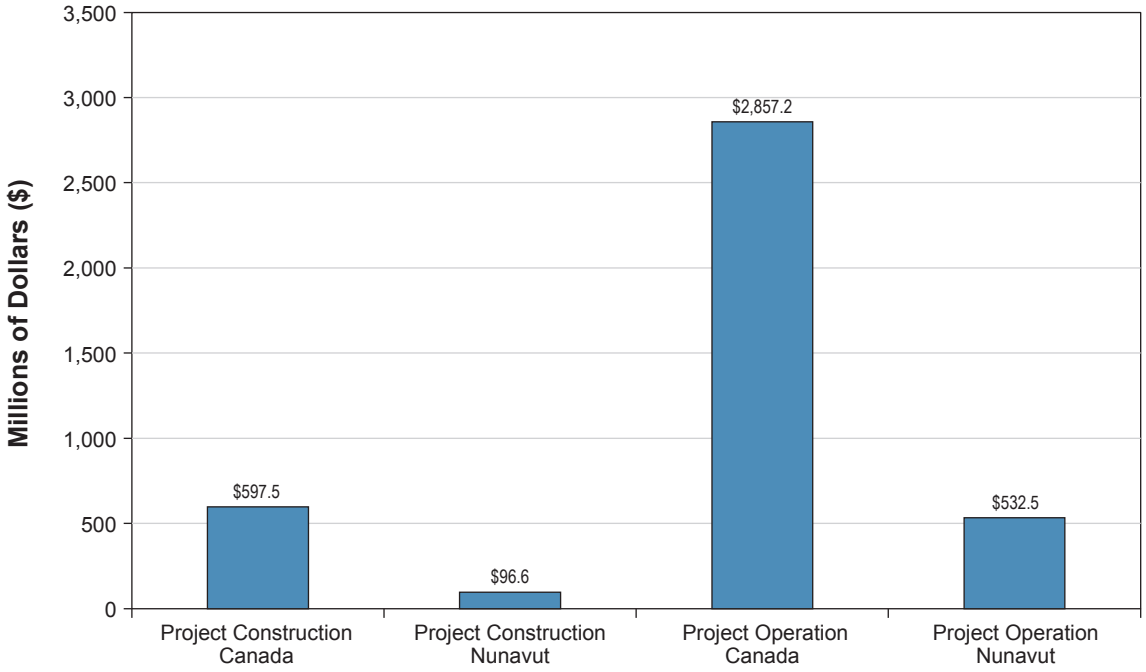


Figure 3.5-3

Operation and Construction Contributions to GDP for Nunavut and Canada

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It is important to note that the economic impact modelling (Appendix V8-3B) is only able to estimate the direct government tax revenues associated principally with income tax paid by workers. Excluded from the above tax estimates are any corporate profit tax or royalties paid directly by the Project. These are in addition to the described government tax revenue benefits and are expected to be substantial.

Finally, the Operation of the Project is expected to result in notable increases to local and regional economic capacity and performance. Skills and experience obtained starting from the Construction phase would have strengthened the ability of employees and local businesses both in preparation for additional Project work but also in preparation for other work during Operation. The further development and deepening of the economy during Operation is expected within the LSA and RSA.

The Project is expected to make substantial contributions (e.g., provision of employment and business opportunities) affecting local and regional economic performance. Changes to economic performance may be based on:

- Direct, indirect, and induced economic effects, supporting the expansion and diversity of local economies; and
- An increased in the overall income and expenditures of individuals engaged in Project-related employment, creating new demand for goods and services which may provide a foundation for new businesses and investments.

Reclamation and Closure Phase/Post Closure

The Reclamation and Closure phase is expected to be characterized by the natural end to most major Project contracts as well as Project employment. Reclamation activities are expected to continue to provide limited income and business related opportunities for small contracts that would potentially contribute to economic growth, diversity, and performance. Although some employment and Project contracts will be available during this phase, the closure of the Project will likely cause a slowdown in economic activities and growth in the Region as it is related to the Project. However, the increase in capabilities and capacity, as well as experience gained by both individuals and companies as a result of their involvement with the Project, would be retained, positioning the Region for further economic growth in the future.

The nature of the effect of Reclamation and Closure on economic growth, diversity, and performance would be dependent on a number of factors, including the overall condition of the economy, the flexibility and adaptability of the economy, as well as the presence of other employment and business opportunities.

During the Post-Closure phase, continued economic growth associated with benefits from Project contributions to GDP, government tax revenues, and others is expected. However, in comparison to the Operation phase these benefits are expected to be substantially reduced.

Temporary Closure and Care and Maintenance

During a Temporary Closure of the Project or Care and Maintenance Phase, operation activities are discontinued and many of the direct effects to economic development are stalled (e.g., direct contributions of the Project to GDP and government tax revenues). Indirect and induced benefits would not be immediately stalled, as earlier direct expenditures and income continue to circulate through the economy, but are expected to slow after some time.

3.5.3.2 Business Opportunities

The Project is expected to result in an increase to the number of locally available business opportunities. It is anticipated that the Project may result in the following effect on the VSEC Business Opportunities:

- Changes in the growth and diversity of Inuit and northern firms.

This effect is defined as the potential for new businesses and the ability of existing businesses to expand or diversify and as a result of local Project expenditures and the expenditure of Project-related income of workers. These changes are anticipated to occur mainly during the Construction and Operation phases of the Project, and less so during the Reclamation and Closure/Post-Closure phases.

Changes to the Growth and Diversity of Inuit and Northern Businesses

Site Preparation

Changes to the growth and diversity of Inuit and northern businesses are not expected to be notable during the Site Preparation phase.

Construction

Project Construction is predicted to increase the growth and diversity of Inuit and northern firms, both directly and indirectly. Construction activities include, for example, drilling the open-pit and underground mines at the Goose and George Properties, building the winter roads connecting the properties each December, and also building supporting infrastructure like camps, processing facilities, and the MLA in southern Bathurst Inlet. Many of these activities will be components of contract work, which during the Construction phase, might include maintenance services, transportation and logistics services, equipment rental services, catering services, and general construction (heavy equipment operators, labourers, etc.).

During Construction, the main change which will affect business opportunities is the expected increase in contracting and sub-contracting opportunities associated with the Project, as well as to a lesser degree increases in community retail and consumer-based business activity with the increase in personal incomes associated with Project employment. Project activities that are anticipated to promote growth and diversity among Inuit and northern businesses include:

- Provision of contract and sub-contract opportunities, specifically the procurement of goods and services from local suppliers; and
- Contribution to personal incomes, increasing the purchasing power of local residents (for example, direct Project employees or those who become involved with contact and/or sub-contract work).

The expected increase in local business activity itself is expected to bring about an increase in capital investment (e.g., investment in the expansion of businesses or the creation of new businesses) in anticipation of the Project. Local businesses will be presented with opportunities to bid on Project work, facilitated by the Project through mitigation and management measures established to maximize the benefits of contracting opportunities and the local sourcing of goods and services.

During this phase, the main opportunities will come directly from supply/sub-contracting opportunities associated with Construction. The main construction and engineering contractor for the Project will be primarily responsible for coordinating local sub-contractors and suppliers during the Construction

phase. This main contractor will likely sub-contract for a variety services including maintenance, equipment rental, catering, and general construction (heavy equipment operators, labourers, etc.). These components tend to be short term and labour intensive.

Direct and indirect Project procurement is expected to increase the growth and diversity of Inuit and northern businesses and generally contribute to local business development. Project expenditures are anticipated to be $447.6 million during the Construction phase. Businesses that supply the Project either directly or indirectly or who benefit from the presence of the Project in some other way (e.g., expenditure of personal incomes) may choose to expand their operations to take advantage of newly defined markets. That is, business that supply the Project, or that benefit from induced economic effects, may expand their current operations or establish new operations to take advantage of new opportunities.

Inuit and northern businesses that become engaged with Project contracting or sub-contracting are anticipated to experience substantial benefits through their experience supplying the Project. These benefits include:

- Increased experience and capacity as a result of participation in the bid preparation and contract negotiations process;
- Revenues obtained from Project contracts could be used to finance capital purchases such as equipment or to hire additional employees;
- Increased experience and capacity gained as a result of the successful completion of Project contracts is expected to add to the value of a business;
- Increases to the experience, skill levels, and qualification of business employees;
- Increased or improved business capital (e.g., equipment purchases or upgrades); and
- Increased ability of a locally-based business to meet community infrastructure and maintenance requirements.

Each of these is anticipated to result in the development of the local business economy and increased capacity of local business to expand and pursue future businesses opportunities. Should Project contracts be secured by local businesses, the aforementioned benefits are expected to materialize as not only short-term benefits during Project Construction but are expected to continue to generate benefits within local communities following the completion of Construction. Increases to business reputation/credibility via successful participation in Project contract work is expected to result in further opportunities during Project operation as well as additional non-Project opportunities.

The Project may also contribute to the viability of retail and consumer service business located in the Kitikmeot. Within the socio-economic LSA, there are a number of businesses in Cambridge Bay (approximately 30) and a few in Kugluktuk (approximately three). Services include:

- Construction, contracting, and property management;
- Accommodation;
- Retail; and
- Taxi.

Additional business services in Cambridge Bay include paramedical, mining sector services, explosives, catering, camp management, and janitorial services, finance and accounting, and lodge and guide

outfitting. The extent to which local businesses are able to benefit from direct and indirect Project procurement is dependent on a number of factors. For example, the capacity and experience of local businesses will dictate whether or not the business is capable of delivering/producing the requirements of Project contract.

While increased growth and diversity is a desirable effect for Inuit and northern businesses, positive local outcomes materialize when local economies can respond to and meet the increased demand. In circumstances characterized by limited capacity and limited/time-sensitive access to resources (e.g., materials, equipment, skilled workers) additional measures are required to facilitate local businesses participation and to maintain the benefits of Project work locally. Section 3.5.4 (Mitigation and Management) sets out a number of measured aimed to enhance the ability of Inuit and northern businesses to participate in Project contract and sub-contract work (further details provided in the Human Resources Plan: Volume 10, Chapter 28).

The successes and challenges of other projects, for example, the Meadowbank mine near Baker Lake, provide invaluable insight as to the nature and capacity of Arctic economies as they relate and respond to mine projects. These experiences have informed the mitigation and management measures presented in Section 3.5.4 that seek to address or avoid negative outcomes while enhancing the benefits of change to local demand and Project related business opportunities in general.

Operation

The effects of the provision of contract and sub-contract opportunities described during Construction are similar to the effects expected as a result of the Operation phase. However, during the Operation phase of the Project, longer-term contracts for services (such as catering, security, and maintenance services) are expected to be available. In many cases, these services are required for the duration of the Operation phase. As result, Project contracting opportunities have the potential to increase local business development and contribute to local economies.

In addition to demand created by the provision of contract work, some indirect local demand is anticipated as a result of Project employment, increased incomes, and purchasing power, potentially resulting in the creation of new Inuit and northern businesses, as well as the expansion of existing businesses. As residents associated with the Project spend their income locally, entrepreneurs are expected to take advantage of the increase in local spending power and consumer demand. Lastly, it is during Operation that Project contributions to GDP and personal incomes will reach their peak, further fuelling demand and creating potential for increased local business development.

Numerous measures have been established by the GN to promote the development of local businesses. The Project has also established measures to promote local business development (see Business Development Plan, Volume 10, Chapter 24). The objective of these efforts is to promote the retention of Project-related money within the Kitikmeot Region. Specifically, the lack of local retail and consumer service businesses has typically resulted in an import of goods and services from outside of the region.

Reclamation and Closure Phase / Post-Closure

The Reclamation and Closure and Post-Closure phases of the Project will be characterized by the end of the majority of Project-related contract work which would serve to reduce the number of business opportunities available in the Region.

During these Project phases, changes in the growth and diversity of Inuit and northern businesses is expected be reduced as related to the Project as activities wind down and reclamation activities begin.

However, business capacity established as a result of the Project is expected to be retained and to continue to benefit the Kitikmeot Region and Nunavut.

These phases will be characterized by notably less Project contracts and a diminished demand for goods and services. Additionally, at this time most Project-related employment will come to an end; expectantly, personal incomes and the amount of available income for spending to support local businesses would also be diminished. The reduction in Project expenditures may result in reduced indirect and induced employment as well as the associated loss of income.

Overall, the effect of Project closure on business opportunities is expected to be negative; however capacity and experience gained as a result of the Project is expected to be retained. Mitigation has been developed to assist LSA communities with the transition from operation to closure (Section 3.5.4).

Temporary Closure and Care and Maintenance

During a Temporary Closure, changes to growth and diversity of Inuit and northern businesses as a result of the Project are expected to effectively be diminished, as many Project expenditures would be discontinued. Further, news of a Temporary Closure may cause entrepreneurs and business firms to restrict their spending in light of change to the status of the Project, indirectly affecting any local service businesses established as a result of increased economic demand during Operation.

Should the Project enter into a Care and Maintenance phase contract and sub-contract work would be discontinued. Additionally, the demand for goods and services as related to Project expenditure, employment (i.e., incomes), and procurement would also be discontinued.

3.5.3.3 Employment

This section reviews the potential effects of the Project on employment for all phases of the Project. The Project is expected to affect employment in the following ways:

- Changes to employment and income levels;
- Changes to the capacity of the labour force; and
- Changes to competition for local labour.

These effects are the result of direct procurement and hiring by the Project which also result in increased incomes. In addition to direct employment and increased income, the Project is also expected to have indirect and induced effects on employment and personal income. The indirect and induced effects of the Project are predicted by the economic model described in detail in Section 3.5.2 and Appendix V8-3B. All monetary measures provided are in constant 2012 Canadian dollars. The changes are anticipated to occur mainly during the Construction and Operation phases of the Project, and to a lesser extent during the Reclamation and Closure/ Post-closure phases. Each of the effects is described below, according to the phases of the Project.

Changes to Employment and Income Levels

Site Preparation

Project-induced changes to employment and income of note are not expected during the Site Preparation phase, as the workforce requirements are modest.

Construction

The Project is predicted to cause changes to employment and income levels as a result of direct Project employment and procurement. During the Construction phase, activities expected to generate employment and income include, for example, open-pit and underground mine development at the Goose and George Properties, development of winter roads connecting the Properties each December, and development of supporting infrastructure like camps, maintenance, and processing facilities. Additionally, the MLA and port in southern Bathurst Inlet would be established during the Construction phase.

Direct employment associated with the Project during the Construction phase is expected to have a positive and beneficial effect. As estimated by the economic impact model (Section 3.5.2), indirect and induced employment benefits are also anticipated. During the Construction phase, the Project is estimated to result in a total of 6,245 person-years of direct, indirect, and induced employment across Canada (the majority of which are expected from the years 2015 through 2017; Table 3.5-12). In the first year of Construction it is estimated that the Project would create approximately 1,631 person-years of employment year and would peak during the second year at 2,485 person-years. This would include an estimated 1,086 person-years of employment, with an average of about 480 direct, indirect and induced jobs in Nunavut during the two years of Construction, with additional indirect and induced employment extending past the initial years of Construction. Table 3.5-12 provides a summary of the expected effects of the Project on employment.

Table 3.5-12. Employment Effects of the Back River Project for Construction

	Experienced Labour Force (2006)	Total (Direct, Indirect, and Induced) Project-related Employment (person-years)	Average Annual Project-related Employment[1]	
			Total	Proportion of Labour Force (%)
Construction				
Kitikmeot	2,090	483	242	11.58%
Kivalliq	3,065	378	189	6.17%
Qikiqtaaluk (Baffin)	6,925	224	112	1.62%
Nunavut	12,080	1,086	543	4.42%
Canada	16,861,180	6,245	3,122.5	0.02%

Source: Statistics Canada (2011), Rescan (2013)
1The average annual employment was estimated by dividing the total Construction employment impacts by two years (the duration of Construction). Although employment impacts are predicted to be greatest during this two year period, this will be an overestimate because the effects extend up to approximately a five year period.

Across the Canadian provinces and territories changes associated with direct employment are anticipated. The majority of direct employment is expected to be in the province of Alberta (300), followed by British Columbia (240) and Nunavut (180). The Project is also anticipated to result in indirect and induced employment. The majority of indirect employment is predicted to be in Nunavut (745) and Ontario (568), followed by the NWT (504) and Alberta (332). And finally, induced employment is expected to be mainly in Ontario (657), followed by Quebec (403) and British Columbia (389; Section 3.5.2).

The employment benefits (indirect, direct and induced) of the Project would be experienced across the Canadian provinces and territories and are expected to be concentrated in Nunavut and Ontario with 1,086 and 1,345 person-years of employment, respectively. Notably, although the Project is located in Nunavut, substantial benefits to the Canadian provinces are expected. The strength of the benefits to other provinces can be attributed to two main factors:

- construction workers will come from those provinces, and
- businesses located in those provinces are expected to play a role in providing goods and services directly purchased by the Project (for example, businesses based in Alberta and Ontario are anticipated to be important suppliers to the Project).

Of Nunavut's three regions, it is estimated that the Kitikmeot is likely to experience the greatest contributions to employment as a result of the Project Construction (Table 3.5.13). Economic impacts are also expected to be strong for the Kivalliq and the Qikiqtaaluk Regions. In the Kitikmeot, total employment impacts (direct, indirect and induced) are predicted to be 481 person-years of employment created during the Construction phase (Table 3.5-13), or an average of approximately 240 job opportunities for each of the two years of Construction. The Kitikmeot Region benefits from the location of the Project in the west Kitikmeot, accounting for an estimated 44% of the total employment benefits in Nunavut (Appendix V8-3B).

Table 3.5-13. Total Employment Impacts of Construction for Nunavut by Region

Region	Employment (Person-Years)			
	Direct	Indirect	Induced	Total
Kitikmeot	180	270	31	481
Kivalliq	0	325	52	376
Qikiqtaaluk (Baffin)	0	151	73	224
Nunavut	180	745	156	1,082

Source: Rescan (2013)
Note: Rounding errors accounts for discrepancies in totals

Construction has the potential to result in employment for about 10% of the experienced labour force in the Kitikmeot Region as well as almost 4.5% of Nunavut's total experienced labour force.

Associated with the changes to employment, direct, indirect and induced effects to personal income levels are also anticipated during the Construction phase[4]. In Canada, the Construction phase is expected to generate direct ($126.6 million), indirect ($160.4 million), and induced ($110.7 million) personal incomes[5]. In total, Project Construction would provide a total contribution of $397.7 million to the personal incomes of Canadians.

Indirect employment is characterized as employment generated by Project activities that in not directly linked to the Project. For example, employment with subcontractors not working on site would be considered indirect. Induced employment is characterized by positions that are not linked to Project. For example, if additional employees are needed in a local restaurant due to increased spending by mine employees in the community, this would be considered induced employment.

With total income effects in Canada of almost $400 million, Project Construction has the potential to provide notably higher incomes. For Canadians, average direct and total incomes during Construction are estimated at 2.6 and 1.5 times higher as compared to the median full-time earnings in 2005 (Table 3.5-14).

[4] Personal income in this context includes salary as well as the extended benefits of employment including overtime pay and bonuses, as well as medical benefits.

Table 3.5-14. Income Effects of the Back River Project for Construction

	Median Full-time Earnings ($ 2005)	Direct Project-related Personal Income		Total (direct, indirect, and induced) Project-related Personal Income	
		Average Worker Income ($)	Proportion of 2005 Median Full-time Earnings	Average Worker Income ($)	Proportion of 2005 Median Full-time Earnings
Construction					
Kitikmeot	$56,864	$105,555	1.9	$75,467	1.3
Kivalliq	$50,104	$0	0.0	$62,765	1.3
Qikiqtaaluk (Baffin)	$60,060	$0	0.0	$54,464	0.9
Nunavut	$58,088	$105,555	1.8	$66,728	1.2
Canada	$41,401	$105,579	2.6	$63,682	1.5

Source: Statistics Canada (2007b), Rescan (2013)

It is expected that the Construction of the Project would generate approximately $36.3 million in personal income for Kitikmeot residents engaged in Project-related employment, 50.3% of the total Project-related personal income generated in Nunavut. The Project also has the potential to substantially increase the average personal incomes of Kitikmeot residents, as incomes for direct employees would be 1.9 times higher as compared to the 2005 median full-time earnings in the Kitikmeot Region (Table 3.5-14). Average indirect and induced incomes are slightly lower as this employment is expected to be concentrated within other economic sectors (e.g., the service sector).

The provision of higher than average incomes associated with mine employment and other types of resource development employment are now commonly associated with increased drug and alcohol consumption (Angell 2006; NAHO 2008; Collins 2013; Gibson n.d.). The provision of higher incomes for Nunavummiut has implications beyond typical benefits. For example, for Nunavummiut increased incomes have the potential to reduce food security and support harvesting activities, but also have the potential to fuel substance abuse and other negative social behaviours. Further discussion of the implications of higher than average incomes for Nunavummiut is presented in Section 3.5.3.6.

While employment associated with the Project Construction is predicted to be highly beneficial for the Kitikmeot Region, employment will be limited by the short duration of the Construction phase, specifically concentrated mainly over a two year period. The effects of employment during Construction are considered positive and present the potential for numerous indirect positive effects associated with productive work and increased incomes (e.g., increases to standard of living, household food security, and sense of self-reliance). However, the ability of local residents to benefit from and experience the long-term benefits associated with employment and increased incomes are expected to culminate during the Operation phase. Further discussion of the effects of the Project on regional unemployment rates is provided in the following section.

Overall, the employment and income effects of the Project during Construction are highly beneficial and have the potential to enable increased standards of living for Kitikmeot families. Those who benefit from mine employment and the associated incomes may choose to invest in housing, education, personal savings or other positive productive avenues of spending.

Operation

The Operation phase of the Project would take place over a ten year period, providing substantial employment benefits within the Kitikmeot, Nunavut, and Canada. This phase is also characterized by

longer-term contracts for services (such as catering, security, building maintenance, etc.) that are expected to be available. In many cases, these services are required for the duration of the Operation phase (see Section 3.5.3.2). In terms of direct employment, the Project will engage semi-skilled, skilled and professional staff to support Project Operation. As result, Project employment is anticipated to be most beneficial during this phase.

Total employment for Canada is estimated to be 28,041 person-years or on average, 2,800 person-years annually, throughout the Operation phase (Table 3.5-15). Operation of the Project is expected to result in direct and spin-off (indirect and induced) economic impacts that include employment gains as well as increases in personal incomes. It is estimated that Nunavut would experience the most benefit from direct employment with the Project, followed by Alberta and British Columbia.

Table 3.5-15. Employment Effects of the Back River Project for Operation

	Experienced Labour Force (2005)	Total (Direct, Indirect, and Induced) Project-related Employment (person-years)	Average Annual Project-related Employment (person-years)[1]	
			Total (Person-Years)	Proportion of Labour Force (%)
Operation				
Kitikmeot	2,090	2,185	219	10.5%
Kivalliq	3,065	976	98	3.2%
Qikiqtaaluk (Baffin)	6,925	1,091	109	1.6%
Nunavut	12,080	4,266	427	3.5%
Canada	16,861,180	28,041	2,804	0.2%

Source: Rescan (2013)
Note: Rounding errors accounts for discrepancies in totals
[1]The average annual employment was estimated by dividing the total Operation employment impacts by ten years (the duration of Operation). Although employment impacts are predicted to be greatest during this ten year period, this will be an overestimate because the effects extend up to approximately a 20 year period.

During the Operation phase, Nunavut is expected to have 4,266 person-years of employment (or approximately 430 job opportunities annually), ranking third in terms of employment benefits, after Ontario (6,939 person-years) and Quebec (4,670 person-years). Table 3.5-15 provides a summary of the employment effects of the Project during the Operation phase. Notably, the Project has the potential to employ approximately a tenth of the total experienced labour force of the Kitikmeot. That is, within the Kitikmeot the Project is estimated to generate approximately 220 jobs annually over the ten years of Operation.

Direct Project employment during the Operation phase is predicted to result in beneficial effects in Nunavut. Nunavut's share of employment during Operation is mostly indirect as the Project makes use of locally supplied goods and services. During Operation, employment impacts are expected to be strongest in the Kitikmeot, as total employment is estimated to be approximately 2,185 person-years, or approximately 220 job opportunities annually for 10 years (Table 3.5-16)[6].

[6] All direct Nunavut employment for Construction and Operation is assumed to be based in the Kitikmeot Region, with no direct employment of Kivalliq and Qikiqtaaluk residents. This assumption was required lacking more specific information on the sourcing of workers within Nunavut, but is believed to be a reasonable approximation given the geographic location of the Project and existing socio-economic relationships between the regions, the Northwest Territories, and other Canadian jurisdictions.

Table 3.5-16. Total Employment Impacts of Operation for Nunavut by Region

Region	Employment (Person-Years)			
	Direct	Indirect	Induced	Total
Kitikmeot	1,111	943	131	2,185
Kivalliq	0	786	190	976
Qikiqtaaluk (Baffin)	0	801	290	1,091
Nunavut	1,111	2,531	611	4,253

Source: Rescan (2013)
Note: Rounding errors accounts for discrepancies in totals

Currently, unemployment rates among the Aboriginal identity population in the Kitikmeot are notably higher as compared to rates in other Nunavut Regions (Kivalliq, 19%; Baffin, 20%) and Canada (15%). Specifically, 2006 unemployment rates in the Kitikmeot range from highs of 26%, 31%, and 32% in Kugluktuk, Taloyoak and Gjoa Haven, respectively, to 21% in Kugaaruk, and a low of 14% in Cambridge Bay. Mitigation and management measures that focus on training, recruitment, and retention have been developed to enhance the participation of local Inuit in Project employment and are detailed in the Human Resources Plan (Volume 10, Chapter 28). The targeted recruiting of Inuit employees may serve to reduce higher than average unemployment rates.

For Canada, the operation of the Project is estimated to generate a total income of $1,743.9 million dollars, approximately 45% of which is indirect personal income. Within Nunavut, the total income effects of the Project are expected to be highest in the Kitikmeot Region and are estimated to be a total of $193.3 million. Direct Project employment is estimated to generate average incomes of approximately $106,750 within the Kitikmeot Region (Table 3.5-17). As noted earlier, personal income in this context includes salary as well as the extended benefits of employment, including overtime pay and bonuses. Total incomes (including direct, indirect, and induced employment income) are estimated to be slightly lower as this includes all induced service sector employment generated by the infusion of capital from Project expenditures and the expenditure of direct and indirect personal incomes.

Table 3.5-17. Income Effects of the Back River Project for Operation

		Direct Project-related Personal Income		Total (direct, indirect, and induced) Project-related Personal Income	
	Median Full-time Earnings (2005 $)	Average Worker Income ($)	Proportion of 2005 Median Full-time Earnings	Average Worker Income ($)	Proportion of 2005 Median Full-time Earnings
Operation					
Kitikmeot	$56,864	$106,750	1.9	$88,467	1.6
Kivalliq	$50,104	$0	0	$54,611	1.1
Qikiqtaaluk (Baffin)	$60,060	$0	0	$56,645	0.9
Nunavut	$58,088	$106,750	1.9	$72,514	1.2
Canada	$41,401	$106,788	2.6	$62,192	1.5

Source: Rescan (2013)

The provision of increased incomes during the ten year Operation phase of the Project may serve to increase standards of living the Kitikmeot Region and address a number of issues (e.g., food security, housing shortage, access to recreation programs for youth) currently faced by residents. As an indirect

effect of increased income, the operation of the Project may support the development of new businesses or expansion of existing business within the socio-economic LSA. Further, increased incomes may facilitate land use activities by increasing the ability of residents to purchase the necessary equipment and other supplies for harvesting. Notably, average personal income for direct Project employment during Operation is expected to be approximately 1.9 times higher in the Kitikmeot and 2.5 times higher in Canada as compared to median incomes in 2005 (Table 3.5-17).

Overall, the employment and income effects of the Project during Operation are expected to be highly beneficial and, as mentioned above, have the potential to enable increased standards of living for Kitikmeot families. Those who benefit from mine employment and the associated incomes may choose to invest in housing, education, personal savings or other positive productive avenues of spending. The link between increased incomes and well-being is acknowledged and is further discussed in Section 3.5.3.5. Mitigation measures have been developed to actively steer the choices and decisions associated with increased income for those who obtain direct employment with the Project (see Human Resources Plan, Volume 10, Chapter 28).

Finally, Project employment may present an opportunity for Inuit to provide for their families within the wage economy while continuing to participate in land use and family activities as a result of designated periods of time (two weeks on/two weeks off; see Section 3.5.3.5 for further discussion). Overall, Project employment has the potential to provide an opportunity for individuals to increase their personal and family self-reliance and to engage in both the traditional and modern elements of society.

Reclamation and Closure

During Reclamation and Closure, there will continue to be some beneficial employment effects, despite the loss of direct employment during the transition following the Operation phase. The closure of the Project is expected to have some adverse effects as direct employment with the Project comes to an end. During the Reclamation and Closure phase, a number of Project components require continued maintenance (e.g., camps, rock storage facilities, power plant, water treatment) and are expected to provide continued employment opportunities for Kitikmeot residents. Specific estimates of direct employment and expenditures during this phase of the Project were unavailable at the time of writing. Overall, direct Project employment is expected to be notably lower as compared to the Operation phase. The loss of employment may result in adverse effects; however, mitigation has been developed to assist Project employees with the transition from the operation to closure phase (see Section 3.8.1.1 and the Human Resources Plan, Volume 10, Chapter 28).

Individuals who have gained skills and work experience as a result of Project employment will likely aim to obtain other employment once Project operations are discontinued. While the future of mine projects, other resource development, and northern economies are difficult to predict, it may be fair to estimate that some individuals may find other local employment opportunities or choose to relocate to other communities in Nunavut or other jurisdictions in Canada to obtain other employment upon closure of the Project. However, it is also fair to anticipate that the number of individuals who relocate for this reason would be minimal due to the close-knit nature of Inuit families and communities.

Post-Closure

During Post-Closure, some employment opportunities associated with continued reclamation and monitoring of the Project site are expected to be available. While some employment opportunities are anticipated during this phase, the number of positions available will be very limited as compared to the Operation phase of the Project and may be intermittent or seasonal in nature.

The Post-Closure phase is expected to be characterised by the continued monitoring of the Project, which creates the opportunity for a small number of local residents to continue to gain experience in different areas (e.g., environmental monitoring) further contributing to the increased capacity of the workforce.

Temporary Closure and Care and Maintenance

During a Temporary Closure of the Project, direct Project employment would be stalled as operation activities are discontinued. A very minimal number of employees are expected to remain on-site to maintain Project facilities. A Temporary Closure of the Project would be limited to no more than two years, at which time the Project would either begin operation again or be transitioned to Care and Maintenance.

During a Care and Maintenance phase, direct Project employment would be stalled as mine production would be shut down. As with a Temporary Closure, a very minimal number of employees would be required periodically to maintain the Project site, facilities, and equipment. Overall, Project employment associated with the operation and production of the mine would be discontinued.

Changes to the Capacity of the Labour Force

Direct Project employment and procurement are expected to increase the capacity of the labour force, specifically the skills and experience of the Kitikmeot labour force. This effect considers the resulting increase to human capital within the Kitikmeot Region.

Site Preparation

Changes to the capacity of the labour force are not anticipated during Site Preparation as employment is expected to be minimal during this phase.

Construction and Operation

During the Construction and Operation phases of the Project, it is anticipated that a number of local Kitikmeot residents would receive training and/or become employed with the Project directly or with businesses that have secured sub-contract work with the Project. These Project-related activities are expected to increase the capacity of the local labour force, specifically for the Kitikmeot Inuit. Further, there are a number of mitigation measures in place to increase Inuit participation in Project employment. In addition, contractors with northern hiring requirements will be preferred to further increase the benefits of Project-related employment for Inuit within the Kitikmeot Region.

In 2006, the majority of Kitikmeot residents in the workforce were employed in service-based activities. The largest proportion of the regional labour force worked in sales and service occupations, ranging from 23% (Cambridge Bay) to 36% (Kugaaruk). In the majority of the communities, the second largest portion of the labour force was employed in trade, transport, and equipment operations occupations; Cambridge Bay was the exception where business, finance, and administration was the second largest portion of the labour force, which can be expected given Cambridge Bay's role as a service centre in the Kitikmeot Region (for further information, see Section 3.1).

Increasing the diversity of experience of Kitikmeot residents may serve to increase the capacity of the regional labour force and further, may improve individuals' abilities to obtain employment and may result in higher levels of employment generally.

Increases to local labour force facility are expected to primarily be a result of direct increases to skill and education levels through training and on-going work experience. Although this effect will vary by type of employment, overall increases to the capacity of the local workforce are expected. Education

and training associated with construction employment may include on-the-job training activities or programs attended by residents interested in Project employment.

Working age adults will retain this capacity even after they are no longer engaged in Project employment. Infrastructure development and other activities provide local employment opportunities. The type of employment associated with the Construction phase of the Project is expected to increase the skills and experience of, for example, labourers, heavy equipment operators, or site managers. Operation phase employment is likely to increase work force capacity as a result of the long-term nature of employment and opportunities for career advancement and father training. Further, increases to the experience and capacity of individuals who benefit from Project-related business contracts are also anticipated during both the Construction and Operation phases.

Within the LSA, the total labour force is approximately 1,900 persons in 2006. The local workforce is primarily expected to be drawn from Cambridge Bay and Kugluktuk. However, consideration is also given to the eastern Kitikmeot. Baseline studies indicated there currently is limited capacity in the local labour force (Section 3.1; Appendix V8-3A).

In order to enhance the ability of Kitikmeot residents to benefit from increased experience and capacity associated with mine employment, Sabina has committed to work with local Inuit organizations, education providers, and governments to identify opportunities to partner and implement training programs to better prepare Inuit beneficiaries for mine employment opportunities. These enhancement measures are further outlined Section 3.8. Current opportunities with exploration employment provide on-the-job experience to Kitikmeot residents expected to facilitate the inclusion of local Inuit in employment during the Construction and Operation phases of the Project.

Increases to human capital are expected as of result of local individuals becoming engaged in training and education programs to obtain employment with the Project. Labour force capacity increases due to work experience and increased skills levels are expected to be more substantive during the Operation phase, which is longer term and provides for on-going career development opportunities. Increased workforce capacity enables greater local participation both with the Project and more broadly in the local economy.

During the Operation phase, Project employment opportunities include a variety of semi-skilled, skilled, and professional occupations. For example, drilling and blasting technicians, general foremen, shift foremen, dispatchers, equipment operators, community/environmental coordinators and administrators. The provision of these opportunities by the Project may cause individuals to obtain the required credentials or certificates to be considered for employment. Training obtained prior to employment with the Project and during employment is expected to increase the capacity of the local workforce. On-the-job training and work experience also contribute to the capacity of the local labour force.

The Project has the potential to increase the capacity of the workforce if individuals interested in mine employment obtain specified training and credentials. However, baseline studies indicated there are a number of difficulties associated with obtaining training and credentials in the Kitikmeot, particularly for trades training and certification. This may restrict the degree to which the benefits of the Project related training programs can be realized. Challenges to obtaining trades training and certification include the following:

- lack of regional trades training program; and
- lack of certified masters or journeymen required for students to apprentice.

The Project also has the potential to increase the number of masters and journeymen available to student apprentices which may serve to further increase education and skill levels, and in turn the capacity of the regional workforce. That is, student apprentices may have access to masters or journeymen employed by the Project, enabling them to complete their apprenticeship.

Increases to the capacity of the labour force are also dependent on long-term commitment to increase education and skills in the region. At the time of writing, the NAC offered a pre-trades access program and camp cook. The pre-trades access program was designed to prepare high school students for entrance exams required to access trades training programs offered elsewhere (e.g., Rankin Inlet) while providing credits that contribute to graduation. As has been the experience at Agnico Eagle's Medowbank mine, additional programming and investment is required to establish workforce capable of realizing the benefits of project employment locally. Sabina expects to partner with government, educational institutions, and other mine companies and contribute to the development of a regional training organization (as described in the Human Resources Management Plan, Volume 10, Chapter 28).

The Project is invested in establishing a skilled local workforce for a number of reasons. First, the relationship between the Project and the community is enhanced when interested individuals are able to access and successfully complete training, and obtain employment. Second, increases to the number of local individuals who obtain Project employment reduces the overall costs of the Project. Third, increasing the number of employees that have a deep understanding of the Arctic environment, reside locally, and are committed to the Project and their employment serves to establish a motivated and productive workforce.

Capacity established within the local workforce as a result of the Project is expected to benefit the region beyond the life of the Project. Experience with the Project may enable local residents to obtain future employment with other resource projects and non-resource related projects, as dependent on the type of experience obtained. For example, local contractors that had not previously (prior to the Project) had the opportunity to procure and complete substantive contracts may have increased levels of experience and expertise. Expertise obtained as a result of the Project may enable individuals and businesses to obtain further employment or contracts, beyond that of their previous experience. That is, the increased capacity of the labour force is expected to result in greater future opportunities, as a result of the experience and skills gained from Project employment.

Increased capacity may serve to lower unemployment rates, promote economic growth, and enhance ability of the regional workforce to support future Projects. This effect is anticipated to last beyond the life of the mine and to have an overall positive effect on those involved with the Project as well as others in the region (e.g., youth, through role modelling).

Lastly, should the expanded capacity of the labour force include an increase in the number of individuals with trades experience and certification there may be additional economic benefits. For example, any reduction in Nunavut's reliance on southern workers (e.g., those engaged in construction and maintenance activities for the local housing associations) would reduce the operational costs of communities and could potentially increase local Inuit employment and community self-reliance.

Reclamation and Closure/Post-Closure

During the Reclamation and Closure and Post-Closure phases, Project employment is expected to substantially decline. Most project employment will end following the Operation phase as mine production comes to an end. Despite this, capacity gained from experience with the Project (e.g., skills, education, training) is expected to be retained and is applicable in future employment

scenarios. A number of potential projects may develop in the region, potentially providing additional employment opportunities.

The different types of employees required during this phase (e.g., those positions associated with monitoring and site reclamation) may require different experience or qualifications. This provides an opportunity for some in the local labour force to build skills and capabilities in other areas. Additionally, the Human Resources Plan (Section 3.8; Volume 10, Chapter 28) summarizes measures developed to assist Project employees in their transition from Project employment to other employment, training, or education.

At this time, and as dependent on other developments taking place within the region and territory, the Kitikmeot Region communities may have become somewhat economic and socially dependent on the Project during the Operation phase. Expectantly, the loss of employment that will occur as the Project transitions from production to closure is anticipated to have some negative impacts on workers, families, and communities within the RSA. However, at the end of the life of the Project, the capacity of the local labour force is expected to remain improved as a result on involvement with the Project.

Temporary Closure/Care and Maintenance

During a Temporary Closure or Care and Maintenance phase, increases to the capacity of the labour force are retained; however, employment and contracting activities are discontinued. As new employment is not generated during these phases, further increases to the capacity of the workforce are not expected.

Changes to Competition for Local Labour

Direct Project employment and procurement may cause changes to local competition for labour. That is, the Project creates the potential for individuals currently employed in the Kitikmeot Region to leave their current employment for mine-related employment. The potential for this is indicated by the facts that the predicted employment impacts of the Project in the Kitikmeot Region are a substantial share of the current labour force (Table 3.5-15), the Project offers relatively well-paying jobs (Table 3.5-17), and will require workers with skills and experience also required by other employers in the region. Consideration is given to any increase or decrease in the number of vacant non-mine related jobs by industry sector and changes to expectations of salary or compensation. This effect considers the retention of local employees (e.g., hamlet and Government of Nunavut employees).

Site Preparation

Changes to competition to local labour are not anticipated during the Site Preparation phase of the Project because labour requirements are expected to be minimal.

Construction and Operation

A number of employment generating activities will take place in the Construction and Operation phases of the Project. Construction activities include drilling the open-pit and underground mines at the Goose and George Properties, building the winter roads each December, and also building supporting infrastructure like camps, processing facilities, and the MLA in southern Bathurst Inlet. The Operation phase of the Project would be characterized by a more consistent routine of daily activities, as compared to the Construction phase. Project operation would take place over a ten year period, providing substantial employment benefits within the Kitikmeot, Nunavut, and Canada. During the Operation phase, up to 600 employees will be required by the Project, with about half (e.g., 300) of the employees would be on site at one time because of the work rotation schedule. The Project will actively target and encourage Kitikmeot residents to seek training and employment opportunities

associated with these activities. A notable portion of Project-related employment requires specified skill and/or education levels.

There is a growing need for skilled workers in the Kitikmeot Region and limited capacity in the labour force (see Section 3.1). That is, in the socio-economic LSA there are many vacant positions available that are not filled due to the lack of skilled workers and lack of housing available for workers. For example, baseline studies note there were 50 government-funded positions that were vacant at the new (2010) health facility in Cambridge Bay. Vacant positions included those for nurses, chiropractors, mid-wives, and others. Community consultation, public meetings, and community-based research identified a Project related concern that the employees of local businesses, hamlets, and other organisations may leave their current employment to obtain mine-related employment, thus creating a deficit of much needed skilled employees.

Most Kitikmeot residents employed with local businesses, hamlets, the Government of Nunavut, or organizations are not expected to leave their current employment to obtain work with the Project. Individuals that are gainfully employed in the Kitikmeot have likely investment time and incurred the expense of post-secondary education to obtain the career of their choosing. For this reason, workers such as teachers, nurses, and hamlet employees are not anticipated to leave their current positions.

However, there may be exceptions to this. For example, for teachers that are currently employed to teach a trade (e.g., electrician, carpenter, or plumber) and that have the required credentials, mine employment and the associated higher wages may be of interest. However, this scenario is not very likely given the lack of such qualified instruction currently available in the Kitikmeot Region.

A more likely scenario is the loss of some hamlet employees and workers currently employed with local construction companies and housing associations to the Project, such as truck drivers, heavy equipment operators, and trades people. Community research indicated that this has occurred in the past with other mine projects (e.g., the Doris North Project) involving a small number of individuals. This may place temporary hardship on the hamlet or businesses involved. However, as discussed in the previous section, the Project also serves to increase the skills and experience of the local labour force, over time increasing the availability for local employers.[7]

As another example, a number of people are employed in each community to perform maintenance on GN and other housing units. These employees are skilled and typically certified in a trade (e.g., electricians, plumbers, carpenters) and many have relocated from the south. Non-Inuit that have relocated from the south to fill much needed positions (e.g., nurses, teachers, etc.) are not anticipated to seek Project related employment as they are typically well-paid and reside in housing that is attached to their employment. Increases to the capacity of the local labour force due to the Project may reduce the need for southern employees in communities, potentially lowering costs of operating the communities and resulting in improvements to services.

The Project seeks to inform local businesses, organizations, and hamlets of their hiring requirements and Procurement Practices in advance of the implementation of Construction and Operation and would collaborate to reduce any adverse effects of the Project linked to increased competition for local labour. Further description of mitigation is provided in Section 3.5.3 and in the Business Development Plan (Volume 10, Chapter 24) and Human Resources Plan (Volume 10, Chapter 28).

[7] For example, anecdotal evidence collected during community research indicated that when the Doris North Project entered Care and Maintenance in 2012 a number of skilled truck drivers and heavy equipment operators became available and were able to be utilized by local employers.

Lastly, there is potential for competition for local labour as related to traditional harvesting activities. That is, there are a number of individual harvesters in each Kitikmeot community who are experienced harvesters that provide country food to their families, extended families, and neighbours. The role of these individuals extends beyond the provision of country food, as it is through participation in harvesting activities that Inuit culture is produced, sustained, and transmitted to younger generations. The potential for the Project to act as competition to labour as related to the labour of harvesters would have implications beyond time spent. However, the Project has been designed as a fly-in/fly-out operation based on a two-week on/two-week off work rotation scheduled. The work rotation schedule is designed to be conducive to the maintenance of harvesting activities and is characterized by two weeks of time-off between work shifts. This enables individuals that participate in harvesting activities to also engage in mine employment, or in both traditional and modern economies. Further explanation of management and enhancement measures related to this issue are further described in Section 3.8 and are detailed in the Human Resources Plan (Volume 10, Chapter 28).

Reclamation and Closure Phase / Post Closure

During the Reclamation and Closure phase, as well as during the Post-Closure phase, competition for local labour is anticipated to be negligible. Any competition for labour created during the Construction and Operation phases of the Project would be discontinued once production comes to an end and the number of employees required by the Project is substantially reduced.

Temporary Closure and Care and Maintenance

During Temporary Closure or Care and Maintenance, direct Project employees would be available for work with other employers and in other sectors. Competition for local labour created during the Construction and Operation phases of the Project is expected to be negligible; however, the development of skills and experience within the labour force associated with Project employment may result in a greater availability of skilled employees during Temporary Closure or Care and Maintenance.

3.5.3.4 Education and Training

Effects of the Project on Education and Training are considered positive and include:

- Changes to the demand for education and training; and
- Changes to youth attitudes and behaviours toward education and training.

These effects are expected to vary by Project phase and to be most notable during Construction and Operation.

Changes to the Demand for Education and Training

The Project is expected to result in increased local demand for education and training programs as a result of the provision of Project-related employment opportunities. That is, it is expected that Kitikmeot residents will seek education and training to prepare for employment with the Project. This increase in demand may have a number of indirect effects that are explored in the following section, by Project phase.

Site Preparation and Construction

During the Site Preparation and Construction phases, it is anticipated the Project will create the need for additional training programs associated with mine employment. Sabina expects to partner with local governments, educational institutions, Inuit organizations, and other mine proponents to contribute to the creation of a regional training facility or additional mine employment training programs at the NAC. Sabina has established a trust fund of $1.4 million which is held by the KIA for

training and education as well as infrastructure and other community projects. Further discussion of community investment is provided in the Community Investment Plan (Volume 10, Chapter 26).

The Project expects to facilitate on-the-job training during the Construction phase that may serve to reduce the overall demand for education and training programs within the region. Demand may increase in advance of Project Construction and Operation as local residents aim to secure future employment. Alternatively, demand may not increase until the employment opportunities have become available. Employment opportunities associated with the Project, including a description of education and other job requirements, are currently available on the Project website, www.BackRiverProject.com. In either case, the Human Resources Plan (Section 3.8; Volume 10, Chapter 28) specifies actions to enhance the benefits of Project employment within the local communities though coordination with local education facilities in advance of Project operation. These actions aim to assist individuals interested in mine employment in obtaining access to education and training programs directly relevant to future employment with the Project.

Increased demand for education and training may result in greater availability of training programs in the region. Increases to the availability of training programs is expected to occur through enhancement measures such as the trust fund described earlier. Early development of this fund may serve to prepare the Kitikmeot Inuit to secure the benefits of Project employment and also to reduce the gap between the requirements of Project employment the education and qualification levels of the local labour force. Overall, increased demand for education and training programs is not anticipated to effect education infrastructure or administration. However, the needs of the Project are expected to result in an overall increase in funding resources and increase in the capacity of educational institutions, should the expansion of programs take place.

Operation

The Operation phase of the Project is expected to last approximately 10 years and is expected to require a large workforce, a portion of whom would be residents of local communities. Total Project-related employment (direct, indirect and induced) in Nunavut is estimated to be 4,266 person-years or an average of about 220 jobs in the Kitikmeot Region. The Project will require a workforce with diverse education and skill levels. The provision of employment opportunities is expected to increase demand for education and training programs with in the Kitikmeot Region.

There is potential for the development of long-term capacity building programs in partnership with other mine companies, governments, and Inuit associations. Enhancing and establishing a skilled workforce able to effectively contribute to the operation of the Project is a goal both for Kitikmeot residents and for Sabina. The experiences of those associated with the Meadowbank Mine suggest that investment in training and skills development provide individual and company benefits. Increased demand for education and training may take the form of increased interest in:

- obtaining a high school diploma;
- obtaining a General Educational Diploma;
- general skills upgrading;
- NAC programs;
- Project-specific training; or
- on-the-job training.

Baseline studies (Appendix V8-3A) report that the NAC offers a variety of programs, some specific to mine and related employment. The number and type of programs available at NAC are based on demand. The regional NAC campus in Cambridge Bay consists of four separate facilities and residents equipped to accommodate up to 20 live-in students. As of winter 2012, there were a total of 42 students attending NAC in Cambridge Bay and eight students attending NAC in Kugluktuk.

While baseline studies indicated there are some challenges associated with increasing in the number and type of education and training programs available, Sabina will work with local education institutions to facilitate the provision of training programs (Volume 10, Chapter 28). Challenges to the provision of training programs include:

- attracting skilled instructors from outside the region, as the capacity to fill these positions locally typically does not exist;
- housing for NAC instructors as housing shortages and overcrowding have reached new highs in recent years; and
- NAC instructor retention (Appendix V8-3A).

Changes to the demand for education and training are considered positive and although some challenges may present in terms of logistics, the support of the Project in coordination with local education institutions such as the NAC is expected to result in the development of programs related to future mine employment. Enhancement measures have been developed to retain the potential benefits of Project locally; these include the facilitation of education and training programs (see Volume 10, Chapter 28).

Reclamation and Closure/Post-Closure

During the Reclamation and Closure phase of the Project, the majority of Project employment will come to an end. At this time, the demand for education and training programs may change as individuals engaged in Project employment seek alternative employment. As part of the Human Resources Plan, the Workforce Transition Strategy (Section 3.8; Volume 10, Chapter 28) describes measures to ease the transition to new employment, including coordination with regional training institutions provide industry-specific retraining information sessions, among other measures.

Temporary Closure and Care and Maintenance

Changes to demand for education and training programs during a Temporary Closure of the Project are not anticipated. Any temporary closure of the Project would be limited to two years and holds the potential for the Project, and Project employment to resume.

During a Care and Maintenance phase of the Project, which may occur following a Temporary Closure for two to ten years, the Workforce Transition Strategy (see Human Resources Plan Volume 10, Chapter 28) would be implemented. There is potential for changes in the demand for education and training during this phase, as Project employees may seek alternative forms of education and training to facilitate or obtain other types of employment.

Changes to Youth Attitudes and Behaviour towards Education and Training

The Project is anticipated to result in positive changes to youth attitudes and behaviours towards education and training. This effect refers to changes to youth perceptions of the link between education and employment.

Site Preparation

Changes to youth education and training are not anticipated during Site Preparation as these changes are dependent on the education and employment seeking behaviours of adults that are not expected to be notably affected by the nominal employment opportunities associated with Site Preparation.

Construction and Operation

The Construction and Operation of the Project is expected to have the following implications for youth as a related to education and training:

- increased experience and understanding of the linkages between education and employment;
- potential increased school attendance rates; and
- increased interest in education and training.

Younger generations of Kitikmeot residents have typically not experienced a solid link between the completion of high school or other education and the resulting employment and income benefits. Baseline studies describe a disconnect in that youth and young adults are, in a sense, unable to equate education and training with employment due to the lack of employment opportunities available locally. Employment opportunities in communities are limited and employment is difficult to come by even for those that do graduate high school or obtain some type of post-secondary training.

Participation in Project employment by Kitikmeot residents is anticipated to strengthen knowledge of, or belief in, the link between education and employment for the region's youth and is anticipated to result from role modelling. Overall, local participation in Project employment, or the modelling of productive economic roles, is anticipated to result in positive outcomes for youth in the longer term.

Baseline studies indicate that graduation rates in the Kitikmeot have been variable over the past decade; however, the percentage of Kitikmeot residents without a high school diploma remains well above the Canadian average. For example, the percentage of residents without a high school diploma is 36% in Cambridge Bay and 48% in Kugluktuk as compared to the Canadian average of 15.4% (Appendix V8-3A). The potential for the Project to increase attendance rates is twofold. First, and particularly for high school students, youth who become increasingly aware of the link between education and employment may place higher priority on completing high school in order to access Project or other employment upon completion, thus increasing attendance rates. Second, youth with parents engaged in Project employment may experience a more routinized environment conducive to regular school attendance and later success in the job market.

The Project is expected to increase youth interest in education and training. Specifically, awareness of the availability of different types of employment and related educational requirements associated with the Project may be of interest to youth. Although individuals under 18 years of age are not eligible for mine employment, prior knowledge of the types of opportunities available and their associated requirements may motivate youth to seek out high school courses and/or programs that would enable their future employment.

Overall, the Project is anticipated to promote participation in the wage economy for Kitikmeot residents including youth. As a balance, the Project has also established management measures (which include funding) for land-based youth camps involving Elders that facilitate the maintenance of knowledge and ability to participate in traditional harvesting activities (see Community Involvement Plan, Volume 10, Chapter 26).

Reclamation and Closure/ Final-Closure

Following Closure, it is anticipated that the Project will have resulted in changes to youth attitudes and behaviours towards education, with youth participation in education and training programs related to the mining industry and other industries are expected to have increased. For example, community residents in Kugluktuk have participated in mine employment with the Ekati and Diavik mines in the NWT for some years. High school students in Kugluktuk have had access to a pre-trades program for the past eight years. Baseline studies report that students enrolled in the pre-trades program in Kugluktuk were much more likely to graduate, become employed, or continue their education following high school graduation as compared to students not enrolled in the program (Appendix V8-3A).

Temporary Closure/Care and Maintenance

The Temporary Closure as well as the Care and Maintenance phases of the Project are not anticipated to cause notable changes to youth attitudes and behaviours towards education and training.

3.5.3.5 Health and Community Well-being

The Project has the potential to result in substantial positive impacts for residents of the Kitikmeot Region as a result of the provision of employment and increased incomes. Community consultation, public meetings, and community research indicate that residents of the Kitikmeot are excited for the Project, Project employment, and the various associated indirect benefits. The following review of potential positive and negative impacts to health and community well-being is undertaken in the spirit of enhancement and precaution. That is, the objective of the section is to demonstrate a knowledge and understanding of the current and historical issues faced in the Kitikmeot that has facilitated an approach to the enhancement of Project benefits and the reduction of potential adverse outcomes. This precautionary approach actively guards against, to the extent possible, the realization of negative outcomes through mitigation and management measures, and also serves as means though which the substantial potential positive outcomes of the Project can be realized for both the residents of the Kitikmeot and Sabina.

As described in Section 3.3.2, health and community well-being as envisioned for this assessment is inclusive of issues identified by Kitikmeot residents during public consultation and community research, as well as in GN policy documents (GN 2011) and as indicated by the Kitikmeot Region SEMC. The concept 'health' has been included to reflect the broader implications of changes to well-being. That is, the inclusion of 'health' enables consideration for the physical outcomes that can be associated with well-being. Examples of this include: respiratory issues that are exacerbated by overcrowded housing; the numerous health implications (liver damage, cancer, or injury) that can result from substance abuse; or the sexual health implications (STIs) of risky sexual behavior.

The effects of the Project on health and community well-being are anticipated to be both positive and negative as each is dependent on numerous variables, and include:

- **Changes to the life skills of those employed with the Project** – Project-induced changes to abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life. This effect is focused on individuals that obtain Project employment (WHO 1999).
- **Changes to individual and family spending** – this effect is defined as the expected implications of increased income from Project employment including productive spending (e.g., education, housing, durable goods) and unproductive spending (e.g., gambling, drugs, and alcohol). Increased income as related to family consumption and housing subsidy eligibility, as well as

the linkages between increased levels of substance abuse, domestic violence, family violence, and STIs are also considered.

- **Changes to family/household function** – this effect is defined as the expected implications of the fly-in/fly-out operation of the Project for: 1) family structure (e.g., one or two parents away from home, gender roles), 2) traditional harvesting activities (e.g., changes to traditional harvesting activities as result of employment), 3) children and youth (e.g., implications of having an absentee parent or a role model), and 4) relationships (e.g., marital and parental).

Effects to health and community well-being are expected to accumulate and intensify in accordance with the number of Kitikmeot residents that obtain Project-related employment. The indirect effects (e.g., increased life skills) are expected to take some amount of time to accrue, as more individuals obtain and retain employment and/or receive training and spend time engaged in mine-related employment. Each effect listed is discussed below by Project phase.

Changes to the Life Skills of Individuals

Site Preparation

Changes to the life skills of individuals employed with the Project are not expected to be notable during the Site Preparation phase as the number of individuals employed is expected to be minimal.

Construction and Operations

Construction activities include construction of project infrastructure such as winter roads connecting the George and Goose properties, other supporting infrastructure (e.g., camps, maintenance, and processing facilities), and the MLA and port in southern Bathurst Inlet. These activities will require employment and procurement of contractors. Direct employment and procurement during the two years of Project construction are anticipated to result in employment in the Kitikmeot Region and may have effects on health and community well-being. It is expected that local labour and businesses will be utilized to provide goods and services required by the Project to the greatest extent possible.

The construction of the Project is estimated to generate approximately 180 person-years of direct employment. Hiring preference during Construction, based on qualifications, will be given first to Inuit within the socio-economic LSA (which includes the communities of Cambridge Bay, Kugluktuk, Omingmaktok, and Bathurst Inlet), and second to Inuit within the socio-economic RSA (which includes the LSA communities as well as Gjoa Haven, Taloyoak, and Kugaaruk). Project employment (direct and spin-off) during the Construction phase will provide income to local residents and may increase individual and community self-reliance as a result of enhanced financial independence. Although the Construction phase is only two years in length, increases to the life skills of individuals who obtain employment are anticipated. The greatest changes to life skills, however, are anticipated to occur during Project Operation. Increases to life skills are characterized by the ability to obtain and retain employment, manage income and/or family finances, make decisions that are ultimately supported by ones family members and the community, and generally become an individual that models a positive and productive economic and social role. A number of management measures including the EFAP, cross-cultural awareness training, access to the Inuit Employment and Training Coordinator, and on-going personal development counselling are anticipated to contribute to increases in the life skills of Project employees and are described in Section 3.5-4.

Deficiency in life skills has been cited as a contributing barrier to mine employment for northerners (BHP Billiton EKATI; Rio Tinto Diavik Diamond Mines; De Beers 213). The Project provides the opportunity to participate in education, training, and employment, which creates the potential for the modelling of those behaviours to take place within communities. Increases to the life skills of Project

employees, and potentially their families, are anticipated as a result of their engagement in work and other supportive programs.

Increases to the life skills of Project employees may cause changes to everyday behaviours of individuals. These positive changes may have implications for youth when modelled within the community. Within cultures that have historically based parenting and societal order on behaviour modelling, there is potential for these changes to be widespread. The Project has established management measures to enhance the benefits of Project employment as related to life skills (e.g., the provision financial management programs, counselling, and others). Further details characterizing the measures in place to enhance the life skills of those engaged in Project employment are provided in Section 3.8 and the Human Resources Plan (Volume 10, Chapter 28).

Reclamation and Closure/Post-Closure

Life skills obtained by Project employees during the Construction and Operation phases may assist with the transition from operation to closure. Although there will be some employment associated with the reclamation and closure and post-closure phases of the Project, most direct Project employment will be discontinued. Enhanced life skills are expected to have established a foundation from which individuals can continue to be productive through employment with other projects or in other sectors.

The increased capacity and life skills of individuals employed by the Project are anticipated to be relevant for them over time and in situations distinct from Project employment.

Temporary Closure/Care and Maintenance

During a Temporary Closure or Care and Maintenance phase, increases to the life skills of individuals associated with the Project are expected to remain and to be applicable for everyday decision making, as well as for future employment opportunities. Although most Project employment is anticipated to be suspended during these phases, life skills gained throughout the Construction and Operation phases would be retained and may assist individuals in obtaining new employment.

Changes to Individual and Family Spending

Community-based research and public consultation has indicated particular interest in the aspect of mine employment related to spending habits and how to best realize positive outcomes for individuals and communities. The actual outcomes of resources development project for Indigenous populations have become a much discussed and researched topic, specifically as related to increased incomes (Buell 2006; NAHO 2008; Brubacher Development Strategies 2009).

Site Preparation

The Project is not expected to cause any changes to individual and family spending during the Site Preparation phase. These changes are linked to increased income and employment which are not expected to be substantial during this phase.

Construction and Operation

Changes to individual and family spending are expected to occur during both the Construction and Operation phases of the Project. The Construction phase is anticipated to result in a notable change from baseline conditions as the LSA communities' transition from life without the Project and life with the Project. With the shift to Operation, the number of total jobs (direct, indirect, and induced) within the Kitikmeot is estimated to be slightly lower as compared to the Construction phase (from an annual average of approximately 242 to 219, respectively), but still represent a substantial share of the regional labour force. Furthermore, average incomes during the Operation phase are anticipated to be

slightly higher (Section 3.5.2). Nevertheless, changes to individual and family spending are anticipated during both Construction and Operation. The following section explores the potential for positive and negative outcomes associated Project employment, specifically as related to increased incomes.

Those who obtain mine employment and increased incomes as a result of the Project may choose to use their income in a manner that improves circumstances for themselves and their family. If the majority of local residents who obtain mine employment choose to improve their circumstances, substantial increases to health and community well-being are expected. Positive spending choices might include increased savings, further education for children, purchase of tools and equipment needed for improved subsistence harvesting, debt repayment, and many others. The manner in which individuals choose to spend their increased incomes may be influenced to an extent by employment, family, and financial management programs provided to mine employees.

Positive productive decisions can be measured by the acceptance of the decision within the family and as contributing to the stated goals of the community, region, and territory. Measures of influence include the provision of financial management programs, access to counselling services by the Sabina (through the EFAP), and improved methods of communication to enable workers to remain in regular contact with their families while away at work.

Alternatively, those who obtain employment and increased income may choose to spend their income without improving their circumstances. An example of this would be spending on items such as alcohol, drugs, and/or gambling. If the majority of local residents who obtain mine employment choose to spend their money this way, there will be likely additional negative effects associated with increases to domestic violence, crime, and child neglect in communities. There are also numerous health outcomes associated with increased levels substance abuse. Sabina has proposed, in management plans (Volume 10, Chapter 28) to actively influence mine employees, to the extent possible, to make positive productive spending decisions that contribute to the overall health and well-being of communities and the retention of employment with the Project.

Mine employees who participate in the financial management program offered through Sabina will be encouraged to develop a monthly budget and will receive assistance planning the allocation of their increased incomes. For the Construction and Operation phases, a number of issues are addressed as related to increased incomes, including:

- increases to substance abuse;
- increases to crime, domestic violence, and STIs and risky sexual behaviours, mainly as a result of increased levels of substance abuse;
- changes to housing and income support; and
- changes to food security, traditional harvesting, and country foods consumption.

Substance Abuse

Project employment may have implications for individuals that struggle with substance abuse issues as a result of the higher wages typically associated with mine employment. The link between mine employment and alcohol abuse as a result of increased income has gained the attention of regulators, community service providers, and Inuit communities in Nunavut. This is as a result of past experience with mine Projects in the Canadian north generally (Ekati, Diavik) and within Nunavut (Meadowbank, Jericho). Baseline studies indicate that despite attempts to limit the consumption of alcohol, the sale and consumption of alcoholic beverages in Nunavut has increased over the last decade. Drug and

alcohol counsellors in the Kitikmeot reported high levels of alcohol and drug use in the region (Appendix V8-3A).

Mine employment may represent a dramatic increase in income for some individuals. A review of recent literature (Brubacher Development Strategies 2009) indicates that the increased consumption of alcohol as related to increased incomes and mine employment does not affect all employees. Interviews with individuals employed by other projects and their family members (InterGroup Consultants 2005; Brubacher Development Strategies 2009) indicate binge drinking has been an issue for a notable number of mine employees and subsequently, their partners. Some accounts link the issue to extended periods of time off, nothing to do, and not knowing what to do with increased income, while others indicate making active plans to binge drink. Others yet reported that mine employment and being the away from the community was somewhat of a relief and provided an environment away from social pressure and access to alcohol (Brubacher Development Strategies 2009). While substance abuse can be an issue for people of all ages, interviewees noted that younger employees seemed more likely to struggle with the substance abuse as a result of increased income as compared to more mature employees.

Mine employment is contingent on compliance with the zero tolerance rule - no drug and alcohol use. The Project has proposed to instigate random searches and employees are not permitted to consume alcohol at the Project site (see Human Resources Plan, Volume 10, Chapter 28). Individuals who choose to engage in excessive use of drugs and alcohol jeopardize their employment as all employees must undergo a fitness for work exam, which assess alertness and mental state of Project employees for safety reasons. Additional mitigation has been established to influence employees to make positive choices with their increased incomes (see Section 3.5.3 and the Human Resources Plan, Volume 10, Chapter 28 for further discussion and details).

Crime Rates and Domestic Violence

Other concerns stem from the potential indirect effects of increased incomes and substance abuse. Numerous studies and community research link increased levels of drug and alcohol consumption to increased social problems such domestic violence and crime. Baseline studies report that the RCMP in the Kitikmeot Region characterize a notable portion of crime in communities as being related to substance abuse and domestic violence (Appendix V8-3A). Concerns related to increased rates of crime and domestic violence as a result of increased substance abuse were noted during community research. However, it is acknowledged that these effects are generally related to substance abuse and the choices that these individuals are making, and are not a result of mine development per se.

First, there is a concern that mine employment may be indirectly linked to increased crime in nearby communities. This concern is a likely a result of experience with of knowledge of past projects. However, the root of increased crime as related to resource development primarily stems from an influx of workers into communities and their increased income which creates the potential for increased drug and alcohol use. The Project is not anticipated to promote relocation either from outside the Kitikmeot or within the region due to the fly-in/fly-out operation of the Project. Individuals that obtain employment with the Project are expected to be motivated to retain their employment and are not expected to participate in criminal activity that would potential jeopardize their positions.

Second, increased alcohol consumption has also been linked to increased domestic violence, as well as participation in risky sexual behaviours and the rate of STIs. Baseline studies report that mental health counsellors throughout the Kitikmeot Region link increased in substance abuse to increases in domestic violence (Appendix V8-3A). The social ills that result from the misuse of alcohol are in a sense limitless and may include (but are not limited to) domestic violence, child neglect, and risky sexual behaviour

and, therefore, the potential for increases to incidence rates of STIs, the breakdown of relationships and families, irresponsible gambling activities, and crime. Again, these outcomes are the result of substance abuse generally and are not considered to be an effect of the Project. Notably, while the increased incomes may have negative implications for some individuals, overall, employment and income are desired aspects of the Project, facilitate Inuit participation in the wage economy, and contribute to community health and well-being.

Substance abuse and the related social issues have presented challenges to the employment of northerners with other projects; for example, Jericho, Ekati, and Diavik (BHP Billiton EKATI; Rio Tinto Diavik Diamond Mines; De Beers 213; Brubacher Development Strategies Inc. 2009). As such, it is in the best interest of the Project and of Project employees to work collaboratively to address these issues to the extent possible. The realization of positive increases to individual and community well-being as a result of Project employment is a real possibility that is further supported by programs and other Project mitigation and enhancement measures (e.g., the EFAP and the Inuit Employment and Training Coordinator, as part of the Human Resources Plan, Volume 10, Chapter 28).

Overall, increased substance abuse is not anticipated to be an issue for most workers. Evidence for this claim is provided in recent studies of the Jericho, Ekati, and Diavik projects (BHP Billiton EKATI; Rio Tinto Diavik Diamond Mines; De Beers 213; Brubacher Development Strategies Inc. 2009). Some former Jericho mine employees have described their time in camp residence as similar to attending a rehabilitation program and refer to this as one means through which to get way from social influences at home that lead to drug and alcohol abuse (Brubacher Development Strategies 2009). Ultimately, spending choices are at the discretion of the individual and cannot be controlled by one's employer. Programs and counselling are already available regional communities and will also be available to Project employees.

Housing and Income Support

Project-related changes to employment status are expected to result in changes to income support and housing subsidies. Public housing is the most common type of housing tenure in the region, accounting for approximately 62.1% of housing in the Kitikmeot in 2009/2010, 49% in Cambridge Bay and 64% in Kugluktuk (Appendix V8-3A). Public housing in Nunavut is highly subsidized by the GN and is linked to social assistance and employment. Individuals who are unemployed or underemployed are eligible for social assistance and housing for nominal monthly rent. However, for those who are employed, the housing subsidy is scaled back according to income. It is expected that individuals who currently receive social assistance and obtain Project employment will have their rental subsidy decreased or eliminated.

The transition to paid employment and management of monthly finances is a known challenge for many. As part of the Projects management plans, financial management training will be provided as part of employment orientation (see Human Resources Plan, Volume 10, Chapter 28). The presence of the Project and resulting increase in employment opportunities are expected to decrease the number of individuals receiving income support and may transform the community in that respect, to one that is more self-reliant. Employment opportunities associated with the Meadowbank Mine resulted in a 20% reduction in income support to Baker Lake between 2008 and 2010 (Scherkus 2011). Other costs to families may include the costs of have one (or two) less family member available in the household. These costs may have implications for household maintenance and childcare.

The Wage and Subsistence Economies, Food Security, and Country Food Consumption

The Project provides an opportunity for local Inuit to participate in the wage economy. The struggle to reconcile the wage and subsistence economies has been on-going since settlement in communities approximately 50 years ago. For many young people, retaining Inuit identify through participation in

the subsistence economy while providing for their families through participation in the wage economy has been largely implausible.

Project employment may present an opportunity for Inuit to provide for their families within the wage economy while continuing to participate in land use and family activities. The potential to engage in traditional harvesting activities is facilitated by the worker rotation schedule (two weeks on/two weeks off). Inuit were initially exposed to the wage economy without a means though which to effectively participate. This was detrimental to traditional gender/relationship/social roles within Inuit society (see following section for further discussion of changes to household structure; Appendix V8-3A). The provision of Project employment may serve to enhance or facilitate a regeneration of individual and community self-reliance and identity.

The Project hast the potential to positively affect food security for families as a result of increased income associated with employment. Baseline studies indicate that moderate and severe food insecurity is approximately four times higher in Nunavut as compared to Canada. For many, lack of income negates the ability to purchase food or to harvest traditional foods (i.e., due to the expense of equipment, fuel and supplies for harvesting). Increased income among Project employees has the potential to reduce levels of food security within the Kitikmeot, as traditional foods are often shared. Access to employment and income as well as time to participate in harvesting is much needed.

While employment with the Project may not provide a realistic option for everyone, those who do obtain mine employment have an opportunity to continue their traditional harvesting activities. In some respects, mine employees that have a worker rotation schedule of two weeks on two weeks off have a greater opportunity to participate in traditional harvesting as compared to individuals who obtain employment with a typical work week (i.e., eight hours a day, five days a week) and can only harvest on weekends.

Individuals who choose to use their increased incomes to purchase the tools and equipment necessary to engage in subsistence harvesting may be inclined to harvest more often than the in past (for further discussion see Volume 8, Chapter 4, Land Use Effects Assessment). If this occurs at the community level, there may be an overall increase in subsistence harvesting and country foods consumption. Should these outcomes occur there is potential for additional opportunities for youth in terms of engagement and experience with harvesting activities, leading to overall increases in community well-being. Alternatively, if a number of individuals with increased incomes choose to use their incomes in ways that have adverse effects for the community, such as for the increased consumption of drugs and alcohol, adverse effects to community well-being are expected.

In sum, Project employment has the potential to provide individuals with the opportunity to increase their personal and family self-reliance through Project employment and to participate in both the traditional and modern elements of society.

Summary of Potential Effects due to Changes to Individual and Family Spending

Overall, the Project is anticipated to cause indirect changes to individual and family spending during Construction and Operation. These changes may have additional implications for certain segments of the population that will differ depending on individual or family decisions. The following four points contribute to the resulting determination of whether Project employment results in changes to individual and family spending.

First, there is potential for Project employment to result in changes to individual and family spending. Some individuals may choose to spend their income on alcohol and drugs; however, this is not expected for most Project employees. Prior to the provision of employment, individuals undergo a fitness for work

examination during the recruitment phase to identify any barriers to employment. Fitness for work is also an ongoing requirement for employment. For individuals that struggle with substance abuse and who gain Project employment, there is great potential for recovery as access to counselling and other forms of assistance is facilitated and the ability to maintain employment may act as a motivator.

The link between increased levels of substance abuse and increased levels of crime is acknowledged. However, the effect is expected to be mainly limited to individuals who currently struggle with substance abuse and is expected to be even more limited as not all individuals who struggle with substance abuse are engaged in criminal activities. It is also unlikely that individuals engaged in heavy substance abuse and criminal activity would be able to be employed with the Project or other employers in the community.

Second, the link between increased levels of substance abuse and increased levels of domestic violence, STIs, and risky sexual behaviour is acknowledged. This is the case with substance abuse in general, and is not specifically related to the Project. These indirect effects are of concern as they have been identified as current struggles faced within the Kitikmeot Region, without the Project. The Project has developed management measures to assist individuals in addressing substance abuse issues as necessary (see Volume 10, Chapter 28). Further, the EFAP and other services provided through the Project have been developed to assist employees in their transition into Project employment. These programs represent an additional support to Kitikmeot residents and, therefore, have the potential to result in a reduction to the number of individuals struggling with substance abuse, which may in turn serve to reduce the indirect social problems associated with substance abuse currently facing Kitikmeot residents.

Third, there is potential for the Project to cause changes to individual and family spending as related to changes in employment status, housing, and income support. The Project has developed measures to assist employees to adjust to these changes through financial management and the EFAP. Following the development of the Meadowbank Mine, reliance on income support decreased by 20% in Baker Lake (Scherkus 2011). This effect is positive as increased income and levels of responsibility for finances serve to establish greater overall self-reliance for individuals and families.

Finally, Project employment and income may result in increased levels of subsistence harvesting. Community research indicated that lack of income was a major barrier to participation in subsistence activities and harvesting. Further, the work rotation schedule (two weeks on/two weeks off) allows for longer, more extensive trips on the land than would be the case with a weekly employment schedule.

Reclamation and Closure/Post-Closure

Following the Operation phase, Project employment will be greatly reduced. There will be some employment associated with the Reclamation and Closure phase, however, at much lower level as compared to the Operation phase.

The implications of reduced employment and, hence, individual and family spending may include negative economic outcomes for local goods and service providers. Individual and family spending is expected to decline at this time as the majority of Project employment comes to an end and employees begin the transition to other employment. The transitions expected to take place at this time would be enabled by the increased capacity of the workforce discussed previously.

Temporary Closure/ Care and Maintenance

During a Temporary Closure or Care and Maintenance phase, Project employment is expected to largely come to an end. The loss of employment may have a number of different outcomes as related to changes in individual and family spending which are dependent on individual and family decisions.

Minimally, employee income would be reduced from employment income to income from employment insurance. In response, individuals and families may limit their spending.

Changes to Family and Household Structure

The Project has the potential to cause changes to the family and household structure of those engaged in mine employment as a result of the fly-in/fly-out worker rotation schedule. This effect considers the implications of Project employment on families (e.g., one or two parents away from home, gender roles) and relationships (e.g., marital and parental).

Site Preparation

The Project is not anticipated to result in changes to family/housing function during the Site Preparation phase as notable levels of employment are not expected during this phase.

Construction and Operation

The Construction and Operation phases of the Project are not anticipated to have differing implications for family and household function. Overall, Project employment has the potential to cause changes to family and household function, specifically, the absence of one or more parents in the household may have implications for family structure. This is expected as a result of Project employment and the fly-in/fly-out operation of the Project. The potential for one or both parents to be away from the family for extended periods of time is especially relevant for Inuit as a result of the heightened value of the family unit within Inuit culture. There may be both positive and negative effects associated with this change.

The positive effects of the Project for individuals and families are mainly linked to productive employment and increased income. It is generally accepted that increased income as a result of employment results in standard of living increases. However, there may be a number of implications for families with one or more individuals engaged in Project employment (InterGroup Consultants 2005). For example, if one parent is away from the home, the remaining parent may find they have an increased workload as the sole parent and additional household responsibilities.

Recent research (InterGroup Consultants 2005) that details the implications of fly-in/fly-out work rotation schedules describes the following potential effects for families and children:

- the increased strain on the remaining spouse of having to make decisions independently;
- increased worry and concern for absent family members;
- increased rates of family violence and break-ups;
- younger children may experience difficulty with a parent's absence, requiring a period of adjustment; and
- loneliness associated with separation from family.

Additionally, Project employment may create additional need for day care services within communities; however, an increase in daycare requirements would be coupled with increased income, which may also serve to relieve some economic stress currently experienced by families in the Kitikmeot Region.

Project employment, while generally positive, has the potential to result in strain on common law or martial relationships as a result of the prolonged separation of two individuals and the fly-in/fly-out operation of the Project. This is a particular concern for families in Nunavut as result of the heightened importance of family and social/marital relationships within Inuit culture. Mitigation such as measures

to ensure mine employees are able to remain in contact with their partner throughout their time at the Project site are summarized in Section 3.5.3 and detailed in the Human Resources Plan (Volume 10, Chapter 28). Further, a recent research study (InterGroup Consultants 2005) indicated that of those interviewed a majority of mine workers and their spouses felt their relationship was both positively and negatively affect by the fly-in/fly-out worker rotation schedule. Both mine employees and spouses expressed that they adjusted and got used to the arrangement over time.

Some families in the Kitikmeot, particularly Kugluktuk, have past experience with mine employment and various worker rotation schedules and will be familiar with Project work and routines. Lastly, families in the Kitikmeot Region have experienced prolonged separation for a number of reasons including other employment (including mine employment), travel for medical reasons (e.g., pregnancy), and lack of housing. Ultimately, some families have had prior experience adjusting to the absence of a family member, while others may have more difficulty adjusting to the shift rotation schedule.

Tension may be created within couples due the unhappiness associated with separation. This might include for example, loneliness, jealousy, and feelings of distrust, which have the potential to result in anger and associated negative behaviours. The EFAP will provide support to promote the management of both home and work life. Finally, Project employees will have extended periods of time to spend with their families during their two weeks off.

The work rotation schedule may also have implications for children in that the absentee parent is effectively away from the home while at work. Research suggests work rotation schedules are most difficult for families with young children and become easier as children get older (InterGroup Consultants 2005). The Project is expected to have an initial effect in this sense, as families become used to the work rotation schedule.

Overall, mine employment, increased incomes, and economic development are considered to have a positive effect on individuals, families, and communities. Understanding and mitigating potential undesirable outcomes of employment and increased incomes maximizes the potential benefits of the Project for all segments of the local population.

Reclamation and Closure/Post-Closure

Upon Project closure, Inuit mine employees that have increased their skill levels over the lifetime of the Project may choose to seek employment elsewhere in Nunavut and Canada. This scenario is not anticipated to be prominent due to the close knit family ties that exist in Inuit culture. As such, it is anticipated that most Kitikmeot residents involved with the mine will continue to reside the region upon Project closure.

Changes to family structure and function as a result of Project employment are expected to result from the fly-in\fly-out operation of the Project and work rotation schedule. Although some employment would continue to be available during these phases, Project employment is expected to largely come to an end following the Operation phase. Additional changes to family structure and function may take place during Reclamation and Closure as Project employees return home and begin their transition to other employment.

Temporary Closure/Care and Maintenance

Family structure and function may undergo further changes during a Temporary Closure or Care and Maintenance as employees return home and begin to transition to other employment. Having the absentee spouse back in the home may require adjustment but is not expected to have substantial

negative effects on individual, family, and community well-being. Experience and skills gained during Operation are expected to ease the adjustment.

3.5.4 Identification of Mitigation and Management Measures

The following section details mitigation and management measures designed to enhance Project benefits and reduce or eliminate adverse effects. Once these measures are taken into account the end result, or expected residual effect is characterized in Section 3.5.5.

Mitigation measures involve taking a tangible action to avoid, minimize, restore on-site or offset effects. Mitigation measures that are recommended to reduce an adverse effect are technically, environmentally, and economically feasible and aim to avoid, reduce, control, eliminate, offset, or compensate potential effects. The Project has been designed to reduce adverse effects by optimizing alternatives, incorporating specific design changes, following best practices, and enhancing benefits.

The following sections detail mitigation measure proposed to reduce the potential Project effects of each of the VSECs.

3.5.4.1 Economic Development

Overall, the effects of the Project on local, regional, territorial, and national economic development are anticipated to be positive. The Project will make contributions to GDP, territorial and federal tax bases, as well as royalties and other monies to regional Inuit associations. These contributions generally serve to promote economic prosperity and facilitate a greater degree of economic activity than would be possible without the Project.

Management practices, monitoring, and adaptive management, as well as enhancement measures will be implemented to enhance the potential effects on economic development. Specifically, the Business Development Plan and Human Resources Plan (Section 3.8.1.1) detail enhancement measures that together aim to increase the benefits of the Project on economic local and regional development (see also Volume 10, Chapter 24 and 28). These measures are based on industry best practices and regional practices that address concerns identified by regulators and community members in scoping meetings, public meetings, and during community research and other stakeholder engagement.

Project effects to economic development include changes to economic growth and diversity. These effects will be enhanced through experience with the Project, support for local Inuit and northern businesses, capacity building, and through community investment. The Business Development Plan and Human Resource Plan detail measures aimed at increasing local access to employment and business opportunities, which together enhance local and regional economic development. The former aims to encourage the involvement of local and regional Inuit-owned businesses in Project work while the latter aims to enhance the employment, income, and education and training benefits available locally and regionally, while mitigating any related potential adverse effects associated with these benefits.

Essentially, mitigation to enhance business opportunities and employment for local Inuit together aim to enhance local and regional economic development. The Human Resources Plan (Volume 10, Chapter 28) and Business Development Plan (Volume 10, Chapter 24) describe the measures Sabina will follow to enhance business opportunities and employment for Inuit. These plans are summarized in Section 3.8.

3.5.4.2 Business Opportunities

Effects to local and regional business opportunities are anticipated to be positive. These effects are expected to culminate in a larger economic foundation from which local enterprises can build upon. Direct contracting opportunities associated with Project work and indirect business opportunities associated with increased local demand for goods and services are expected to have implications for the local economic context and regional business investment.

A number of measures are proposed to enhance the benefits of direct and indirect business opportunities that result from the Project. These measures are detailed in the Business Development Plan (Section 3.8.1.1; Volume 10, Chapter 24) and are focused to facilitate Inuit participation in business opportunities. The Project is anticipated to produce an increase in demand for goods and services directly, as a result of direct procurement, and indirectly, as a result of increased incomes, increased wealth in communities, increased demand by business involved with the Project or businesses that develop as a result of the Project. Measures to enhance Inuit participation in business opportunities associated with the Project are summarized in Section 3.8 and are detailed in The Business Development Plan (Volume 10, Chapter 24).

3.5.4.3 Employment

Effects to employment are anticipated to be positive at the local, regional, territorial, and national levels. Mitigation and management measures have been established to further enhance the effects of the Project on employment. These measures aim to increase Inuit participation in Project employment and are detailed in Section 3.8.1.1, Human Resource Plan (Volume 10, Chapter 28). The Human Resources Plan includes a number of strategies based on consultation with regulators, community members, Inuit groups (KIA), and in concert with best practices and recent mine experience in Nunavut. The strategies included in the Human Resources Plan that aim to enhance Project effects on employment include the following:

- Labour Relations Strategy;
- Preferential Recruitment Strategy; and
- Worker Transition Strategy.

The measures contained in these strategies aim to enhance employee retention and minimize worker turnover. Highlights of the Human Resources Plan include the Inuit Employment and Training Coordinator and the Financial Management Training. The Inuit Employment and Training Coordinator will act as a liaison for Inuit employees and will provide assistance in a number of areas, for example, in navigating the workplace, career development, and accessing employee benefits. The Financial Management Training Program aims to facilitate the transition into the workplace by assisting employees to develop monthly budgets, reviewing actions conducive to employment and promotion, and providing information about banking services.

The Project includes mitigation designed to provide open, early and transparent communication throughout the RSA regarding Project activities and related employment and recruiting requirements. The communication of Back River Project labour force needs and schedule will enable both individuals and employers to make informed and proactive decisions with respect to careers and staffing. These measures are defined by the Human Resources Plan (Volume 10, Chapter 28) and the Community Involvement Plan (Volume 10, Chapter 26).

3.5.4.4 Education and Training

Effects of the Project on education and training are anticipated to be positive at the local and regional levels. Potential changes to the education and training levels are anticipated as well as changes to the capacity of education and training institutions including available funding levels. As part of the Human Resources Plan, a Workforce Training Strategy is proposed (Section 3.8.1.1; Volume 10, Chapter 28) that details measures to enhance Project benefits related to education and training. Objectives of this strategy are similar to those discussed previously and include enhancing the number of skilled Inuit, the number of Inuit employed with the Project, and employee retention generally.

Education and training will take place throughout the life of the Project through ongoing relationships with the NAC, the Kitikmeot Regional high schools, Kitikmeot School Operations, the GN Department of Education and other relevant training consortiums and organizations. Further details are provided in the Human Resources Plan, which includes the Workforce Training Strategy (Volume 10, Chapter 28).

3.5.4.5 Health and Community Well-being

Effects of the Project on health and community well-being are anticipated to be varied, both positive and negative. Community well-being is an issue of importance and of concern in the Kitikmeot communities. Current issues affecting community well-being include food security, unemployment, substance abuse, and suicide. Many programs are in place within the Region to promote community well-being (see Section 3.1.2.7 or Appendix V8-3A for further details). The effects of the Project as they relate to community well-being are primarily linked to Project employment and increased incomes. The manner in which individuals choose to spend their incomes is ultimately dependent on individual choice. Measures to steer individual decision making have been established to enhance the benefits of the Project and of increased income and employment. The objective of these measures is for Project employees to make choices their families and community will support.

Potential effects to community well-being include changes to the life skills of individuals, changes to individual and family spending, and changes to family/household structure. Individuals engaged in Project employment may have access to a number of services including the Inuit Employment and Training Coordinator, counsellors, and other support, as well as the Financial Management Program. The objective of these services is to facilitate Inuit inclusion in mine employment in a way that melds with and is complimentary to Inuit culture, and can be maintained in the long term.

In addition to the Inuit Employment and Training Coordinator and other services that will be available to Inuit employees at the Project site to promote worker well-being, a socio-economic monitoring program that will be implemented using an adaptive management approach has been created to oversee the effects of the Project on community well-being (among others). The adaptive management approach enables quick response where applicable to change management strategies in place to meet the dynamic need of Project employees and their families as they arise. The monitoring program identifies a number of socio-economic indicators important to Kitikmeot residents to be monitored throughout the life of the Project. Any change to these indicators from baseline conditions will be reviewed, analysed, and reported on. Reporting requirements enable discussion as to whether or not additional action or mitigation needs to be established or updated to better address Project effects or to better enhance Project benefits. The discussion and review of these items takes place between the NIRB, community stakeholders, and others. Further details of the monitoring program and approach of adaptive management are provided in Section 3.9 (see also Volume 10, Chapter 23).

3.5.5 Characterization of Residual Effects

The following section characterizes the residual effects of the Project on the socio-economic VSECs. Each potential effect is examined as related to one of the corresponding five VSECs. It is acknowledged that, for the most part, the Project activity influencing the effects discussed in this section is direct employment and procurement. Residual effects that are determined to be negative are further rated for significance in Section 3.5.6. However, positive residual effects are not further evaluated.

3.5.5.1 Economic Development

Changes to Economic Growth, Diversity, and Performance

The Project is expected to increase economic growth, diversity, and performance. Enhancement measures have been established to retain benefits locally and to support local communities in realizing the substantial positive benefits of the Project. Contributions to GDP and tax revenues would be substantial. Increased economic growth is anticipated to have positive residual effect on the VSEC Economic Development. The Project has the potential to reshape the economy of the Kitikmeot, as one that is increasingly experienced and diverse, and able to support various types of development. Increased economic growth, diversity, and performance are expected to have a positive residual effect on the VSEC Economic Development.

3.5.5.2 Business Opportunities

Changes to the Growth and Diversity of Inuit and Northern Businesses

The Project is anticipated to result in the growth and diversity of Inuit and northern business as linked to Project related expenditure, contract, and sub-contract work. Enhancement measures have been established to maintain the benefits of the Project locally and to support the development of local businesses. Changes to the growth and diversity of Inuit and northern business are anticipated to have a positive residual effect on the VSEC Business Opportunities.

3.5.5.3 Employment

Changes to Income and Employment Levels

The Project is anticipated to increase employment and income levels within the Kitikmeot Region and Nunavut, as well as elsewhere in Canada. Enhancement measures have been developed to retain the benefits of the Project for local residents. The provision of employment opportunities has the potential to result in substantial positive benefits for the Kitikmeot. Increased income and employment levels are anticipated to have a positive residual effect on the VSEC Employment.

Changes to the Capacity of the Labour Force

The Project is anticipated to increase the capacity of the labour force in the Kitikmeot Region. At present, Kitikmeot residents face a number of barriers to employment including lack of experience and opportunity. The Project has the potential to alter outcomes for those who become employed directly or indirectly, increasing the ability of individuals and communities to engaged in the wage economy. Enhancement measures developed to engage as many Kitikmeot residents as possible seek to maximize Project benefits locally. The increased capacity of the labour force is anticipated to have a positive residual effect on regional levels of employment generally, and on the VSEC Employment.

Changes to the Competition for Local Labour

The Project is anticipated to result in increased competition for local labour for a limited number of specific comparable job categories, primarily within the LSA communities (e.g., truck drivers and heavy equipment operators currently residing in Kugluktuk and Cambridge Bay). While Project employment may be perceived as presenting a viable opportunity for those presently employed, this effect is not expected to be widespread. Overall, the number of individuals that choose to leave current employment within the Kitikmeot is anticipated to be negligible and isolated to a few individuals. Therefore, a residual effect is anticipated and is further rated for significance in Section 3.5.6.

3.5.5.4 Education and Training

Changes to the Demand for Education and Training

The Project may create increased demand for education and training programs as a result of the provision of employment and contracting opportunities. There is regional capacity in the NAC to provide increased training opportunities with support from the Project. Challenges to the provision of increased education and training programs was been reviewed (Section 3.5.3.4). A number of enhancement measures have been presented describing the actions the Project would take to support and assist in overcoming challenges associated with this increased demand. Overall, increases to the demand for education and training are considered to have a positive residual effect on the VSEC Education and Training.

Changes to Youth Attitudes and Behaviour toward Education and Training

The Project has the potential to change youth attitudes toward education and training through the modelling of behavior and changes to the employment status of local residents. Baseline research reported that youth currently experience a disconnect between the value of education and the realization of employment benefits due to the lack of local employment opportunities in communities. Consequently, youth experience difficulties linking their efforts in school to the reward of employment. Should a notable number of local residents become employed with the Project, youth may experience or witness the connection between education and employment as adults begin to upgrade their skills or participate in training for employment with the Project. The shift in youth attitudes may serve to increase participation in education and interest in school generally. This change in youth attitudes toward education and training is considered as a positive residual effect on the VSEC Education and Training.

3.5.5.5 Health and Community Well-being

Changes to the Life Skills of Individuals

The Project is anticipated to increase the life skills of individuals who obtain Project-related employment. Engagement in economic productive work, the management of finances, and responsibility associated with employment are expected to assist with or support decision making and increase life skills. Enhancement measures have been developed to promote the retention of positive Project effects locally including those aimed to increase the number of Inuit employed (e.g., EFAP, financial management counselling). Increased life skills are considered positive and are anticipated to have a residual positive effect on the VSEC Health and Community Well-being.

Changes to Individual and Family Spending

The project is anticipated to cause changes to individual and family spending as a result of employment and increased incomes. How individuals choose to spend their income dictates whether the outcome of

this residual effect is positive or negative for the VSEC Health and Community Well-being. Should local residents that obtain employment with the Project choose to spend their increased incomes on drugs and alcohol and engage in negative social behaviors, the Project could be perceived as having a negative effect on community well-being. Research indicates that this behavior does not materialize in most mine employees. To this end, and in addition to the currently available supports, the Project has developed a number of mitigation measures specifically for Project employees and their families and will actively promote positive decision making in terms of alcohol and drug use and other negative social behaviours.

Project employment and increased income has the potential to result in numerous benefits that would contribute to individual, family, and community health and well-being. While these decisions are also based on individual choice, examples of positive decision making and outcomes might include increased spending on equipment for harvesting or groceries, reducing higher than average levels of food insecurity, or increased savings for larger purchases, old age, or children's education.

Spending decisions are ultimately at the discretion of the individual. Positive spending decisions have been described as those that would be supported by one's family and community. While it is beyond the ability of the Project to control decision making, mitigation aims to influence decision making towards positive outcomes. The outcome of changes to individual and family spending can only be seen in time. The adoption of the adaptive management approach further allows the Project to monitor the social outcomes of the Project and adjust mitigation and management strategies with the aim of increasing Project benefits and decreasing adverse effects.

For the reasons described, both positive and negative changes to individual and family spending are expected. Changes to spending are expected to differ by individual, that is, the effect might be positive or some and negative for others. Some individuals may only ever experience positive effects as related to increased income and Project employment. The provision of support programs, coupled with modelling behavior, financial management, and the EFAP are in place and aim to support those individuals who do struggle with these issues. The Project will continue to work to enhance the number of Project employees who experience this effect in a positive way. Due to the potential for some individuals to experience a negative outcome, this effect is further rated for significance in Section 3.5.6.

Changes to Family and Household Structure

The Project is anticipated to cause changes to family and household structure as a result of Project employment. Most notably, the periods away from the home while on shift and the social stressors that this can bring to family relationships due to the separation (and periodic re-introduction) can lead to or exacerbate relationship and family issues. These changes are especially important to Inuit due to the heightened importance of the family unit within Inuit culture. Mitigation has been established to assist families with the transition to gainful Project employment. Although the families of those engaged in Project employment may experience some disadvantages, such as increased workload for the spouse that remains in the home or need for childcare services, the benefits of Project employment can outweigh these potential challenges that can be addressed in a number of ways. Overall, changes to family and household structure are expected to result in a negative residual effect, and is further rated for significance in Section 3.5.6.

3.5.6 Significance of Residual Effects

Residual effects that have been assessed as positive (including those effects on Economic Development, Business Opportunities, Employment, Education and Training, and Health and Community Well-being detailed above) are not further assessed for significance. The effects assessment methodology is detailed in Volume 9, Chapter 1 and is also summarized in Section 3.5.1, above.

The Project is anticipated to result in residual effects on the VSECs Employment, and Health and Community Well-being. Specifically, the Project is expected to result in competition for local labour effecting Employment as well as changes to individual and family spending and changes to family and household structure effecting health and community well-being.

Changes to individual and family spending are expected to result in both positive and negative outcomes. While mitigation is in place to enhance the positive aspects of this effect and to further reduce the likelihood of negative outcomes, the precautionary approach necessitates inclusion of this effect for further assessment and significance rating.

The following sections assess the significance of the residual effects of the Project. Summaries of the assessments are provided in Tables 3.5-18 and 3.5-19.

3.5.6.1 Employment

The provision of Project employment is expected to produce substantial benefits in the Kitikmeot Region. These employment opportunities may result in competition for labour locally as a result of the demand for skilled labour and the higher than average incomes often associated with mine employment.

Changes to Competition for Local Labour

This effect is expected to be negative in direction and low in magnitude. The magnitude is assessed as low because the expected competition for labour is anticipated to be minimal and to affect a small number of operations/businesses. The duration is anticipated to be medium term as there is potential for competition to local labour throughout the life of the Project. The equity of this effect is determined to be neutral. The frequency is expected to be sporadic as the effect not expected to occur continuously and has limited applicability[8].

The geographic extent is expected to be largely limited to the LSA. The effect is reversible and exists only as an indirect effect of employment. There is a moderate probability that this affect will occur and a medium level of confidence is provided based on past experience. For example, as noted earlier, in past experience a small number of Cambridge Bay residents left their employment to obtain employment with the Doris North Project. Therefore, the effect 'changes to competition for local labour' is determined to be **Not Significant**. This significance rating is based on the low magnitude, limited geographic extent, and the reversible nature of the effect.

3.5.6.2 Health and Community Well-being

Effects to health and community well-being are a concern as communities in the LSA and RSA already face a number of challenges as they continue to traverse the integration of Inuit culture and western economic and governance systems. Notably, the challenges to health and well-being under discussion (i.e., changes to individual and family spending) stem from the same direct Project impact (employment) that also makes possible the achievement of great increases to health and community well-being.

[8] There is limited applicability as the number of individuals expected to leave to their current employment for Project employment is anticipated to be minimal considering the limited number and type of operations/businesses in the RSA communities that would be affected.

Table 3.5-18. Summary of Residual Effects and Overall Significance Rating for Employment

	Significance Criteria				Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	**Direction** (positive, neutral, negative)	**Magnitude** (low, moderate, high)	**Duration** (short, medium, long)	**Equity** (equitable, neutral, inequitable)	**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)**
Changes to Competition for Local Labour	Negative	Low	Medium Term	Neutral	Sporadic	LSA	Reversible	Moderate	Medium	N

Table 3.5-19. Summary of Residual Effects and Overall Significance Rating for Health and Community Well-Being

	Significance Criteria				Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	**Direction** (positive, neutral, negative)	**Magnitude** (low, moderate, high)	**Duration** (short, medium, long)	**Equity** (equitable, neutral, inequitable)	**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)**
Changes to Individual and Family Spending	Positive/ Negative	Moderate	Short/ Medium Term	Neutral	Continuous	LSA/RSA	Reversible	Moderate	Medium	N
Changes to Family Household Structure	Negative	Low	Medium Term	Neutral	Continuous	LSA/RSA	Reversible	Moderate	High	N

Changes to Individual and Family Spending

This effect may be either positive or negative and is dependent on choices made by individuals. Both positive and negative changes to individual and family spending have the potential to have a moderate magnitude, that is, to affect a number of households. However the magnitude of this effect is dependent on the number of Kitikmeot resident that obtain Project employment.

The positive aspects of this effect have the potential to be long term in duration. That is, income used to improve standards of living (e.g., improvements to housing, food security) coupled with the other numerous positive effects associated with Project employment have the potential to result in substantial increases to community well-being that may extend beyond the life of the Project. The negative aspects of this effect have the potential to last throughout the life of the Project, and more specifically throughout the duration of employment. For that reason, the potential negative outcomes of individual and family spending are determined to have either a short or medium duration.

Equity is determined as neutral for both the positive and negative potential outcomes of this effect. The positive outcomes associated with this effect are expected to be continuous as they would occur throughout the life of the Project. The negative outcomes of this effect have the potential to be continuous (to occur over the life of the Project); however, the ability to maintain employment while engaging in negative social behaviours such as substance abuse is questionable. The geographic extent of the effect is the same for both positive and negative outcomes and consists of all RSA communities. The geographic extent of this effect will depend on the residence of those who obtain Project employment. This effect is reversible for the negative aspects of changes to individual and family spending. That is, negative social behaviors (e.g., substance abuse, gambling) depend on employment and increased income. The removal of Project employment and, therefore, increased income, is expected to reduce to the extent to which continued participation in negative social behaviours is possible. Similarly, the end of Project employment would suspend the ability of individuals and families to continue to spend their Project-related incomes.

Positive changes to individual and family spending are very likely for some if not most that become involved in Project employment. A probability rating of moderate is provided for potential negative changes to individual and family spending, as the real outcomes of this effect are based on the choices of individuals and families. A medium level of confidence is provided for both positive and negative changes to individual and family spending.

Negative changes to individual and family spending are determined to be **Not Significant.** This determination is based on the reversible nature of the effect, and the short to medium term duration. Finally, although specific data is unavailable, the number individuals currently struggling with substance abuse is thought to be notable in the communities but relatively low. That is, community research indicated that substance abuse is an important issue affecting some individuals and families, but is not widespread, affecting the majority of individuals within a community. The social extent of this effect is limited.

Changes to Family and Household Structure

The direction of this effect is expected to be negative as a result of the heightened importance of and value on the family unit in Inuit culture. The magnitude of this effect is considered low, as the employment opportunities directly with the Project are estimated to equate to less than approximately 4% of the active labour force - or in other words, a small number of households. The duration is expected to be medium term or within the life of the Project. This effect is limited to Project employees and their families.

The frequency of this affect will be continuous and is expected to be concentrated with the LSA, though this effect will extend into the RSA should individuals in the eastern Kitikmeot obtain Project employment. This effect is reversible as it is dependent on Project employment.

There is a moderate probability that this effect will occur. A high confidence is provided as it is expected that most families will require a period of adjustment if one or more family members obtains Project employment. Overall, this effect is determined to be **Not Significant** because the magnitude is low and the effect is reversible. The determination is further supported as the effect does not extend beyond the life of the Project and is only applicable for individuals who receive the corresponding benefit of employment.

3.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

The Project is anticipated to have residual non-significant effects on the VSECs Employment, and Health and Community Well-being. There is one residual effect to Employment, specifically 'changes to competition for local labour' and two residual effects to health and community well-being, 'changes to individual and family spending' and 'changes to family/household function'.

For each identified residual Project effect, a cumulative effect may occur if the same community members or organizations are affected by additional projects or human activities that have similar effects. More specifically, this assessment focuses on other Projects that may affect those who are expected to be affected by the Project.

3.6.1 Methodology Overview

The Cumulative Effects Assessment (CEA) was carried out in compliance with Section 7.11 of the EIS guidelines (NIRB 2013a) and follows a process similar to that used for the effects assessment. Consideration was given to the following factors when conducting the CEA:

- a regional spatial boundary (i.e., the socio-economic RSA);
- a longer temporal scale – the CEA will examine potential effects with past activities whose effects have already occurred, existing activities whose effects are known, and future activities, who effects are uncertain but have a reasonable potential to interact with the effects of the Project;
- consideration for the socio-economic VSECs and residual effects; and
- evaluation of significance of identified cumulative effects.

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 judgement was used (based on previous experience in similar geographic locations) to approximate expected socio-economic conditions. Project and activities to be considered in the CEA for the 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) project and activities occurring within the outer geographical limit of possible interaction with the Project.

Data sources that contributed to the identification of projects to be considered in the CEA included: the draft Nunavut Land Use Plan (NPC 2012); registered exploration mining permits; active projects on NIRB's website; projects listed on the Mackenzie Valley Environmental Impact Review Board website; the Canadian Centre for Energy Information; Natural Resources Canada website; AANDC website; and individual resource development company and project-specific websites.

The socio-economic profile of the area was also considered and identified by review of the *2012 Socio-economic and Land Use Baseline Report* (Appendix V8-3A) and the Project TK report (KIA 2012).

3.6.1.1 Approach to the Cumulative Effects Assessment

The CEA followed a series a steps that prescribed by Hegmann et. al. (1999) in the *Cumulative Effects Assessment Practitioners Guide* and included the following:

- defining boundaries – within which the residual effects of this Project might interact with the residual effects of other Projects and human activities;
- identifying other relevant activities – to identify other Projects and human activities whose effects may interact with the residual effects of the Project;
- scoping of effects – determine the potential for Project-related residual effects to interact with residual effects from other human activities and projects within the specified assessment boundaries;
- designing mitigation – to eliminate, avoid, reduce, control, offset, or compensate for potential cumulative residual effects; and
- significance – analyse cumulative residual effects that remain after mitigation and define each effect by providing a significance rating.

3.6.1.2 Spatial and Temporal Boundaries Used for the Cumulative Effects Assessment

The CEA will focus on the RSA communities which include Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk.

The spatial boundaries used for the CEA include those Projects and human activities in the Kitikmeot and the NWT considered to have potential effects within the socio-economic RSA that are relevant to current residents. That is, Projects whose effect cannot reasonably interact with the socio-economic effects of the Project due to the projects location have not been included in this assessment.

The temporal boundary used for the CEA includes those projects and human activities considered to have residual effects that may act on current residents that are also affected by the Project as defined by the phases of the Back River Project (i.e., there is temporal overlap).

3.6.1.3 Scoping of Past, Existing, and Future Projects for Inclusion in the Cumulative Effects Assessment

The scoping of past, existing, and future projects for inclusion in the CEA followed the Assessment Methodology described in Volume 9, Chapter 1. Cumulative effects can occur when potential residual effects of the Project combine with the past, current, or future effects of other projects and/or human activities relevant to the study area. When effects from the Project and other activities combine, the consequences of the initial effect may be more extensive. For example, multiple projects that are not individually a major user of local services may collectively comprise to be a major user of local services. Therefore when combined they would produce different, notably larger, effects on the

availability and quality of services for residents as compared to those predicted for each individual project.

This section identifies the past, present, reasonably foreseeable future activities that, along with the Project, were assessed to determine potential cumulative effects on residents. The CEA will be further focused to projects and activities where is there is an anticipated cumulative interaction with the residual effects of the Project. The following sections provide a review of other projects potentially relevant to the CEA and rationale for their inclusion or exclusion in the evaluation of cumulative effects.

Past Projects and Activities

A number of past projects in both Nunavut and the NWT have had effects that require consideration related to the potential socio-economic effects of the Project. These are summarized in Table 3.6-1.

Based on the review of projects listed in Table 3.6-1, there is one past project that may be relevant to the identified residual Project effects on VSECs Employment and Health and Community Well-being, specifically:

- Jericho.

Jericho is included in the CEA because this project was operational recently and may have effected or influenced:

- competition for local labour;
- individual and family spending; and
- family and household structure.

Recent research describes both challenges faced by employees and their families during their employment at Jericho. The same reports also suggests that employed individuals have limited interest in leaving their full-time community based employment for temporary mine employment (Brubacher Development Strategies 2009).

The Lupin project is excluded as the majority of Lupin employees where from outside the Kitikmeot Region. Specifically, the communities of Lutselk'e, Rae-Edzo, Rae Lakes, Wha Ti, Wekweti, Dettah, Ndilo, and Yellowknife were considered as capturing most of the socio-economic benefits and effects.

The Roberts Bay project is excluded from the CEA because it this project has not been operational for almost 40 years and, therefore, is not expected to have the potential for temporal overlap with the Back River Project. The Tundra and Salmita projects, which have been inactive for over two decades, are also excluded from the CEA as both are located in areas that do not overlap with the socio-economic LSA or RSA. The Tundra project is currently in care and maintenance and the Salmita project has concluded remediation.

Existing Projects

A number of existing projects in both Nunavut and the NWT have been reviewed to determine whether their effects may act cumulatively with the effects of the Back River Project. Each of these projects is summarized in Table 3.6-1.

Table 3.6-1. Past, Existing and Future Projects and Activities Whose Effects May Interact with Residual Effects of the Project

Project	Location/ Development Type	Company/ Organization	Location/ Coordinates	Distance to Goose Property	Description	Operational Period	Status
PAST PROJECTS AND ACTIVITIES							
Lupin	Nunavut - 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 use if Ulu deposit is developed.
Jericho	Nunavut - Diamond Mine	Shear Diamonds Ltd.	65° 59' N 111° 28' W	238 km	Former diamond mine located 255 east of Kugluktuk	2006 to 2008	Currently in care and maintenance. All project work has been halted.
Roberts Bay and Ida Bay	Nunavut - Silver Mine	Quantum Murray LP	68° 10' 45" N 106° 33' 29" 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.
Tundra	NWT - Gold Mine	Indian and Northern Affairs Canada	64° 11' N 111° 33' W	290 km	Underground mine workings, mill, tailings containment	1964 to 1968; reopened briefly in 1990s	Care and maintenance. Remediation plan is being developed
Salmita	NWT - Gold Mine	Giant Yellowknife Mines Limited	64° 36' N 114° 21' W	297 km	Underground mine workings	1984 to 1989	Remediated.
EXISTING PROJECTS AND ACTIVITIES							
Doris North (Hope Bay Belt)	Nunavut - Gold Mine	TMAC Resources	68° 09' N 106° 40' W	279 km	Airstrip, accommodation buildings, dock for shipping, tailings facility	Mine site construction 2009 to 2011	Currently in care and maintenance
Ekati	NWT - Diamond Mine	Dominion Diamond Ekati Corporation (Dominion Diamonds, Chuck Fipke and Stu Blusson)	64° 44' N 110° 36' W	226 km	Canada's first and largest diamond mine, 310 km NE of Yellowknife. Open pit and underground. Mine life to 2019. Workforce of approx. 1,500.	1998 to 2020	News release updated Q1 results for Dominion. Reserves released April 24.
Diavik	NWT - 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 in 2012. Workforce approx. 1,000.	2003 to 2025	Diavik produced 1.9 million carats from 0.5 million tonnes of ore in Q4, bringing 2012 production to 7.2 M carats from 2.1 million tonnes of ore processed (up from 6.7 million carats from 2.2 million tonnes of ore processed in 2011 - Rio Tinto cancelled plans to sell diamonds business.
Snap Lake	NWT - Diamond Mine	De Beer Canada Inc.	63° 35' N 111° 15' W	310 km	Canada's First all underground diamond mine. 220 km NE of Yellowknife. Mine life to 2028. Workforce approx. 750.	Construction began In 2005. Mine officially opened on July 2008. 22 year mine life	Commercial production began January 2008 and the official mine opening took place July 2008
FUTURE PROJECTS AND ACTIVITIES							
Bathurst Inlet Port and Road (BIPR)	Nunavut - 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	Construction expected to begin 2017 Operation for 20 years	In NIRB process. Updated DEIS to be submitted in 2013.
Hackett River	Nunavut - Base metal mine - 25 km spur road to BIPR road	Glencore Xstrata	65° 55' N 108° 30' W	94 km	Proposed open pit mine. 104 km SSW of Bathurst Inlet. Access road from BIPR; estimated construction jobs: 900; estimated mine jobs: 500.	Estimated 15 year mine life	Pre-feasibility and environmental baseline studies. DEIS submission currently on hold.
Hope Bay Belt (Phase 2)	Nunavut - Gold Mine-Extension of Doris North Gold Mine	TMAC Resources	68° 09' N 106° 40' W	279 km	Proposed gold mines 130 km S of Cambridge Bay. Estimated mine jobs: 300.	15 years of operation	Project Description submitted in 2011 DEIS guidelines issued in 2012. NIRB confirms reassignment of Project Certificate for Doris North to TMAC April 2013.
Izok Corridor Project (Grays Bay Port, High Lake, Izok)	Nunavut - 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° 25'9 W (Dock)	288 km -Izok/High Lake 309 km -Grays Bay Port	Two mine Properties – High Lake and Izok. Estimated construction jobs: 1,140. Estimated mine jobs: 710.	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 examining alternative designs to reduce costs, add value, and improve economic viability of the Project, and are to provide a revised project description by December 2013.
Canadian High Arctic Research Station (CHARS)	Nunavut - Arctic Science and Technology Centre	Aboriginal Affairs and Northern Development 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. Development includes sub-division to house employees and their families	Design and Construction 2011-2017; Operations 2017 and onwards	Government of Canada announced commitment to a world class high Arctic research station and residential sub-division in November of 2007. Feasibility study issued in March 2011. Cambridge Bay community met with the Project architects in June 2013.
Gaucho Kué	NWT - Diamond Mine	De Beers and Mountain Province	63° 30 N; 109° 30' W	257 km	Proposed open-pit mine approx. 180 km ENE of Yellowknife, NT. Estimated mine jobs: 360.	Construction to begin 2014. Est. 11 year mine life.	Gaucho Kué Joint Venture and NWT Gov't signed socio-economic agreement June 28.
Courageous Lake	NWT - Gold Mine	Seabridge Gold	64° 11 N	290 km	Proposed open pit mine 240 km NE of Yellowknife. 6.5 million oz. proven and probable reserves. (Positive Preliminary Feasibility Study July 2012).	Construction expected to begin in 2014. Estimated 11 year mine life. Prefeasibility	New 5-year land use permit issued December 28 to allow up to 700 drill holes.

Based on review of the projects listed in Table 3.6-1, all exiting Projects are included in the socio-economic CEA. This inclusion is based on: 1) the potential that these projects may have resulted in competition for local labour, and 2) the potential that Kitikmeot residents are presently or have previously been employed by one or more of these projects and may have experienced changes to individual and family spending and/or changes to family and household structure. Therefore, the projects that are relevant for the Employment and Health and Community Well-being VSECs are:

- Doris North - previously employed a number of community members from the LSA; however, this project is currently in care and maintenance.
- Ekati – which may presently or have previously employed a number of Kitikmeot residents of the LSA.
- Diavik - which may presently or have previously employed a number of Kitikmeot residents of the LSA.
- Snap Lake - which may presently or have previously employed a number of Kitikmeot residents of the LSA.

Foreseeable Future Project and Activities

A number of foreseeable future projects in both Nunavut and the NWT have been reviewed to determine the potential for cumulative effects with the Back River Project. Each of these is summarized in Table 3.6-1.

Based on review of projects listed in Table 3.6.1, there are four future projects and one other activity that are relevant to the VSECs Employment, and Health and Community Well-being.

- Bathurst Inlet Port and Road (BIPR);
- Hackett River;
- Hope Bay Belt (Phase 2);
- Izok Corridor; and
- Canadian High Arctic Research Station (CHARS).

The BIPR, Hackett River, Hope Bay Belt, and Izok Corridor projects have the potential to contribute to local employment affecting competition for local labour, individual and family spending, and family and household structure. These proposed mine and mine-related projects have the potential to result in residual effects that are similar to the residual effects of the Back River Project, thus creating the potential for cumulative effects. Note that these other project proponents are expected to establish similar mitigation measures to avoid or minimize these effects.

There is potential for the Back River Project to result in cumulative effects on competition for local labour in combination with the CHARS facility. CHARS is the development of a science and technology research hub that would introduce approximately 30 to 35 researchers and their families as permanent residents of Cambridge Bay. Construction of the facility and residence to house researchers and their families will take place between 2013 and 2017 (AANDC 2013). The potential for interaction with the effects of the Project is characterized as follows:

- Changes in competition for local labour – cumulative effects are possible as CHARS construction takes place over the same period of time (2013 to 2017) as the construction of the Back River Project (2015 to 2016), creating higher demand for construction-related workers such as heavy

equipment operators, truck drivers, and general labourers in Cambridge Bay. Some additional but comparably minimal strain may occur during the operation of the CHARS facility as the facility and new residence will create a general increase in the level of community services (e.g., water, sewer) required. For example, additional water and sewage truck drivers may be needed in Cambridge Bay if demand for truck drivers is increased by CHARS and individuals presently doing this work become interested in employment with the Back River Project, or other potential mine projects in the region.

- The Project is not anticipated to result in a cumulative effect on competition to labour as related to CHARS employment because skills sets for mine employment and CHARS employment are not similar.
- CHARS is not relevant to the CEA of the Project for changes to individual and family spending as CHARS does not aim to provide substantial local employment (expected to be staffed mainly by external hires).
- CHARS is not relevant to the CEA of the Project for changes to family and household structure as CHARS does not aim to provide local employment and further is not located away from the community.

In sum, the introduction of this facility and additional residents is not anticipated to have effects that are similar to the residual effects of the Back River Project on health and community well-being. That is, CHARS is not anticipated to cause changes to individual and family spending or family and household structure. The potential for CHARS to have cumulative effects related to competition for local labour is further assessed below.

Gaucho Kué and Courageous Lake are excluded as hiring preferences for these projects would first be given to residents of the northeastern NWT First Nations and Métis communities. Hiring from the Kitikmeot communities will not be a focus of these projects.

3.6.2 Potential Interactions of Residual Effects with Other Projects

With respect to socio-economic effects, the following VSECs were considered in the CEA:

- Employment; and
- Health and Community Well-being.

For the purpose of this CEA only negative residual effects were addressed. The majority of residual socio-economic effects assessed for the Project were deemed to be positive or beneficial in nature. In reviewing the socio-economic positive residual effects, none of these are expected to become negative when combined with existing, past and future projects. Therefore, these positive socio-economic effects are not further assessed in this chapter. For further information on CEA methodology refer to Volume 9, Chapter 1.

The following effects were determined as residual effects of the Back River Project:

- Employment
  - Changes to competition for local labour.
- Health and Community Well-being:
  - Changes to individual and family spending; and
  - Changes to family and household structure.

To assess the potential for cumulative effects on the health and community well-being of Kitikmeot residents the CEA will review one past project (Jericho), four current projects (Doris North, Ekati, Diavik, Snap Lake), and four future projects (BIPR, Hackett, Hope Bay Phase 2, and Izok Corridor). To assess the potential for cumulative effects on Employment the CEA will also review these past, existing, and future projects as well as the CHARS. The following sections consider the residual effects of the Project in relation to the effects of projects identified for inclusion in the CEA.

3.6.2.1 Employment

Changes to Competition for Local Labour

The Project's potential effect on competition for local labour is primarily an indirect effect of Project employment and procurement. As a result of the demand for skilled labour and the relatively high wages associated with mine employment, skilled workers and others presently employed within the socio-economic LSA may have interest in Project employment. This may result in a loss of skilled employees or demand for higher wages within the socio-economic LSA. However, this effect is expected to be minimal is only applicable to a small number of individuals with the requisite skill set and interest.

Past and existing projects result in the conditions noted at baseline (Appendix V8-3A), which indicated a present need for additional skilled labour. The development of the Project and one or more future projects may result in cumulative effects on competition for local labour. Mitigation has been developed to reduce this effect and is described in Section 3.6.3.

3.6.2.2 Health and Community Well-being

Changes to Individual and Family Spending

The Project's potential effect on individual and family spending is primarily an indirect effect due to increased employment and income levels. As personal income increases due to direct and indirect employment associated with the Project, residents of the LSA will have increased financial means to purchase drugs and alcohol, and participate in other potentially damaging social activities such as gambling. Direct employees are expected to come primarily (and as prioritised by the Project) from within the LSA; however, there is the potential that employees may be sourced from the RSA. Past and existing mine projects, and the associated provision of employment opportunities and higher than average incomes may have contributed to current individual and family spending patterns including spending that contributes to current levels of substance abuse and gambling.

A number of mitigation measures are planned by the Project to address this effect, specifically with direct Project employees as outlined in the Human Resources Plan and the Socio-economic Monitoring Program (Volume 10, Chapters 28 and 23).

In sum, there is potential for additional changes to individual and family spending within the Kitikmeot should other mine projects be developed and employ residents of the socio-economic LSA and RSA. However, as noted earlier, the available labour force may quickly become exhausted as those individuals able to retain employment become engaged in work with the Back River Project or other projects.

Changes to Family and Household Structure

The Project's potential effect on family and household structure is primarily an indirect effect due to increased employment. The fly-in/fly-out workforce rotation schedule of two weeks on/two weeks off will alter family and household structure for those engaged in Project employment as one or more family

member(s) would be away during their work shift. Direct employees are expected to come primarily (and as prioritised by the Project) from within the LSA; however, there is the potential that employees may be sourced from the RSA. The implications of time away for marital and parental relationships were described in Section 3.5.5.5. A number of mitigation measures are planned by the Project to address this effect, specifically with direct Project employees as outlined in Volume 10, Chapters 23 and 28.

3.6.3 Identification of Mitigation and Management Measures

Mitigation measures involved taking further action, where possible, to avoid or minimize negative cumulative effects on VSECs. Cumulative effects typically result from the combined effects of multiple developments and as a result the responsibility for their prevention and management is shared among the various projects that contributed to them. It is usually beyond the capacity of one party to implement all of the measures needed to reduce or eliminate cumulative effects. Key approaches to avoid, reduce, control, eliminate, offset, or compensate for potential cumulative effects include:

- Optimizing alternatives – preventing or reducing adverse cumulative effects by changing aspects of the Project. For example, should the BIRP Project be approved and developed, the Project would change its design and use this road rather than establishing project-specific winter road.
- Design changes – preventing or reducing adverse cumulative environment effects by redesigning aspects of the Project. For example, the use of winter roads only to avoid impacts to migrating caribou.
- Management Practices – eliminating, minimizing, controlling, or reducing adverse cumulative effects on VSECs through management practices. For example, consulting with non-traditional land users to facilitate undisturbed day trips, where feasible. One further example, as a result of issues identified during community consultation, the Project will only ship during the open water season and will not break the ice in Bathurst Inlet.
- Compensation – offsetting remaining cumulative effects that cannot be prevented or reduced through remedial actions, so that the net effect is neutral or beneficial.
- Enhancement – providing measures to enhance a beneficial effect. An example of this is found in the fish-out program through which the fish in lakes to be dewatered are studied and provided to local communities. As a result, greater research on the function of lake ecosystems is facilitated, valued country food is not wasted, and positive relationships with local communities are promoted.

3.6.3.1 Employment

Changes to Competition for Local Labour

Specifically as it applies to the effect ‘changes to competition for local labour’, the Project includes mitigation designed to encourage the development of the local labour force through education and training, and to provide open, early and transparent communication throughout the RSA regarding Project activities and related employment and recruiting requirements. The communication of Back River Project labour force needs and schedule will enable both individuals and employers to make informed and proactive decisions with respect to careers and staffing. These measures have been previously described and are defined by the Human Resources Plan (Volume 10, Chapter 28) and the Community Involvement Plan (Volume 10, Chapter 26).

3.6.3.2 Health and Community Well-being

Changes to Individual and Family Spending

Community well-being is an issue of importance and of concern in the Kitikmeot communities. Many programs are in place within the Kitikmeot Region to promote community well-being (see Section 3.1.2.7 and Appendix V8-3A for further details). The effects of the Project as they relate to CWB are primarily linked to Project employment and increased incomes and changes to individual and family spending. The manner in which individuals choose to spend their incomes is ultimately dependent on individual choice. Measures to steer individual decision making have been established to enhance the benefits of the Project associated with increased income and employment. The objective of these measures is for Project employees to make choices their families and community will support.

Individuals engaged in Project employment have access to a number of services including the Inuit Employment and Training Coordinator, counsellors, and other supports such as the financial management program. The objective of these services is to facilitate Inuit inclusion in mine employment in a way that melds with and is complimentary to Inuit culture, and can be maintained in the long term.

Changes to Family and Household Structure

In addition to the Inuit Employment and Training Coordinator and other services that will be available to Inuit employees at the Project site to promote worker well-being, a socio-economic monitoring program that will be implemented using an adaptive management approach has been created to oversee the effects of the Project on community well-being. The adaptive management approach enables quick response where applicable to change management strategies in place to meet the dynamic need of Project employees and their families as they arise.

The Project would provide multiple means through which Project employees can remain in contact with the partners and families while away for work. Family supports available to Project employees include the EFAP and other services.

The Socio-economic Monitoring Program identifies a number of socio-economic indicators important to Kitikmeot residents to be monitored throughout the life of the Project. Any change to these indicators from baseline conditions will be reviewed, analysed, and reported on. Reporting requirements enable discussion as to whether or not additional action or mitigation needs to be established or updated to better address Project effect or to better enhance Project benefits. The discussion and review of these items takes place between the NIRB, community stakeholders, and others, as appropriate. Further details of the monitoring program and approach of adaptive management are provided in Section 3.9 and Volume 10, Chapter 23.

3.6.4 Characterization of Cumulative Residual Effects

With the additional effects of other projects in the area, residual cumulative effects on the VSECs Employment and Health and Community Well-being are anticipated, including:

- Employment
  - Changes to competition for local labour.
- Health and Community Well-being
  - Changes to individual and family spending; and
  - Changes to family and household structure.

In the characterization of cumulative residual effects, it is assumed that other resource development projects in the Kitikmeot and NWT would adopt mitigation and management measure similar to those of the Back River Project, where applicable.

3.6.4.1 Employment

Changes to Competition for Local Labour

The Project's potential effect on competition for local labour is expected to be minimal. However, the development of the Project, and one or more future projects may create more substantial strain in terms of competition for local labour. That is, should skilled individuals (e.g., heavy equipment operators, mechanics, and other trades people) terminate their community based employment to obtain mine employment as the result of the development of the Project and one or more future projects, a negative cumulative effect is expected. As noted previously, baseline conditions indicated a current shortage of skilled labour in the Kitikmeot communities. Past and existing mine projects may have contributed to this shortage. Mitigation in this instance is focused on development of the labour force and assisting communities in dealing with and preparing for the expected increase demand in labour. As a result, the Project is assessed as having the potential to result in cumulative residual effects on Employment due to increased competition for labour should one or more future projects be developed.

3.6.4.2 Health and Community Well-being

Changes to Individual and Family Spending

A number of mitigation measures have been developed to enhance positive individual and family spending and to avoid negative individual and family spending habits (Section 3.6.3-2). It is anticipated that other projects would adopt similar mitigation. However, recent research of past and existing mine projects associates the higher than average mine employment income with negative social behaviours. As noted earlier, it is expected that past experience with mine employment has contributed to the current challenges and concerns associated with substance abuse and other negative social behaviours. Experience with past mine employment is expected to act as a mitigation and to ease the transition to Project employment for some families.

The employment and income associated with the Back River Project and one or more future projects are expected to result in overall positive cumulative effects to health and community well-being; however, for some individuals there is also potential for negative cumulative effects to health and community well-being as a result of unproductive or negative individual and family spending (e.g., spending on drugs, alcohol, and/or gambling).

Changes to Family and Household Structure

The Project's potential effect on family and household structure is primarily an indirect effect due to Project employment and the fly-in/fly-out worker rotation schedule. The absence of one or more family members, specifically parental heads of family, is expected to cause changes to family and household structure of those Kitikmeot residents who become engaged in employment with the Project. Changes to family and household structure as a result of past and existing projects may have contributed to current concerns related to the breakdown of relationships and other family issues. Should the development of a one or more future projects proceed and also utilize a fly-in/fly-out worker rotation schedule for employees, which is expected, additional Kitikmeot families may experience change to family and household structure.

A number of mitigation measures have been developed to assist families with the transition to full-time employment based on a fly-in/fly-out work rotation schedule. Notably, the potential positive outcomes of

employment are numerous. The adjustment to the work schedule is anticipated to be easier for those families that already have experience with fly-in/fly-out work rotations, as is the case for many families in Kugluktuk. Essentially, past experience with mine employment is expected to have a mitigative impact associated with this effect. However, there is a potential for negative outcomes for some families who do not have previous experience with mine employment. The development of one or more additional projects is expected to increase the number of households that may experience a negative outcome as related to changes in family and household structure. For this reason, the Project is expected to have a residual cumulative effect on health and community well-being as a result of changes to family and household structure.

3.6.5 Significance of Cumulative Residual Effects

The Project is anticipated to result in residual cumulative effects on the VSECs Employment and Health and Community Well-being. Specifically, the Project is expected to result in competition for local labour effecting Employment as well as changes to individual and family spending and changes to family and household structure effecting Health and Community well-being.

The following sections assess the significance of the residual cumulative effects of the Project. Summaries of the assessments are provided in Tables 3.6-2 and 3.6-3.

3.6.5.1 Employment

Employment opportunities related to the Project and other projects may increase competition for labour locally as a result of the higher demand for skilled labour and the higher than average incomes often associated with mine employment.

Changes to Competition for Local Labour

This effect is expected to be negative in direction and low/moderate in magnitude. The magnitude is assessed as low/moderate because the expected competition for labour as a result of the Project is anticipated to be minimal, affecting a small number of organizations/businesses. However, should two or more future projects be developed, it is possible that additional individuals/businesses may be affected.

The duration is anticipated to be medium term as there is potential for competition to local labour throughout the life of the Project. The equity of this effect is determined to be neutral. The frequency is expected to be sporadic as the effect not expected to occur continuously and has limited applicability.

The geographic extent is expected to be the LSA, as currently, transport to the Project site has not been established in the eastern Kitikmeot. The effect is reversible and exists only as an indirect effect of multiple employment opportunities with different mine project.

It is unlikely that this effect would be experienced by more than a few organizations/businesses. The potential for this effect to be experienced by a large number of individuals is also rated as low. Even with the provision of multiple high income employment opportunities, the number of individuals with community-based employment who would be interested in mine employment is anticipated to be moderate. A medium level of confidence is provided as the certainty of future mine project development is unclear.

As such, the cumulative effect ‘changes to competition for local labour’ is determined to be **Not Significant**. This significance rating is based primarily on the low/medium magnitude and limited geographic extent ratings.

Table 3.6-2. Summary of Cumulative Residual Effects and Overall Significance Rating for Employment

	Significance Criteria				Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	**Direction (positive, neutral, negative)**	**Magnitude (low, moderate, high)**	**Duration (short, medium, long)**	**Equity (equitable, neutral, inequitable)**	**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)**
Changes to Competition for Local Labour	Negative	Low/ Moderate	Medium Term	Neutral	Sporadic	LSA	Reversible	Unlikely	Medium	N

Table 3.6-3. Summary of Cumulative Residual Effects and Overall Significance Rating for Community Well-being

	Significance Criteria				Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	**Direction (positive, neutral, negative)**	**Magnitude (low, moderate, high)**	**Duration (short, medium, long)**	**Equity (equitable, neutral, inequitable)**	**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)**
Changes to Individual and Family Spending	Positive/ Negative	Moderate	Short/ Medium Term	Neutral	Continuous	LSA/RSA	Reversible	Moderate	Medium	N
Changes to Family and Household Structure	Positive/ Negative	Low	Medium Term	Neutral	Continuous	LSA/RSA	Reversible	Moderate	Medium	N

3.6.5.2 Health and Community Well-being

Changes to Individual and Family Spending

Changes to individual and family spending are expected to have both positive and negative outcomes. There is potential for negative outcomes to affect a larger number of households with the development of additional future projects.

The Project is expected to result in both positive and negative outcomes as related to individual and family spending. The magnitude is anticipated to be moderate as either outcome denotes a notable change from baseline conditions and affects a number of households, but does not represent an extreme change beyond what has occurred in the past. That is, Kitikmeot Region communities have experienced changes to individual and family spending as result of mine employment in the past.

The duration of this effect may be either short term or medium term and is dependent on the retention of mine employment. The equity of the effect is determined to be neutral and the frequency continuous, given the retention of Project employment.

The geographic extent of this effect is primarily within the LSA but may extend to the RSA as dependant on employment patterns of the projects. This effect is reversible as the end of employment and income impedes further induced changes to spending.

The probability for cumulative effects to spending is moderate and a medium confidence is provided. Overall, this cumulative residual effect is determined to be **Not Significant** because the magnitude is moderate and is expected to be positive for some families. The non-significant determination is further supported as the effect is reversible and does not extend beyond the life of the Project.

Changes to Family and Household Structure

The direction of this effect is expected to be negative and the magnitude is expected to be low as the change from baseline conditions is expected to be notable but not extreme. The magnitude of this effect continues to be assessed as low. This rating is based on the following:

- Direct employment opportunities associated with the Back River Project are estimated to equate to less than 4% of the 2005 labour force in the Kitikmeot. Should two or three additional projects be developed and provide similar employment opportunities, this effect could become relevant for a larger share of the local population. Even with this larger influence across the labour force, the effect is expected to be a relatively small share of the existing labour force (both in terms of numbers and proportions).
- Some Kitikmeot families have past experience with mine employment and fly-in/fly-out work rotation schedules and may not experience a negative effect on family and household structure. Others, however, may experience negative outcomes or require a period of adjustment following the commencement of mine employment. The addition of one or more future project creates the potential for this effect to be experienced by additional families.

The duration of this effect may be either short term or medium term and is dependent on the retention of mine employment. The effect is determined to be neutral and the frequency continuous, given the retention of Project employment. The geographic extent of this effect is primarily within the LSA but may extend to the RSA and also is dependent on project employment patterns and priorities. This effect is reversible.

The probability for Kitikmeot residents to experience cumulative changes to family and household structure is moderate, as the future of mine development for all identified projects is uncertain. Should other projects be developed, a medium confidence is provided that this effect would be realized. Overall this cumulative residual effect is determined to be **Not Significant** because the magnitude is moderate and is expected to be positive for some families. The non-significant determination is further supported as the effect is not detrimental to livelihoods and does not extend beyond the life of the Project.

3.7 TRANSBOUNDARY EFFECTS

Transboundary effects are defined by NIRB 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 EIS guidelines (NIRB 2013a) require that consideration be given to the potential for transboundary impacts which may result from interactions between the effects of the Project within the NSA and the effects of the other projects which may be located outside the NSA. Further, the potential for transboundary impacts related to cumulative effects associated with the Project must also be addressed.

This Transboundary Effects Assessment (TEA) follows methodology described in Volume 9, Chapter 1. In sum, the TEA first employs a systematic process to consider the residual effects of the Project that may have transboundary implications. Second, a determination is made to whether or not the potential residual effects may operate cumulatively in a transboundary context with the effects of other projects or activities located in other jurisdictions. Finally, applicable mitigation is outlined as it relates to the potential transboundary effects of the Project.

3.7.1 Potential VSECs and Effects included in the Transboundary Effects Assessment

VSECs and socio-economic effects examined in the TEA of the Project were selected based on their potential interaction with the residual effects of the Project and informed though consultation with the Kitikmeot communities, as well as consultation conducted in the Yellowknife, NWT and with regulatory agencies, available TK information, and professional expertise. Specifically, the determination of VSECs and potential effects for inclusion in this TEA considered and were informed by:

- the EIS guidelines (NIRB 2013a);
- the public, during public consultation and open house meetings held in the Kitikmeot communities; and
- the public, during public consultation and open house meetings held in Yellowknife, NWT.

NIRB scoping meetings in Yellowknife included discussion that led to the identification of components important to the Dene-Métis community, as related to the Project. Comments made during these sessions were compiled and analyzed as part of VSEC and effect scoping.

3.7.2 Potential Transboundary Nature of Residual Effects

The EA concluded the Project would have non-significant residual effects on the VSECs Employment and Health and Community Well-being, including:

- Employment:
  - Changes to competition for local labour
- Health and Community Well-being

- Changes to individual and family spending; and
- Changes to family and household structure.

3.7.2.1 Employment

Changes to Competition for Local Labour

The effect changes to competition for local labour may have transboundary implications for the labour supply in Yellowknife, NWT. While hiring will favor the Kitikmeot Inuit, it is expected that a number of employees will also come from Yellowknife.

3.7.2.2 Health and Community Well-being

Changes to Individual and Family Spending

The effect 'changes to individual and family spending' was described as having the potential to have both positive and negative outcomes and is dependent on individual choice as well as the success of mitigation. These effects stem from Project employment and are further identified as having transboundary implications because it is expected that individuals from outside the NSA will also become employed with the Project.

As was the case within the Kitikmeot, individuals residing in northern communities outside of the NSA and who obtain Project employment are expected to experience changes to individual and family spending. The effect is expected to be less notable in communities outside the NSA as employment and income are more readily available with a deeper and longer term experience with the market economy, particularly in Yellowknife.

The effect is not expected to be relevant for Project employees who are resident of larger cities in southern Canada. The effect of the Project on individual and family spending for those who obtain Project employment was grounded in the knowledge that financial management is a known challenge for Kitikmeot residents and is linked to the relatively recent introduction of the wage economy. Alternatively, residents of southern communities are expected to have firsthand experience with the wage economy and income, reducing or at least not exacerbating the potential negative outcomes of increased income and spending.

The transboundary nature of this effect is expected to be relevant for families residing in small northern communities outside the NSA and less applicable to families residing in large urban centers.

Changes to Family and House Structure

The effect 'changes to family and household spending' was described as negative and thought to be most applicable for those families without previously mine employment experience. This effect is expected to be relevant for individuals residing in other small communities in northern Canada who obtain employment with the Project.

The effect of the Project on family and household structure for those who obtain Project employment considered the implication of Project employment for other family members, particularly the spouse or partner that remains at home. This issue is particularly relevant for communities in the Kitikmeot and other small northern, relatively isolated communities in which supports, such as daycare services, can be limited. Relevant supports may also include the availability of general services used to ease household responsibilities and services to replace any function the absentee family member may have provided.

As a result, the transboundary nature of changes to family and household structure as described in the effects assessment is expected to be less applicable for families that reside in larger urban centres, but is similarly applicable for families that reside in small northern communities outside the NSA.

3.7.2.3 Other Potential Transboundary Effects

In additional to the consideration of the residual effects of the Project with the TEA, a letter from the Minister of Aboriginal Affairs and Northern Development Canada identified three elements for consideration within the TEA, specifically:

1. 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;
2. Impacts to the local, regional, and territorial health system on the NWT as a result of reliance on medical services; and
3. Impacts to employment and businesses within the region affected by the Project.

Resulting community impacts of potential changes the caribou population are described and assessment in the Land Use Effects Assessment (Volume 8, Chapter 4).

The Project is not expected to affect the territorial health system of the NWT due to the fly-in/fly-out operation of the Project. Project employees will have access to health services on-site while at work and are expected to continue to access health services in their home communities. For employees retained from the South, they will continue to access health services in Edmonton, Calgary, or other cities. For Kitikmeot residents, Project employees similarly have access to health services at the Project site and continue to access health services as they did prior to the Project. For many Kitikmeot residents this means continuing to access services in the NWT and elsewhere in Canada as services in the Kitikmeot for some specialized services limited. Overall, the Project is not expected to place additional demand on health services in the NWT.

Impacts to employment and businesses within the region affected by the Project are explored as part of the transboundary implications of the Project for 'changes to competition for local labour' effecting Employment.

3.7.3 Identification of Mitigation and Management Measures

3.7.3.1 Employment

<u>Changes to Competition for Local Labour</u>

As noted previously, the public communication of Back River Project labour force needs and schedule will enable both individuals and employers to make informed and proactive decisions with respect to careers and staffing. This mitigation is similarly applicable to those located outside the NSA, including Yellowknife. This measure aims to enable employers to assess whether there is potential for their employees to obtain mine employment and take proactive measures (Volume 10, Chapter 28). Relevant mitigation has been previously described and defined by the Human Resources Plan (Volume 10, Chapter 28) and the Community Involvement Plan (Volume 10, Chapter 26).

3.7.3.2 Community Well-being

Changes to Individual and Family Spending

Community well-being is an issue of importance and of concern in the Kitikmeot communities. Many programs are in place within the Kitikmeot Region to promote community well-being (see Section 3.1.2.7 or Appendix V8-3A for further details). The effects of the Project as they relate to community well-being are primarily linked to Project employment and increased incomes and changes to individual and family spending. The manner in which individuals choose to spend their incomes is ultimately dependent on individual choice. Measures to steer individual decision making have been established to enhance the benefits of the Project and of increased income and employment. The objective of these measures is for Project employees to make choices their families and community will support.

Individuals engaged in Project employment have access to a number of services including the Inuit Employment and Training Coordinator, counsellors, and other supports such as the financial management program. The objective of these services is to facilitate Inuit inclusion in mine employment in a way that melds with and is complimentary to Inuit culture, and can be maintained in the long term.

Mitigation as defined by the Human Resources Plan (Volume 10, Chapter 28), with the exception of those measures specifically targeted at Kitikmeot Inuit, applies to all Project employees, regardless of their location of residence. This includes, for example, Project operational practices and employee support programs (e.g., EFAP) designed to mitigate the potential negative effects of poor spending choices.

It is further expected that other projects developed in the region and outside the NSA accessing the same labour force would adopt similar measures to mitigate potential negative outcomes associated with changes to individual and family spending.

Changes to Family and Household Structure

The Project will provide multiple means through which Project employees can remain in contact with the partners and families while away for work. Family supports available to Project employees include the EFAP and other services. As stated previously, the mitigation defined for the Project, with the exception of those measures specifically targeted at Kitikmeot Inuit, applies to all Project employees, regardless of their location of residence. It is expected that mitigation will also be effective for workers living outside of the NSA.

It is further expected that other projects developed in the region and outside the NSA accessing the same labour force would adopt similar measures to mitigate potential negative outcomes associated with changes to family and household structure.

3.7.4 Characterization of Residual Transboundary Effects

The socio-economic transboundary effects of the Project are limited to those effects on Employment and Health and Community Well-being and each stem from the provision of Project employment, which is expected to result in overall increases to standard of living for Kitikmeot residents and others involved with the Project living outside of the NSA.

Project induced competition for labour is not expected to be substantial outside the Kitikmeot Region, but rather is anticipated to provide desired employment. Project induced changes to individual and family spending are anticipated to be most notable within the Kitikmeot but may potentially also occur

in other small northern communities. Project induced changes to family and household structure are expected to be most relevant for families without previous mine employment experience who reside in communities with limited access to services and supports. The Project is not anticipated to result in additional strain on the health system in the NWT.

With respect to cumulative transboundary effects, the development of the Project and other potential future NWT projects may have cumulative transboundary implications related to Employment and Health and Community Well-being for small northern communities outside the NSA. However, it is expected that these negative effects will be mitigated through the measures defined above for the Back River Project. In addition, it is expected that other projects developed in the NWT would adopt similar measures to mitigate potential negative outcomes.

3.8 MITIGATION AND ADAPTIVE MANAGEMENT

This section provides a summary of the mitigation measures and adaptive management plans, which have been developed for the socio-economic environment of the Project. These mitigation measures and adaptive management plans reduce potential adverse effects of the Project, while maximizing the potentially beneficial outcomes as they relate to the socio-economic environment within the RSA and LSA. The socio-economic mitigation measures and adaptive management plans can be found in the Business Development Plan (Volume 10, Chapter 24), The Community Involvement Plan (Volume 10, Chapter 26), and the Human Resources Plan (Volume 10, Chapter 28), as well as the associated Socio-economic Monitoring Program (Volume 10, Chapter 23).

An adaptive management strategy enables engaged parties to instigate change where required and to employ the use of new data and best practices as they become available. The Project's Management staff will be responsible for implementing and updating the plans on an annual basis.

Each plan identifies the measures that will be adopted to ensure that Inuinnaqtun and Inuktitut will be incorporated and accommodated as part of the work environment, where appropriate. Volume 3 further describes measures to be adopted throughout the life of the Project to maintain compliance with Nunavut's evolving *Official Languages Act*.

3.8.1 Business Development Plan

The objective of the Business Development Plan is to encourage the involvement of local and regional Inuit-owned businesses in Project work to enhance the benefits of the Project within the Kitikmeot Region. To meet this objective, the Business Development Plan includes: 1) Procurement Strategy; 2) Local Business and Entrepreneur Capacity Building Strategy; and 3) Community-based Investments for Business Development.

The Business Development Plan is comprised of several different mitigation and management strategies, which will be implemented by Sabina throughout the Project life cycle. These strategies aim to:

- increase the capacity of local businesses and entrepreneurs through their involvement with the Project;
- support the development of Inuit firms interested in contract work with the Project by assisting them to develop capacity;
- extend the education and training benefits of the Project within the region where possible; and
- promote broad-based access and use of available community-based investments for local business development.

The Project may also provide other community investments and funding that is demand driven and based on the needs and wants of communities, with a focus upon the promotion of the Kitikmeot Region as an area for economic growth and the development and capacity building of youth within the region.

The Project has also established a donations policy that aims to enhance livelihoods and socio-economic development in the Kitikmeot Region. The donations policy is applicable to initiatives pertaining to 'youth and education' and 'community wellness and traditional lifestyles' in Kitikmeot communities.

The mitigation measures and adaptive management strategies described in the Business Development Plan seek to maximize the potentially positive and beneficial outcomes and to reduce or eliminate negative or adverse effects with respect to Business Development within the Project area. Further details are provided in Volume 10, Chapter 24.

3.8.2 Community Involvement Plan

The objective of the Community Involvement Plan is to fulfil Project external public engagement commitments and maintain meaningful relationships with communities and the public. For the purpose of the Community Involvement Plan, the term 'public' refers to populations within the area of influence and the term 'community' will, for the most part, refer the communities within the Kitikmeot Region.

To meet this objective the Community Involvement Plan describes the Project's commitment to provide Project updates, to incorporate public feedback, to promote Inuit participation in employment and contracting opportunities, receipt of community input, and to communicate research results. Community meetings utilize translators which enables local Kitikmeot residents to provide their input and comments in their language of preference.

The Project's community engagement methods include: public meetings, stakeholder meetings, the Sabina office and Community Liaison Officer (CLO) in Cambridge Bay, CAGs, site visits, social media, project newsletter, other distribution materials, radio shows, and trade show participation.

The mitigation measures and adaptive management strategies described in the Community Involvement Plan seek to maximize the potentially positive and beneficial outcomes of the Project while reducing or eliminating, negative or adverse effects where possible. The Community Involvement is detailed in Volume 10, Chapter 26.

3.8.3 Human Resources Plan

The Human Resources Plan is a living document and will be regularly updated based on management reviews, incident investigations, regulatory changes, or other Project-related changes. The Plan will be revisited and updated or adapted on an annual basis. The objective of the Human Resources Plan is to maximize the employment, income, and education and training benefits available to local and regional communities, while mitigating any related potential adverse effects associated with these benefits.

The Human Resource Plan responds to the following potential Project effects and topics of concern:

- changes to employment levels and income;
- changes to work experience, education, and skill levels;
- changes to family and community dynamics that result from the fly-in/fly-out work rotation schedule;

- changes to individual and community participation in traditional land based activities; and
- unemployment associated with job loss at Project closure.

The Project's Human Resources staff or other designated management personnel will work to implement and update this plan throughout the life of the Project. The Human Resources Plan includes: 1) Labour Relations Strategy; 2) Preferential Recruitment Strategy; 3) Workforce Training Strategy; and 4) Workforce Transition Strategy. To increase potential benefits of the Project related to employment the Project will take measures to reduce entry barriers and enhance the experience, education, and skill levels of the local workforce.

The objective of the Workforce Transition Strategy is to enhance employees' ability to secure suitable employment elsewhere during the closure phase of the Project. This strategy focuses on areas likely to enhance employees' ability to secure suitable employment.

The Human Resources Plan includes mitigation measures and adaptive management strategies that seek to maximize the potentially positive and beneficial outcomes of the Project while reducing or eliminating the negative or adverse effects where possible.

Finally, although the working language in the mine will be English, Sabina is committed to providing culturally appropriate conditions in the workplace and will establish rules and practices that promote the use of Inuit languages to the extent possible. All signs and postings at the mine site and camps will be provided in English, Inuktitut, and Inuinnaqtun. Sabina will provide support for employees interested in improving their English, Inuinnaqtun, or Inuktitut skills.

Sabina will explore the possibility of establishing Inuit language speaking work groups within sub-activities of the Project, with the provision that members of each work group can communicate competently in English with other personnel on the Project.

3.8.4 Summary of Mitigation and Adaptive Management

Table 3.8-1 provides a summary of the mitigation and adaptive management measures as stated in the Business Development Plan, the Community Involvement Plan and the Human Resources Pan.

Table 3.8-1. Summary Table of Mitigation and Adaptive Management Measures

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
Use of well-appointed onsite camps to house workers, to meet the needs of workers and avoid the use of accommodations and others services in communities.	
Fly-in/fly-out operation using direct routes from home communities when reasonable minimizing layovers during the transport of workers, and the use of an appropriate worker rotation schedule (two weeks on/two weeks off).	
2. Best Management Practices	
Best management practices are defined by the Business Development Plan, Community Involvement Plan, and Human Resources Plan to reduce potential adverse effects of the Project, while maximizing potential benefits to the region. Specific provisions relate to employment, economic development, business opportunities, education and training, and health and community well-being.	
Economic Development - maximize the potential employment and contracting opportunities for local communities. This will include preference for local individuals and businesses when designing and developing Project related-employment and contracting opportunities.	

(continued)

Table 3.8-1. Summary Table of Mitigation and Adaptive Management Measures (completed)

Mitigation Category	Mitigation Measures
2. Best Management Practices *(cont'd)*	
Employment – first opportunity for hire will be provided to Inuit, work rotation that enables local people to continue their land use activities, fly-in/fly-out operation, and work program to increase Inuit employee retention. Specific activities include: 1) provide a worker rotation schedule that enables individuals to continue to participate in the subsistence economy through land use and harvesting activities (two weeks on/two weeks off); 2) the fly in/fly out operation of the Project where reasonable and onsite camps ensures local employees can return home during their time off and discourages southerners from relocating to northern communities where community infrastructure and services (including housing) are fully utilized; 3) first opportunity for hire will be provided to local Inuit to maximize the potential gain in mining and other work experience, which in turn promotes the development of human capital in the region; 4) provision of EFAP program including counseling and other services helpful in retaining local Inuit employees; and 5) timely communication of all employment opportunities and related skills requirements. Business Opportunities - maximize the potential benefits of contracting opportunities with the Project to local Inuit-owned businesses. Specific activities include: 1) first opportunity to bid on Project contracts will be provided to Inuit-owned businesses in the Kitikmeot Region; 2) provision of assistance with contract bidding; 3) breakdown of larger contracts to smaller contracts that match the capabilities of local Inuit firms; 4) opportunities for capacity building through experience with the Project; 5) preapproval of Inuit businesses interested in Project work and first opportunity to bid on Project contracts will be provided to preapproved businesses; and 6) timely and targeted communication of all contracting opportunities. Education and Training - facilitate education and training related to participation in Project employment through financial contributions and early communication of education and skill requirements. Specific activities include: 1) financial contribution to education and training programs to further local education and skill levels relevant to Project employment; 2) advanced notice and continued communication related to the levels of education and skill required for various positions; 3) on-the-job training for employees; 4) mine employment orientation; 5) career development throughout the course of employment; and 6) opportunities for additional training and skills upgrade once employed. Health and Community Well-Being - provision of on-the-job training and an Employee and Family Assistance Program (EFAP) for mine employees that require assistance overcoming challenges related to financial management, substance abuse, and family relationships (among others), and that provides support to assist employees and their families in managing work related stress. Specific activities include: 1) provision of direct transportation to the minesite from home communities; 2) provision of a financial management program as part on on-the-job training and as a component of the EFAP; 3) provision of cross-cultural orientation training; 4) provision of country foods at minesite camps, when feasible; 5) provision of direct travel from home communities (avoiding layovers) and appropriate worker rotation schedule (two week on/two week off) that enables extended periods of time-off that facilitates continued land use and harvesting activities; and 6) EFAP including counseling for work stress, substance abuse, financial management, family stress, and other counseling services.	
3. Adaptive Management	
Adaptive management will occur through updates and adjustments to the Community Involvement Plan, Human Resources Plan, and Business Development Plan as needed. Overall, an approach of adaptive management will be employed to ensure the objectives of the plans are met and, in turn, meet the needs of employees, local communities, and the Project with respect to economic development, employment, business opportunities, education and training, and health and community well-being.	
4. Monitoring	
The Socioeconomic Monitoring Plan (SEMP) includes indicators that will be used in the evaluation of changes to economic development, employment, business opportunities, education and training, and health and community well-being.	

3.9 PROPOSED MONITORING PROGRAMS

3.9.1 Socio-economic Monitoring Program

The Project has committed to managing the social and economic effects of the Project in such a way so as to maximize potential positive and beneficial outcomes and reduce, or where possible eliminate,

negative or adverse effects. To this end, the following Socio-economic Monitoring Program (SEMP) has been developed.

The SEMP is related to a number of specific management plans developed to respond to, manage and/or mitigate the potential social and economic effects identified in the EIS. The primary socio-economic management plans that have been identified for the Project include the following:

- Business Development Plan (Volume 10, Chapter 24);
- Community Involvement Plan (Volume 10, Chapter 26); and
- Human Resources Management Plan (Volume 10, Chapter 28).

The SEMP is organized according to the VSECs established for the EIS and, where possible, aligned with reporting practices used by the Kitikmeot Region SEMC. The SEMP outlines the methods that will be used to support the specific management plans listed above. The SEMP is a 'living document' and as such will be updated as required based on management reviews, incident investigations, regulatory changes, or other Project-related changes. The SEMP may be revisited and updated or adapted on an annual basis.

There are three overarching objectives of the monitoring program:

- Verify the accuracy of key predictions made in the EIS with respect to the direction and magnitude of socio-economic effects, gauge the efficacy of mitigation measures, and facilitate early identification of any unanticipated effects.
- Contribute to and support adaptive management through evaluation of planned mitigation measures. Monitoring results will be used to provide a basis from which to develop additional or alternative mitigation plans in cases where initial mitigation measures are insufficient or ineffective.
- Help ensure that wherever possible, the monitoring program design and methodologies themselves are culturally appropriate and relevant to the issues and concerns of local Inuit, including respect for the confidentiality of certain socio-economic information. In part, this objective will be achieved by the consideration and incorporation of Inuit Qaujimajatuqangit (Inuit knowledge) into the SEMP, when and as appropriate.

The Project is also committed to contributing to the social, cultural, and economic development of sustainable communities near their operations. To this end, socio-economic monitoring is important to:

- Fulfill best practice in social responsibility as it relates to community engagement and capacity building;
- Realization of benefits from the Project, especially for Inuit;
- Confirm baseline status of social and economic conditions in the communities and region and to measure and track changes over time;
- Help ensure that the Project impacts and benefits are being realized according to or better than predicted; and
- Inform adaptive management should changes be required to Project activities, such that Project benefits are maximized and adverse effects on communities are minimized.

The Project supports the sharing of monitoring information with governments, communities, and other stakeholders, and their participation in evaluating and responding to changing socio-economic conditions.

The SEMP proposed 37 indicators, the Project will provide data for 28 indicators and the remaining nine indicators will be based on GN data, NAC, Nutrition North Canada, and/or data obtained from the federal government as provided and reported by the Kitikmeot Region SEMC initiative.

The monitoring report will be produced on an annual basis and distributed in electronic and hardcopy format to all stakeholders and interested parties.

The SEMP will assist the Project in achieving desired outcomes as related to the mitigation measures and management plans as delineated in the Business Development Plan, the Community Involvement Plan and the Human Resources Plan. These outcomes are to maximizing potentially positive and beneficial outcomes and reduce and where possible eliminate negative or adverse effects by ensuring that the mitigation measures and adaptive management plans are having their intended effects.

3.10 IMPACT STATEMENT

The Project has the potential to affect the socio-economic characteristics of the Kitikmeot Region. The socio-economic effects of the Project stem from direct Project employment and procurement and are expected to be strongest during the Construction and Operation phases. The five VSECs selected to assess the effects of the Project were based on values identified by local residents, community-based research, Project scoping meetings, and public consultation and included: Economic Development, Business Opportunities, Employment, Education and Training, and Health and Community Well-being.

The assessment concluded that most Project effects on the VSECs would be positive and beneficial; however, negative residual effects were determined for VSECs Employment, and Health and Community Well-being, including:

- Employment
  - Changes to competition for local labour
- Health and Community Well-being
  - Changes to individual and family spending; and
  - Changes to family and household structure.

Overall, the effects assessment concluded that the identified residual effects were **Not Significant**.

The residual effect ‘changes to competition for local labour’ highlighted the nature of Kitikmeot economy and difficulties in obtaining skilled labour (e.g., trades people, professionals) in the Region. The evaluation pointed to difficulties in obtaining and retaining these employees locally, and the potential negative effect of the Project on local governments and businesses in being able to find and retain skilled labour. Conversely, the Project represents an opportunity for the development of the local labour force to be able to meet the needs of the economy. The effects assessment determined the residual effect ‘changes to competition for local labour’ was **Not Significant**.

The residual effect ‘changes to individual and family spending’ was noted to result in both positive and negative outcomes. This effect facilitated discussion of the potential outcomes of relatively high incomes within communities characterized by higher than average levels of unemployment and limited exposure to the wage economy. The potential negative associated outcomes included increased spending on drugs

and alcohol, as well as other negative spending habits such as gambling, and the implications within Kitikmeot communities. The assessment noted that while there is a potential for negative outcomes to occur, which indirectly stems from a desirable Project benefit - employment. Mitigation measures are anticipated to provide viable and effective support for individuals so that individuals make positive choices. However, as there is difficulty in predicting human behaviour and noted community concern related to this issue, the precautionary principal was employment and the Project was assessed as having a non-significant residual effect on Health and Community Well-being. The effects assessment determined the residual effect 'changes to individual and family spending' was **Not Significant**.

The residual effect 'changes to family and household structure' reviews the implications of the Project for families. The absence of a family member is expected to have greater implications for families that do not have past experience with mine employment as compared to those who do. Specifically, potential implications for marital relationships and parental roles were discussed. The effects assessment determined the residual effect 'changes to family and household structure' was **Not Significant**.

The potential cumulative effects of the Project were reviewed and assessed as **Not Significant**. The CEA considered the effects of past, present, and future projects on VSECs for which the primary assessment resulted in residual effects, specifically, on the VSEC Health and Community Well-being. The CEA similarly concluded there was potential for non-significant residual cumulative effects associated with present and future projects related to the VSEC Health and Community Well-being. The CEA noted that should other projects be approved and developed, the adoption of similar mitigation and management measures to reduce or eliminate potential negative outcomes is expected.

As was noted throughout the assessment, the socio-economic effects of the Project are generally positive and desirable for the Kitikmeot Region's residents. Where negative residual effects are anticipated mitigation and management measures have been established to reduce or eliminate these effects. The benefits of the Projects, economic development, business opportunities, employment, education and training and the potential to for positive effects to Health and Community Well-being, represent a unique opportunity for regional development that other industries have not been able to provide to date. Northern economies in Canada, and in particular in Nunavut, have often struggled to find balance between modern and traditional economies. In other cases, the absence of economy has contributed to this struggle. The Project may serve to contribute substantially to the GNs vision to increase individual and community self-reliance in Nunavut and to produce general increases to standard of living.

The Back River Project represents notable socio-economic benefits for the Kitikmeot Region and Nunavut. Increased levels of employment and income, as well as education and training, are known determinants of overall well-being and standard of living. The Project provides an opportunity for Kitikmeot residents to participate in the wage economy at a scale not previously realized by private industry. Other beneficial Project outcomes arise from resource royalty payments, contribution to regional and territorial tax revenues, and IIBA-defined support to Inuit organizations. Some of the most valuable positive outcomes of the Project may be found in the potential to reduce the disconnect youth experience between education and employment benefits, and support for the continuation and enhancement of traditional land use activities.

Sabina is committed to working with individuals, families, organizations, and communities to increase the potential for positive outcomes through the use of adaptive management and the on-going monitoring of socio-economic conditions. Sabina has adopted mitigation that represents current best-practices that have been found to produce beneficial outcomes related to other mine projects, for example, Meadowbank, Ekati, and Diavik. Sabina strives to meet and exceed corporate social responsibility goals and to become an industry leader contributing to continued successes and positive outcomes for both company and community.

4. Land Use

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4. Land Use

The potential effects of the proposed Back River Project (the Project) on land and resource use are assessed in this chapter. This includes consideration of predicted effects on non-traditional land and resource use and subsistence economy and land use. Land use effects are predicted and evaluated at the local and regional levels.

4.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

This section provides a summary of the methods and results of the land use baseline information collected for the proposed Project. Data was collected in 2012 and 2013, with field data collection occurring primarily in November 2012. Detailed information on the methods and results for the land use study is provided in the 2012 Back River Project Socio-Economic and Land Use Baseline (Appendix V8 - 3A; Rescan 2012).

4.1.1 Methods

The collection of baseline information focused on the need to generate a profile of key land use characteristics for the Kitikmeot Region. Desk-based research consisted of reviewing documents and databases to identify and compile available information. Initially, an internet and bibliographic search was completed to identify potential information sources. The identified sources were then reviewed and applicable information extracted. Sources that were accessed included publically available statistics from government agencies, government reports, private sector and non-governmental organization reports, academic literature, and internet publications.

Land use fieldwork consisted of three hunter and trapper focus group sessions held in November of 2012, including hunter and trappers from Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet. The focus groups included resource mapping and had an average of eight to ten participants per session. Interviews were also conducted with Hunter and Trapper Organization (HTO) managers or board chairpersons in each community.

The results of the land use study first present an overview of the land and resource use activities of individuals residing in the western Kitikmeot Region. This overview enables greater understanding of the continued influence of subsistence activities. This is followed by a discussion of study results using the geographic scope of a defined Regional Study Area (RSA) and Local Study Area (LSA). The land use RSA was defined as the areas of land and water that encompass the Project and is consistent with the largest boundary of the wildlife, regional marine, and terrestrial study areas as defined by those disciplines. This boundary is chosen because of the strong link between these environmental components and traditional land use activities. The land use LSA encompasses the footprint of the Project including areas immediately surrounding the physical Project infrastructure (see Figure 4.4-1).

4.1.2 Results

4.1.2.1 Nunavut Land Title and Tenure

There are two main types of land title and tenure within Nunavut: Inuit Owned Lands (IOL) and Crown lands (NTI 2004). The Project properties are located on both IOL and Crown land. IOL is designated under the Nunavut Land Claims Agreement (NLCA) as lands that vest in a designated Inuit organization, for example the Kitikmeot Inuit Association (KIA), while Crown land refer to lands currently held by the federal government (NTI 2004). Nunavut Tunnagavik Inc. (NTI) is responsible for IOL and Aboriginal

Affairs and Northern Development Canada (AANDC) is responsible for most Crown lands. Management of IOL is guided by NTI bylaws (Johnson 2009).

Inuit-owned Lands

The NTI Department of Lands and Resources manages IOL on behalf of all Inuit. There are two main types of title to IOL - surface and subsurface. The subsurface IOL title includes the land and all specified substances (e.g., carving stone and aggregate, earth, soil, and peat), which are held by the Regional Inuit Associations (RIA), and the mineral and mine deposits, which are held by NTI. The surface IOL title, which is held by the RIAs, includes the land and all specified substances but does not include rights to mineral and mine deposits. Subsurface rights on surface IOL are held by the Crown and are administered by AANDC (NTI 2004; Johnson 2009).

The RIAs administer access to surface IOL rights through the provision of land use licences (three classes); commercial leases (three classes); right-of-way, residential, and recreational leases; and quarry rights. Leases are issued by the RIAs after considering the advice of community committees (Johnson 2009). The NTI administers access to subsurface IOL rights. Exploration agreements may be granted by the NTI for a term of one year, renewable in up to 20 subsequent years, with an annual fee and work requirement, for areas limited to 10,000 hectares. Once it can be proven that a resource exists, the proponent can apply for a production lease with an original term of 10 years. The original production lease can be renewed for two subsequent five-year terms, if sufficient proof of progress is received by the NTI. Once production is initiated the production lease is automatically renewed for 21 years and an IOL royalty is paid on production. If mineral rights were held on subsurface IOL prior to the signing of the NLCA, the NTI retains ownership of the minerals, but the rights are administered by AANDC (NTI 2004; Johnson 2009). As part of the administration of 'grandfathered' right, AANDC pays quarterly lease payments to NTI. In the 2006-2008 reporting period, approximately 60 such leases were administered by AANDC (AANDC 2011).

Crown Land

Crown land in Nunavut is administered by the Land Administration Division of AANDC, although Inuit have rights to portions of the resource royalties from extractions on Crown land and must be consulted about all resource developments (NTI 2004; INAC 2005). The Canada Mining Regulations govern exploration rights in the form of prospecting claims, mineral claims, and mineral leases. A licence to prospect is required to prospect, record a mineral claim, apply for a prospecting permit, or acquire a mineral lease (INAC 2005). Surface tenure on Crown land is governed by the Territorial Land Use Regulations, which are used to guide the provision of land use permits (INAC 2005).

4.1.2.2 Land Use Planning and Designation

Draft Nunavut Land Use Plan (2012)

The Nunavut Planning Committee (NPC), as established under the NLCA, has developed a draft Nunavut Land Use Plan (NLUP) for all Nunavut regions that are outside of municipal boundaries. The draft NLUP provides guidance for resource use and development and contains goals, objectives, and policies for land use planning in Nunavut (NPC 2012). Going forward, the NLUP must be approved by the NTI, the RIAs, the Government of Nunavut, and the Government of Canada following community consultations (NPC 2012). The NLUP is a draft yet to be fully reviewed by community stakeholders and the public, and may be subject to revision at a later date.

A variety of land use designations are identified under the draft NLUP to guide land use and development. The land on which the Project is located does not currently have any specific designation identified.

Protecting and Sustaining the Environment

The Protecting and Sustaining the Environment land use designation was adopted to support environmental protection and management needs. This land use designation addresses issues related to key bird habitat sites, caribou habitat, Atlantic Cod lakes, cumulative impacts, transboundary considerations, and climate change (NPC 2012). Relative to the Project, the nearest land areas with this designation are northeast of Kugluktuk on Victoria Island and near the southwest shore of King William Island.

Encouraging Conservation Planning

The Encouraging Conservation Planning land use designation was adopted to support environmental protection and management needs. This land use designation addresses issues related to national parks awaiting full establishment, proposed national parks, proposed national marine conservation areas, the Thelon Wildlife Sanctuary, Migratory Bird Sanctuaries, National Wildlife Areas, historic sites, and heritage rivers (NPC 2012). The Thelon Wildlife Sanctuary, located approximately 125 km southeast of the Project, is the nearest area with this designation.

Building Healthier Communities

The Building Healthier Communities land use designation was adopted to support community needs and cultural priorities, while taking into account transportation and communication services and corridors; energy requirements, sources, and availability; community infrastructural requirements, including health, housing, education, and other social services; cultural factors and priorities; and special local and regional considerations (NPC 2012). The nearest location of this land use designation, relative to the Project, is the community of Bathurst Inlet which is located approximately 160 km to the north.

Encouraging Sustainable Economic Development

The Encouraging Sustainable Economic Development land use designation was adopted to support economic opportunities and needs, while taking into account the natural resource base and existing patters of natural resource use; transportation and communications services and corridors; energy requirements, sources, and availability; and special local and regional considerations. The designation addresses issues related to mineral exploration and production, oil and gas exploration and production, and commercial fisheries. The goal of encouraging diversified economic development includes long term strategies for mineral and petroleum resource development and use, among others (NPC 2012). Relative to the Project, the nearest land area with this designation is approximately 30 km to the west.

Mixed Use

The mixed use land use designation was adopted to support a variety of opportunities and land use activity, while taking into account the potential for economic opportunity and conservation initiatives, as well as the social well-being of residents. NPC states that providing for a diverse mix of land uses creates a positive environment for potential growth and the exploration of opportunities (NPC 2012). There are no instances of the mixed use designation within the Kitikmeot Region.

Parks and Protected Areas

The largest protected area close to the Project is the Queen Maud Gulf Migratory Bird Sanctuary, which is a legislated conservation area that supports nearly the entire global population of Ross' Geese, giving it international importance. The Queen Maud Gulf Bird Sanctuary is located approximately 115 km from

the Project (NPC 2004). Designated conservation zones are also found near Hood River in the Wilberforce Falls area and the Hiukitiak River watershed, east of the Bathurst Inlet area (NPC 2004). In addition, the Kitikmeot Region includes numerous territorial parks, located outside the land use RSA.

4.1.2.3 Industrial Land Use

Mining and Mineral Development and Exploration

To help manage development, the NTI has adopted several policies related to exploration and mining, including a general mining policy in 1997, a uranium policy in 2007, and a reclamation policy in 2008 (INAC 2010). A Memorandum of Understanding (MOU) between the Canadian Northern Economic Development Agency and the KIA was signed on November 15, 2012. The MOU confirms both parties' commitment to advance responsible resource development while promoting regional benefit in the Kitikmeot Region (CanNor and KIA 2012). Further information describing the processes in place to govern industrial land use and the organizations responsible to oversee potential development projects (e.g., Nunavut Water Board and Nunavut Planning Commission) including regional socio-economic monitoring committees is provided in the 2012 Socio-Economic and Land Use Baseline Report (Appendix V8-3A).

The first Inuit-owned mining development company, Nunavut Resources Corporation, was established in 2012 and has received a $1 million commitment from the KIA to start exploration activity as well as initial funding of $200,000 from Sabina as a startup fund. The Nunavut Resources Corporation is partnered with HTX Minerals Corp. and will now seek to raise $18 million for exploration which will focus on unstaked portions of the 11,509 km^2 of IOL (surface and mineral rights) within the Kitikmeot Region (Nunatsiaq News 2012).

In 2012, there were 65 active exploration projects in Nunavut, including 22 in the Kitikmeot Region, and 18 near the communities of Bathurst Inlet, Cambridge Bay, and Kugluktuk. This is a reduction from 95 active exploration projects in the Kitikmeot in 2011, including 35 within the western Kitikmeot. Currently, there are no active mines in the Kitikmeot Region. Of the 22 active mineral explorations in the Kitikmeot Region there were 17 in the western Kitikmeot and five in the eastern Kitikmeot. Western Kitikmeot projects included base metals (5), gold (15), and diamonds (2) (Nunavut Geoscience 2012). In 2012, a number of projects were put on "care and maintenance status," including the Hope Bay Belt Project (George 2012). The Hope Bay Belt Project has since been purchased by TMAC Resources Inc. as a partner with Newmont and permitting work is ongoing.

Oil and Gas Development and Exploration

The issuance of oil and gas exploration rights in Nunavut began in 2000 and follows an open, competitive bidding process. Oil and gas resources on Crown land in Nunavut are managed by the Northern Oil and Gas Branch of AANDC (INAC 2009b). Current exploration and development are concentrated in the eastern Arctic (northern Hudson Bay and around Baffin Island), the Arctic Islands, and Sverdrup Basin (INAC 2011b, 2011a). There was no industry exploration or development activity in the Arctic Islands or offshore in the eastern Arctic in 2009 (INAC 2009a). The majority of the southern Kitikmeot is not considered to have oil and gas potential (NPC 2008).

4.1.2.4 Commercial Activities

Hunter and Trapper Organizations

Each community in Nunavut has an HTO that shares responsibilities with respect to the management of hunting, trapping, and fishing activities, as well as management of the environment and wildlife with

the Government of Nunavut. Each HTO typically employs one local person as a manager and performs various functions based on local need. For example, this may include facilitation of programs and services for local hunters and trappers, coordination of research projects (e.g., polar bear monitoring, fish tagging), coordination of and assistance with the commercial and sports hunts, organization and implementation of the community harvest, as well as other administrative duties.

The HTOs in Cambridge Bay and Kugluktuk are active and currently facilitate a variety of programs and projects. The HTOs at Bathurst Inlet and Omingmaktok did not employ an HTO manager at the time of writing, but continue to be actively managed by an HTO board and chair (Back River Project Research Program 2012). The Nunavut Harvesters Support Program, funded through the Nunavut Department of Economic Development and Transportation, provides $97,000 annually to each community in Nunavut for equipment purchases; the HTOs serve as the point of delivery for this program (Back River Project Research Program 2012).

Kitikmeot Foods and the Commercial Food Harvest

Established in 1990, Kitikmeot Foods is a food processing facility located in Cambridge Bay that is owned by the Nunavut Development Corporation and the Ekaluktutiak (Cambridge Bay) HTO. Kitikmeot Foods specializes in muskox and Arctic char for sale in commercial markets. The facility operates year round, processing fish from July to September and muskox from October till March, creating employment for local people including harvesters. Typically, approximately 200 muskox are harvested during the commercial hunt which takes place annually on Victoria Island in late February to early March (Dawson 2012; Nunavut Development Corporation n.d.).

Kitikmeot Foods employs approximately 30 people on a seasonal or full-time basis, including hunters, to help with the annual commercial harvest, which must take place within 30 to 35 miles of the community. The annual muskox hunt typically provides about 25,000 pounds of meat to Kitikmeot Foods (Dawson 2012). In order for meat to be exportable outside of Nunavut, the harvest and operation must be approved by the Canadian Food Inspection Agency, which, among many other regulations, requires the delivery of animal carcasses to the processing facility within one hour of harvesting (Back River Project Research Program 2012).

Sport Hunting

Sport hunting in Nunavut is usually organized through the community HTO office. Each community is allocated a specific number of tags per year by species and can use those tags to accommodate a sport hunt if so desired. Typically, a local hunter, who is also a licenced outfitter, is identified to take a client out on the land to hunt an animal. Revenues from the sport hunt provide financial support to local HTOs (Back River Project Research Program 2012). Species typically targeted for sport hunting include caribou, muskox, grizzly bear, polar bear, and wolf (Back River Project Research Program 2012; Nunavut Tourism 2012).

Fisheries Licences

Fisheries licences in Canada are guided by the Federal Department of Fisheries and Oceans' (DFO) New Emerging Fisheries Policy which defines the three stage process that must be undertaken to obtain a commercial fisheries licence. There is one exploratory licence for an Arctic char fishery located within the land use RSA at 66˚47'N, 108˚10'W near the community of Bathurst Inlet. An exploratory licence is obtained to determine if the stock can sustain a commercially viable operation and to collect additional biological data. To progress from the exploratory licence to a commercial fisheries licence, the applicant must, among other tasks, complete an exploratory harvesting strategy that details the processing plants to be used and market destinations (DFO 2009).

Ecotourism Lodges

Seasonal lodges and adventure tourism companies operate throughout the Kitikmeot Region. One is located near the community of Bathurst Inlet (the Bathurst Inlet Lodge) and the other (Elu Inlet Lodge) is located at the end of Melville Sound nearest to the community of Cambridge Bay.

The Bathurst Inlet Lodge

The Bathurst Inlet Lodge is an ecotourism venture operating during the short tourist season, from June to September, and is one of the primary tourist destinations in the region. Established in 1969, the lodge can accommodate 30 people and occupies an old Hudson Bay Company post. Ecotourism activities include boating in Bathurst Inlet, hiking, sightseeing, and culture and nature interpretation (Back River Project Research Program 2012).

The Bathurst Inlet Lodge offers an outfitting and equipment rental service for self-guided tours, and also offers assistance with logistics, transportation, bear and other safety training, and other necessary precautions. Other packages offered include fully guided tours, most commonly canoeing tours on the Burnside, Hood, and Mara Rivers. Patrons can also purchase weekly all-inclusive packages that include accommodation, guided tours, and transportation from Yellowknife; costs range from $2,500 to $6,000 (Back River Project Research Program 2012). Typically, the lodge accommodates approximately between 100 and 130 clients per year. However, in recent years there has been a lower average of about 100 clients per year. The lodge has four permanent employees and an additional 15 to 20 employees during the summer, depending on the number of clients (Back River Project Research Program 2012).

In addition to the main lodge, the Bathurst Inlet Lodge has several small lodges and camps at various locations including Fishing Creek, Burnside Lake, Pellatt Lake, and Bathurst Lake. Typically, these areas would be visited during fully guided tours, which take place on Fishing Creek, Bathurst Lake, Burnside River, Pellatt River, Mara River, and Hood River (Back River Project Research Program 2012).

The Elu Inlet Lodge

The Elu Inlet Lodge has been operational for over a decade and is located on the shores of the Elu Inlet near the mouth of the Itibiak River. The lodge is owned and operated by local Inuit. During the summer season (July and August) it offers eco-tourism adventures, including hiking, boating, wildlife and bird observation, Inuit culture and heritage tours, and fishing excursions. The Elu Inlet Lodge is accessed by floatplane from Cambridge Bay, and facilities include lodging, an outdoor hot tub, canoes, and kayaks. The lodge specializes in facilitating conferences and corporate retreats (Back River Project Research Program 2012).

The Elu Inlet Lodge can comfortably accommodate 15 people but has hosted as many as 26 when needed. The lodge uses camps located at Pellatt Lake and Burnside River as points of interest to visit during tours. In 2011, the lodge hosted six clients. The lodge did not open in 2012 as there were no clients (Back River Project Research Program 2012).

Tourism and Recreation

In addition to the lodges, there are other tourism companies operating in the area. Adventure Canada is a tour company that specializes in small ship expeditionary cruises in Canada's North (Nunavut Tourism 2011). Their advertised 'Into the Northwest Passage' tour includes travel through Gjoa Haven, Bathurst Inlet, Coronation Gulf, and Kugluktuk. Shore visits include hikes on the open tundra at Bathurst Inlet. Other tourism activities in the Kitikmeot Region include hiking, hunting, fishing, dog sledding, cross-country skiing, and snowmobile riding, among others (Nunavut Tourism 2011).

4.1.2.5 Subsistence Economy and Land Use

Land Use Values

The Inuit culture and way of life are intrinsically connected with the land. The Inuit people of the Kitikmeot have always depended on Inuit Qaujimajatuqangit, or knowledge of the land and environment, and continue to adapt to challenges posed by geography and climate. Practices such as hunting, fishing, and gathering have endured over thousands of years and remain important for maintaining social relationships and cultural identity, as they define a sense of family and community within Inuit culture. These practices link people to their histories, their present cultural settings, and provide a forward way of thinking about livelihoods (ACIA 2005). In Inuit culture, the environment is valued as a whole; the value of one ecosystem component cannot be ranked or differentiated from the value of another. The values that guide traditional activities and subsistence harvests are reflected in the Inuit approach to historic and contemporary land and resource use activities in the Kitikmeot Region.

Maintaining the health of the land and the ability of the land to support the traditional subsistence economy, including hunting, trapping, fishing, and gathering, is essential to the Inuit lifestyle. This includes ensuring the sustainability of wildlife populations in the area. Muskox, caribou, grizzly bear, wolf, and wolverine are among the species people in the Kitikmeot Region rely upon, with caribou being the most harvested terrestrial mammal.

Subsistence Economy

Traditional economic activities are of great importance to residents of the Kitikmeot communities. The subsistence economy includes non-commercial hunting, fishing, trapping, and gathering, as well as the transformation of harvested products into useful items such as clothing or arts and crafts. The value of subsistence harvesting is not only social and cultural, but is also economic, as the need for store bought food and other household items is reduced by harvesting. In many communities in Nunavut, obtaining country foods for personal consumption is an economic necessity. Country food obtained by Inuit hunters is often shared with neighbours and other community members.

In 2006, the latest year for which published statistics are available, the majority of Cambridge Bay and Kugluktuk residents hunted, fished, trapped, or gathered wild plants and berries, in comparable proportions to Nunavut as whole. In addition, the number of community members participating in traditional economic activities appears to be increasing over time. Specifically, the number of adults in Cambridge Bay and Kugluktuk who reported participating in hunting activities in 2006 was approximately 14% greater than the number reported in 2001 (Statistics Canada 2008).

Harvesting

The Nunavut Harvesters Support Program provides direct support for subsistence activities in Nunavut. In addition, the GN and Canadian Northern Economic Development Agency have invested $190,000 to support and promote the Nunavut Seal and Long Fur Marketing Project which aims to develop high-quality products and expand the market for those products domestically and abroad (CanNor 2012).

The Nunavut Wildlife Harvest Survey, conducted between 1996 and 2001, remains the most current and comprehensive information source on subsistence harvests in the Kitikmeot Region (H. Priest and Usher 2004). The survey collected data on subsistence harvesting activities including non-commercial hunting, trapping, gathering, and fishing. Specifically, the survey recorded the number of kills by species as well as the number of hunters for each community in Nunavut. The results indicated that caribou was the most hunted game in Bathurst Inlet, Omingmaktok, and Cambridge Bay; while in Kugluktuk caribou and Canada goose were equally hunted. Other commonly harvested species included Arctic ground squirrel, Arctic and red fox, grey wolf, wolverine, and seal. Bird species were harvested

at varying levels in the communities and included ptarmigan, seagulls and their eggs, Canada goose, and eider duck. Lastly, fish harvested included Arctic char, cod, lake trout, and whitefish.

The survey indicated there were approximately 17 to 18 hunters registered annually in Bathurst Inlet. In Omingmaktok, the number of hunters decreased from a reported 31 in 1996/97 to only 11 in 2001, which likely reflects an overall decline in the community population. Cambridge Bay reported between 330 and 350 hunters each year and Kugluktuk was estimated to have between 263 and 294 hunters annually between 1996 and 2001 (H. Priest and Usher 2004).

Linkages between Harvesting Activities, Country Food, and Well-being

For Inuit, harvesting activities and country food link to, and in sense underpin, well-being for individuals and communities. Kitikmeot Region land users harvest food from the land for themselves, their families, and their neighbours. Animals typically consumed include caribou, muskox, rabbit, ptarmigan, fish, and berries, among others. Land users from Bathurst Inlet and Omingmaktok provided insight into the use and sharing of country food, stating that country foods are thought of as belonging to everyone and as a result sharing is inherent (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

For some Inuit, participation in harvesting activities may be limited to evenings and weekends due to employment in the wage economy; however, participation in harvesting may also be limited by factors associated with not being engaged in the wage economy, which can result in a lack of income and the means to purchase the necessary equipment and fuel. Within Inuit culture the ability to provide for one's family and participate in harvesting activities is highly valued, associated with self and cultural identity, and has been linked to individual and community well-being.

Although food subsidy programs such as Nutrition North and Food Mail aim to provide an affordable healthy diet for Inuit people, the composition of this diet is quite different from the foods Inuit have traditionally consumed to sustain themselves for generations. Fruit and vegetables thought to be an essential part of healthy diet are not available from the natural environment in Nunavut and must be flown into the community at costs that can make fresh produce inaccessible to many. The length of time to transport fresh food into the north usually results in short shelf lives and less appealing produce than is available from southern retailers (National Aboriginal Health Organization 2004). The appropriateness of a traditional diet is best described by the following:

> *When one eats meat, it warms your body very quickly. But when one eats fruit or other imported food, it doesn't help you keep very warm. With imported food… you're warm just a short period of time. But [our] meat is different; it keeps you warm. It doesn't matter if it's raw meat or frozen meat… it has the same effect* (Freeman et al. 1998).

For these reasons, there are strong linkages between harvesting activities, country foods, and well-being of the Inuit.

Land and Resource Use Activities of the Western Kitikmeot Communities

Primary information about current land use activities was obtained through interviews with HTO representatives, and local hunters and Land Use Focus Group Sessions were held with active hunters from Kugluktuk, Cambridge Bay, Omingmaktok and Bathurst Inlet in November 2012. Land Use Focus Group Sessions included the mapping of harvesting activities and travel routes. The land use information obtained from those sessions is summarized in Figures 4.1-1 to 4.1-3. Travelling on the land, hunting, and fishing remain important cultural and subsistence activities for Inuit people in the Kitikmeot Region.

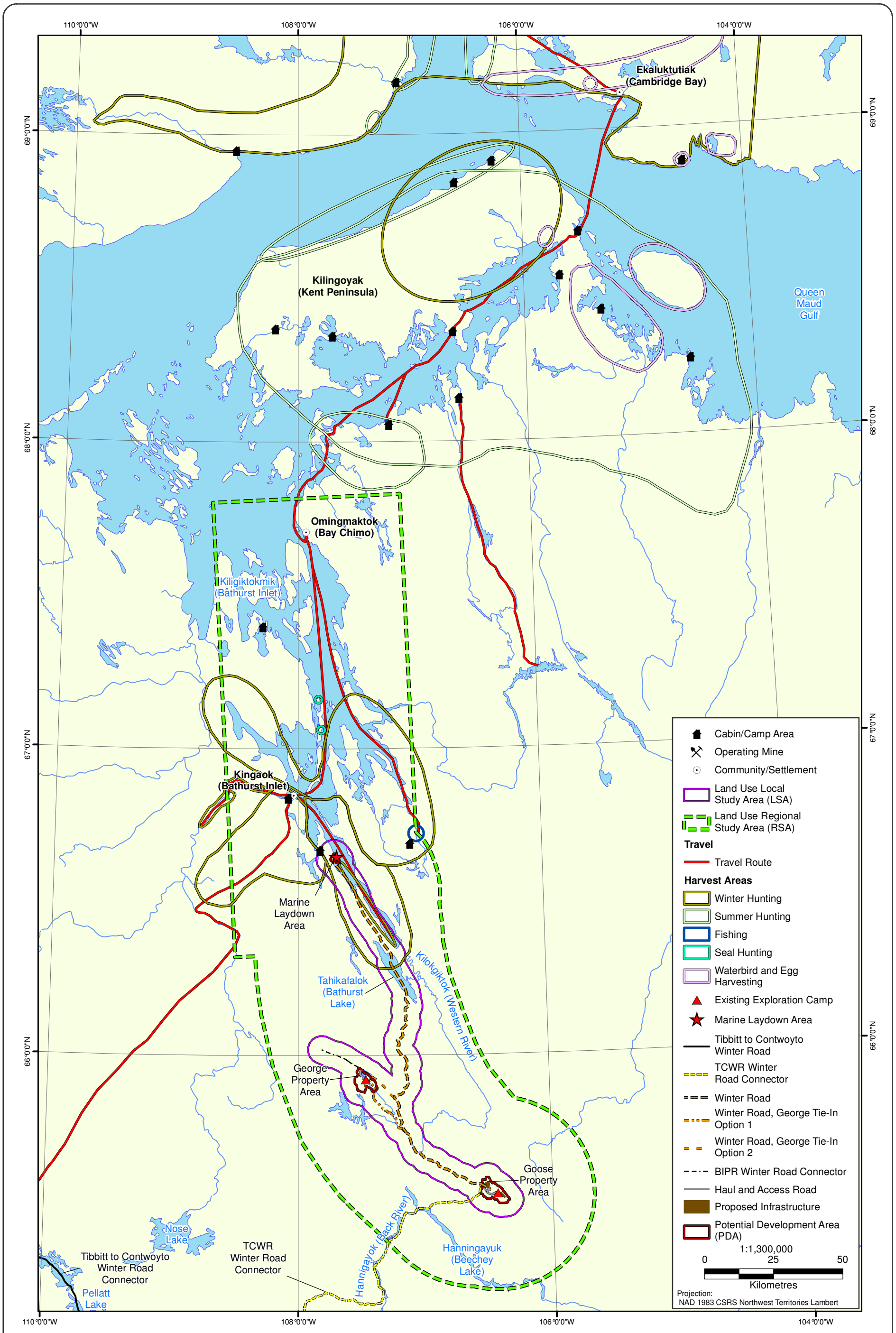


Figure 4.1-1

Sabina GOLD & SILVER CORP.

Land and Resource Use, Cambridge Bay (2012)

Figure 4.1-1

Rescan an ERM company

PROJECT # 0194096 0040 GIS # BAC-19-008 December 18 2013

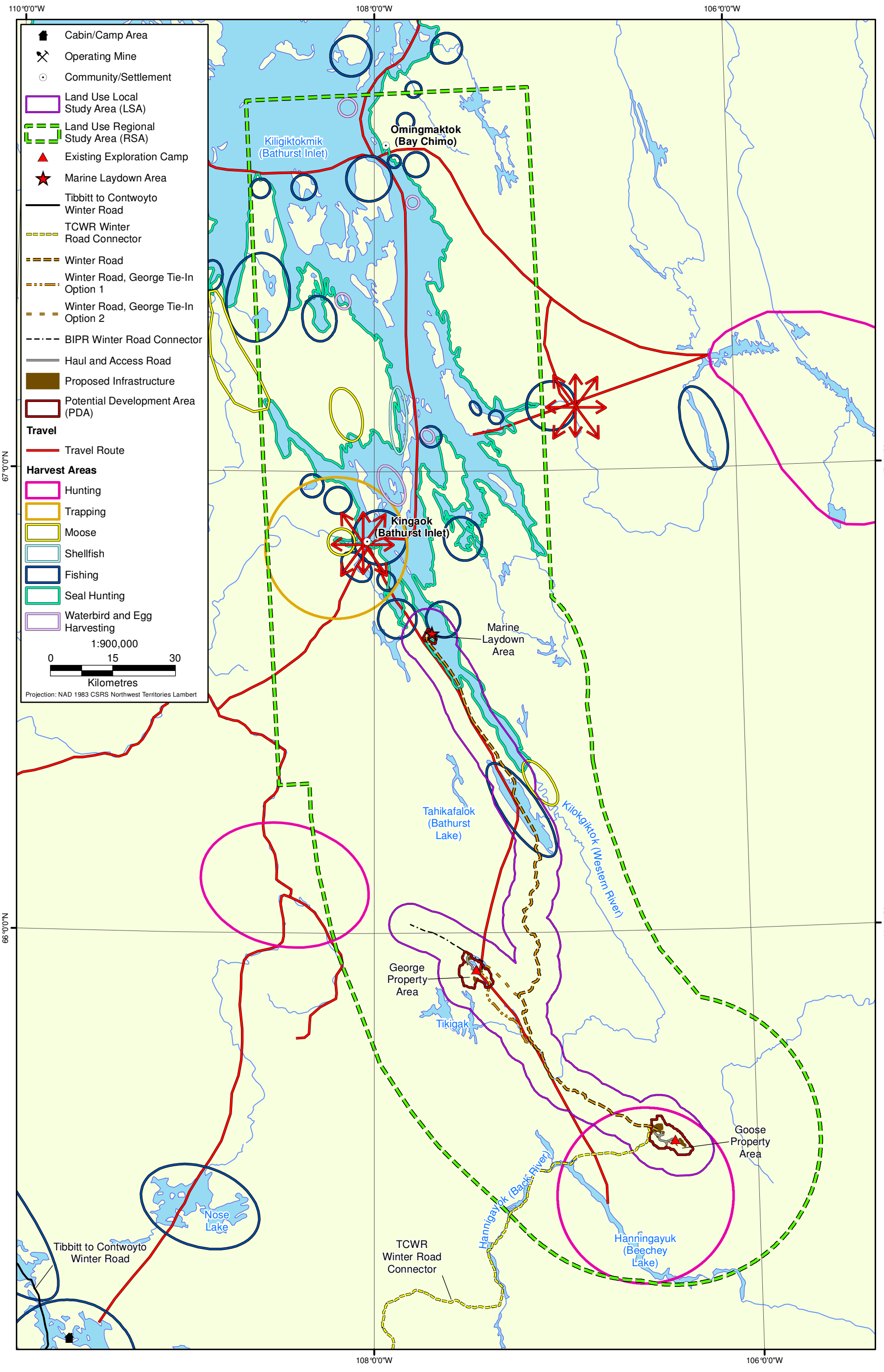


Figure 4.1-2

Sabina GOLD & SILVER CORP.

Land and Resource Use, Omingmaktok/Bathurst Inlet (2012)

Figure 4.1-2

Rescan an ERM company

PROJECT # 0194096 0040 GIS # BAC-19-010 December 13 2013

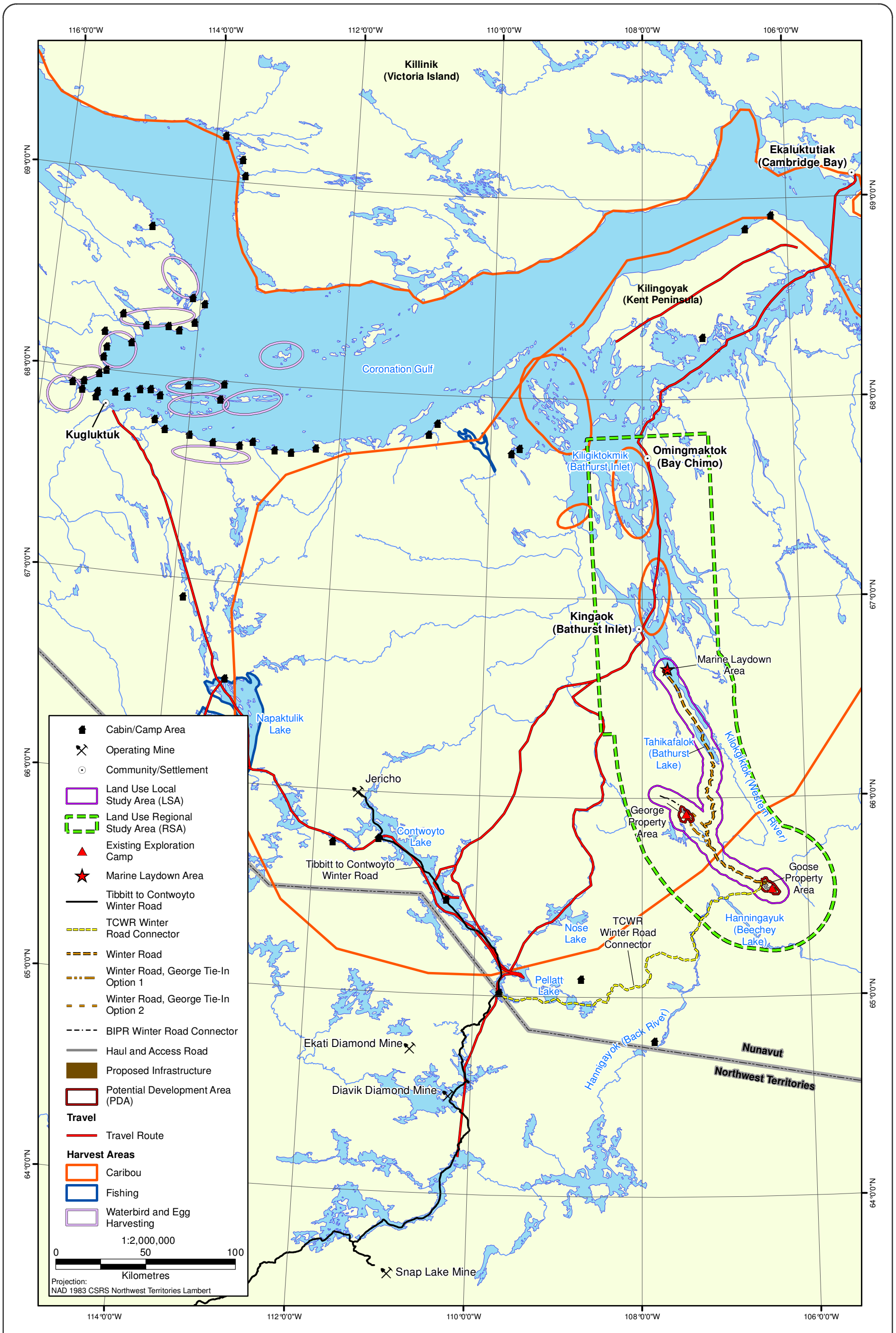


Figure 4.1-3

Sabina GOLD & SILVER CORP.

Land and Resource Use, Kugluktuk (2012)

Figure 4.1-3

Rescan an ERM company

Land Users

Residents of Bathurst Inlet and Omingmaktok have recently relocated to Cambridge Bay; those from Bathurst Inlet relocated approximately five years ago, while those remaining from Omingmaktok relocated in fall 2012. Both groups continue to return to their home communities each spring/summer and also make shorter trips throughout the year (e.g., at Christmas and during spring break). People from Bathurst Inlet and Omingmaktok would prefer to reside in their home communities if they could obtain employment locally (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Cambridge Bay residents have year-round access to the land and resources of Victoria Island. Some residents travel south to the mainland to hunt and fish in November; however, the timing of departure is dependent on weather and ice conditions. Many individuals travel to the mainland because they were born near Bathurst Inlet (Back River Project Research Program 2012).

A notable portion of Kugluktuk land users tend to stay close to the community and participate in harvesting activities on weekends and holidays. For this reason and others related to competition among land users, Kugluktuk land users were hesitant to map their personal hunting areas and reveal to their peers in the focus group which hunting locations had provided them with the most success. Land users noted the recent increase in pelt prices had created healthy competition among hunters and trappers, which underlined the preference to not disclose specific hunting areas. Rather, the group identified common travel routes people use for the purpose of hunting and other harvesting as well as locations known to have an abundance of animals. As such, Figure 4.1-3 identifies the travel route used by hunters and trappers, rather than specifically referring to individual hunting areas.

Although, most Kugluktuk hunters and trappers are engaged in these activities near the community, some spend time travelling and harvesting across the mainland to Bathurst Inlet, and northeast to Victoria Island and elsewhere. A small number of harvesters continue to travel the historic route from Kugluktuk travel to the Contwoyto, Nose, and Pellatt lakes, and then continue on to Bathurst Inlet, and north to Cambridge Bay. Certain land users noted that others travel by boat along the Coronation Gulf coastline, in and around the Kent Peninsula, and beyond the community of Cambridge Bay (Kugluktuk Hunter Focus Group 2012).

Hunting and Trapping

While geographically difficult to access, hunting, trapping, fishing, gathering, and camping does take place throughout the region. Within Cambridge Bay, approximately 75% of people are active hunters, although this includes those originally from Omingmaktok and Bathurst Inlet (Cambridge Bay Hunter Focus Group 2012). Approximately 10 to 20 active hunters continue to hunt in the Bathurst Inlet area (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012) and approximately 80 to 90% of the Kugluktuk population are active hunters. Land users made the distinction that while some individuals harvest fulltime, others mainly hunt on weekends and holidays (Kugluktuk Hunter Focus Group 2012).

Hunters travel in all directions to hunt, fish, and partake in other traditional activities on the land. Species of focus include caribou, wolf, and wolverine, although muskox, seal, geese, fox, eider duck, and grizzly bear are also hunted (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Although grizzly are not a species of focus, and are harvested due to opportunity, sport, or necessity, hunters consume grizzly when the occasion arises, as there has been an increased in grizzly population (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012).

In the summer, people travel in boats along the shores of Bathurst Inlet, hunting caribou and fishing. The areas around the Beechey and Contwoyto lakes are used for hunting, fishing, and camping among other activities (Cambridge Bay Hunter Focus Group 2012). Land users hunt and fish in and near

Bathurst Inlet, south to Contwoyto and Pellatt lakes, east to Ellice River, and also north to Cambridge Bay and beyond. Moose hunting is particularly successful near Omingmaktok and south of the community of Bathurst Inlet (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users from Bathurst Inlet and Omingmaktok harvest seal throughout the Bathurst Inlet area, along shores in the spring and fall, and on ice during the winter. Wolf and wolverine hunting is reported to be optimal near the southern end of Bathurst Inlet. Ptarmigans, fox, and rabbits are also harvested around the Bathurst Inlet area (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Geese, ducks, and other birds and eggs are harvested along the shores of Bathurst Inlet in the spring and fall, although eggs are also harvested more inland (Cambridge Bay Hunter Focus Group 2012).

Caribou hunting takes place year round but is reported to be optimal just before the rut in the fall. In the summertime, caribou are hunted along the shores of the Coronation Gulf. Hunters from Cambridge Bay harvest approximately 20 to 30 caribou before the rut and approximately five or six more over the course of the year. Approximately half of these (25 to 35 caribou per year) would be kept by one family for personal use and the remainder would be distributed throughout the community. Another local hunter from Cambridge Bay noted his usual take was 30 to 40 caribou per year, with an additional five or six throughout the year; this amount provides food for himself, his family, and others in the community (Cambridge Bay Hunter Focus Group 2012). Hunters from Bathurst Inlet and Omingmaktok reported taking between 20 and 50 caribou per year, for personal consumption and to be shared with others (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Trapping activities are much less common today as compared to the past. Cambridge Bay land users report trapping activities are almost non-existent today; however, harvesters from Bathurst Inlet and Omingmaktok continue to trap animals during hunting trips (Figure 4.1-3; (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Kugluktuk trappers reported a recent increase in trapping activities due to an increase in pelt prices that has occurred over the past year. Despite the recent increase in trapping activities by Kugluktuk residents, land users believe overall trapping levels continue to be much lower as compared to the past (Kugluktuk Hunter Focus Group 2012).

Fishing

Fishing occurs throughout the region and is not limited to specific areas. Although focus group participants note certain lakes and rivers are preferred, new lakes and rivers are often and commonly sought out and explored for pleasure and variety (Cambridge Bay Hunter Focus Group 2012). People typically fish along travel routes as they make their way towards a hunting area. Fishing is common on the shores of Bathurst Inlet and in various lakes including Nose Lake, Contwoyto Lake and Pellatt Lake. Species of focus include Arctic char, lake trout, cod, Arctic grayling, whitefish, and wolffish, although clams, seaweed, mussels, sea urchin, crabs, and star fish are also harvested in and near the Bathurst Inlet (Figure 4.1-2; (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users generally harvest as many fish as they can carry, for their own consumption and that of their family and neighbours (Cambridge Bay Hunter Focus Group 2012).

Plant Gathering

Plant harvesting commonly takes place during trips on the land for hunting, but also takes place on a regular semi-daily basis near communities. Species harvested include cloudberry, crowberry, mountain sorrel, and alpine berry. During a hunting trip, harvesters actively look for certain berries, particularly cloudberries, as these are preferred for consumption. (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). Other plants gathered for consumption include sweet leaves, bearberry leaf and flower of Labrador tea, mahok (liquorice root), bog cranberry, and blueberries (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Cabins and Camping

There are a number of cabins located in the region, including personally owned cabins, trapper cabins, and campsites with permanent poles or tent posts (Figures 4.1-1, 4.1-2, and 4.1-3).

Travel Routes

The main travel route utilized by Kugluktuk land users stems from the community, south to Contwoyto Lake, and at times, land users travel beyond to Bathurst Inlet. The main travel route from Cambridge Bay stems from the community, south to Kent Peninsula and on to Omingmaktok, and eventually the southern Bathurst Inlet area, on to Contwoyto Lake or Beechey Lake. The main travel route for land users from Bathurst Inlet and Omingmaktok is now similar to those from Cambridge Bay, due to their recent relocation from Bathurst Inlet and Omingmaktok to Cambridge Bay; common destinations are Contwoyto, Pellatt and Beechey Lake (Figures 4.1-1 to 4.1-3). From main routes, hunting occurs everywhere within approximately 200 km of the route (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). There are other general travel corridors that are commonly used, but the exact route varies each time and is dependent on ice conditions and the purpose of the trip.

People typically travel with approximately 1,000 pounds of gear including food, gas, fish net, tent, chisel, scoop, and many other items. Travellers must carry everything they need to camp and cook, including food itself in case the hunt is not successful. Travel can be made difficult because of weather and climate. Hunters stated their lifestyles have changed along with the change in climate (Cambridge Bay Hunter Focus Group 2012).

Land Use Activities in the Regional Study Area

Land Users

Taloyoak, Gjoa Haven, and Kurtairojuark (based in Kugaaruk) HTO representatives indicated they are not aware of any of their members hunting or trapping in or near the land use RSA. While land users from Kugluktuk did indicate hunting, fishing, and trapping within the land use RSA on occasion, their primary areas of activity are west of the RSA, near Contwoyto and Napaktulik lakes, along the main route leading to Kugluktuk, and along the shores of the Coronation Gulf.

Land users from Cambridge Bay, Omingmaktok, and Bathurst Inlet indicated that they hunt, trap, fish, and gather throughout the land use RSA. Individuals previously residing in Omingmaktok and Bathurst Inlet continue to spend a notable portion of the year in their home communities. Local hunters from the aforementioned communities indicated the land use RSA is used overall and is important for subsistence hunting, fishing, trapping, and gathering, as opposed to particular locations being important. While there are main travel routes within the area, land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables (Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Hunting

Caribou was the most commonly hunted species during both the summer and winter. In summer and fall months, moose and caribou are hunted along the western shores of Bathurst Inlet; at times while travelling by boat (Figure 4.1-2). Bathurst Inlet residents reported three moose were seen in the area in summer 2012. Hunters from Bathurst Inlet and Omingmaktok each reported harvesting a total of between 20 and 50 caribou annually (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Other species commonly harvested in the RSA include wolf and wolverine.

Travel and harvesting occur throughout the land use RSA and there are many different destinations for hunters (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Within the land use RSA, Beechey Lake, a long narrow lake-expansion of the Back River, is a common destination for land users from Bathurst Inlet, Omingmaktok, and Cambridge Bay. The Beechey Lake area is used for hunting, trapping, fishing, gathering, camping, and variety of other recreation activities and is known as a particularly good area for caribou hunting. Bird hunting and egg collection also takes place at Beechey Lake; eider duck and Canada goose are a focus. Within the Beechey Lake area, the species of focus are caribou, wolf, and wolverine (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Beechey Lake is also a main destination for hunters from Cambridge Bay who travel south from the community during the winter on snow machines while fishing Arctic char along the way. The Beechey Lake area is a destination land users choose to spend longer periods of time, sometimes when travelling with their families, due to the rich wildlife, scenic nature views, and availability of camps and cabins (Cambridge Bay Hunter Focus Group 2012).

Hunters from Cambridge Bay reported participating in caribou hunts at the Goose and George lakes. Areas along the Mara River, just west of the land use RSA, were reported as particularly important for wolverine and wolf hunting/trapping. Ptarmigan and rabbit are also found in areas along the Mara River, which is a commonly used travel area leading from the community of Bathurst Inlet. Hunters often travel along the Mara River, hunting wolverine and wolves as they travel south to Contwoyto Lake (Cambridge Bay Hunter Focus Group 2012).

Seal are hunted along shores and throughout Bathurst Inlet, within the land use RSA. Prominent seal harvest areas are located on the western shores of Bathurst Inlet, north of the community of Bathurst Inlet (see Figure 4.1-1). Focus group participants made numerous references to open-water in and near Bathurst Inlet, noting these areas are particularly optimal for seal harvesting (Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Hunters from Bathurst Inlet and Omingmaktok noted four different moose hunting areas on the shores of Bathurst Inlet and Bathurst Lake. Additionally, numerous bird and egg harvesting areas were indicated along the shores of Bathurst Inlet, Bathurst Lake, Beechey Lake and many others. One focus group participant's main caribou hunting area, specifically an area through which the Bathurst herd migrate, is partially within the land use RSA and north of the Hackett River. Fox is also harvested near and south of the community of Bathurst Inlet, while Muskox are harvested east of the land use RSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Fishing

Regionally, fishing takes places throughout Bathurst Inlet, on surrounding lakes such as Beechey Lake, and at many others lakes; fishing is not limited to the specific identified areas. Species harvested in the land use RSA include Arctic char, lake trout, whitefish, cod, wolffish, and Arctic grayling (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Areas along Bathurst Inlet are also reported to be good for harvesting clams, mussels, sea urchin, starfish, and crab. Harvesters take approximately 200 to 400 fish each per year, enough to feed their families and neighbours (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Fishing occurs throughout the year and includes both jigging and set net methods. Focus group participants from Bathurst Inlet and Omingmaktok indicated ice fishing takes places over the Christmas holidays and jigging takes place during spring break, in and near Bathurst Inlet within the land use RSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Species of focus for fishers from Cambridge Bay include Arctic char, whitefish, Arctic grayling, cod, and clams. Cambridge Bay fishers reported the

southern end of Bathurst Bay is known as the best place to fish Arctic char in the region (Cambridge Bay Hunter Focus Group 2012).

Plant Gathering

Within the land use RSA, cloudberries are regularly harvested and frozen for later consumption (Cambridge Bay Hunter Focus Group 2012). Bathurst Inlet and Omingmaktok land users reported harvesting plants and other vegetation in the land use RSA, including sweet leaves, bearberry, blueberries, mahok, bog cranberry, crowberry, and cloudberry. Participants also made note that vegetation and plant life in and around the Bathurst Inlet area is quite different from what is available on Victoria Island, and stated vegetation near Bathurst Inlet is more lush (grows higher and is more green in colour; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Travel and Cabins

Residents of Bathurst Inlet and Omingmaktok travel from Cambridge Bay to their home communities multiple times throughout the year. A number of residents of Cambridge Bay were born in or near the communities at Bathurst Inlet and relocated to Cambridge Bay as children. These individuals also continue to spend time in the Bathurst Inlet area hunting, trapping, fishing, and gathering. Most travel within the land use RSA is by snow machine over ice and land. During the ice-free months, travel is mainly by all-terrain vehicle (ATV) and boat (Cambridge Bay Hunter Focus Group 2012).

Within the land use RSA, there are many travel routes. One common route used by focus group participants from Bathurst Inlet, Omingmaktok, and Cambridge Bay extends from Cambridge Bay to the community of Bathurst Inlet and on to either Beechey Lake or Contwoyto Lake. Local travel patterns are seasonally dependent and often depend on ice conditions, as travel by snow machine between the mainland and the island can only take place once the ice has formed. Travel over the Coronation Gulf is beginning later in the year, typically during the first or second week of December, as the ice is freezing later as compared to past years (Figure 4.1-1 and 4.1-2; Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

There are many camping areas and cabins located within the land use RSA, including some that are no longer used, as well as cabins constructed recently by current land users. One focus group participant indicated the location of his new cabin which was constructed in 2011 within the land use RSA (Cambridge Bay Hunter Focus Group 2012).

Land Use Activities in the Local Study Area

Hunting, trapping, fishing and gathering activities take place throughout the land use LSA. Land users that access this area on a regular basis are typically residents of Bathurst Inlet, Omingmaktok, or Cambridge Bay. Focus group participants from Cambridge Bay identified personal hunting areas that overlap the LSA and discussed use of the southern end of the Bathurst Inlet for fishing and marine harvesting (Figure 4.1-1 and 4.1-2; Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Inuit harvesters reported travel from their cabin at Fishing Creek, near the Marine Laydown Area for the Project, to participate in fishing and other harvesting activities in the surrounding area (Cambridge Bay Hunter Focus Group 2012).

Other Inuit harvesters reported fishing at Bathurst Lake and George Lake on the way to Beechey Lake. Specifically, harvesters reported hunting at George Lake and also indicated they fish at various locations wherever they are hunting. Once harvesters reach the Beechey Lake area, the Goose Lake is one of the surrounding lakes that may be fished. While Goose Lake and George Lake may be fished by traditional land users, they are not known to be destinations or key locations for fishing (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Omingmaktok and Bathurst Inlet land users identified the southern end of Bathurst Inlet as an area used for harvesting moose and seal, as well as fishing. Cod, in particular, are commonly fished in the southern end of Bathurst Inlet. These land users also identified one of their main travel and hunting routes stemming from the community Bathurst Inlet as extending within the LSA for approximately 50 km and as crossing the LSA at numerous points. Along this travel route land users harvest fox, Arctic wolf, and muskox. The land area south of Bathurst Inlet, including the LSA, is important to local Inuit as a location used to harvest caribou during migration to rutting grounds. Additionally, both the George and Goose lakes were identified by this group as areas for egg harvesting (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Cambridge Bay land users hunt caribou, wolf, and wolverine within the land use LSA, along identified travel routes that traverse the northern section of the LSA and then cross the southern portion of the LSA at various points. Individual winter hunting territories encompass the northern half of the land use LSA. The LSA overlaps an area described as mountainous and rocky where Cambridge Bay land users hunt caribou, wolf, and wolverine (Cambridge Bay Hunter Focus Group 2012).

4.1.2.6 Regional Transportation

The main method of transportation in the Kitikmeot Region is by air as the communities are not connected by roads. Other types of traffic include marine vessel and ATV in the summer months, and snowmobile during winter months. Barges (the sealift) deliver annual provisions to communities during the ice-free period. The sealift includes food, household items, construction supplies, heavy equipment, and fuel, among other supplies. Most communities have a barge dock facility that receives barge service from the Northern Transportation Company Ltd. (NTCL) or Nunavut Sealift and Supply Inc. (NSSI) each year. The western Kitikmeot communities, including Cambridge Bay, Kugluktuk, Bathurst Inlet, and Omingmaktok are usually serviced by NTCL (NTCL 2013). NSSI typically provides sealift services to the eastern Kitikmeot communities, with the exception of Kugaaruk which also receives sealift service from NEAS via transhipment at Nanisivik (Mariport Group 2009).

All Kitikmeot communities, with the exception of Bathurst Inlet and Omingmaktok, are accessible by scheduled air travel provided by First Air and Canadian North. Air travel is used for cargo deliveries as well as passenger travel. All communities are also serviced by chartered air travel by a number of companies based in Yellowknife and Edmonton. There is a weekly charter flight from Yellowknife that travels to Bathurst Inlet during the operating season of the Bathurst Inlet Lodge (usually a six week period in the early summer).

4.1.3 Summary

The traditional subsistence economy is of great importance to livelihoods in the Kitikmeot Region. Many individuals within the communities are actively engaged in the traditional economy, and there is evidence that participation is increasing. Harvest activities include hunting, fishing, trapping, and gathering. Maintaining cultural knowledge, education, language, activities, and values are of high importance in Kitikmeot communities. Traditional camps and other education activities are organized for youth, which allows them to learn about Inuit cultural and traditional practices through direct involvement.

As outlined in the NLCA, there are two main types of land tenure in Nunavut - IOL and Crown land. IOL is land that is vested in a Designated Inuit Organization, while Crown land is administered directly by the federal government. Access and rights are administered by RIAs for IOL and by AANDC for Crown land. The Back River Project properties are located on both IOL and Crown land.

There are both cultural and commercial land uses in the vicinity of the Project. Cultural land use typically consists of hunting, trapping, fishing, camping, and travelling, and is guided by a longstanding

relationship of reciprocity and respect between Inuit people and their environments. Commercial land use consists primarily of sport hunting, tourism, mineral exploration, and transportation and shipping. Participation in the subsistence economy remains high and includes the majority of Kitikmeot residents.

Subsistence land use such as hunting, fishing, trapping, and gathering, take place throughout the RSA. Caribou, wolf, and wolverine were the most commonly hunted species; however, marine harvesting for seal and other species was also common. Beechey Lake is a preferred destination for hunters who are active in this area and is reported to have rich wildlife, scenic nature views, and availability of camps and cabins. While there are main travel routes within the area, land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables.

Fishing also takes place throughout the land use RSA in Bathurst Inlet and various lakes and rivers. Species of focus within the RSA include Arctic char, lake trout, whitefish, cod, wolffish, and Arctic grayling. Other species harvested from Bathurst Inlet include clams, mussels, sea urchin, starfish, and crab. Cloudberries, sweet leaves, bearberry, blueberries, mahok, bog cranberry, crowberry, and cloudberry are harvested throughout the RSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012); (Cambridge Bay Hunter Focus Group 2012). Land users travel within the RSA by snowmobile in the winter and by boat or ATV in the summer following seasonally dependent travel routes.

The land use activities of Inuit harvesters within the land use LSA include hunting, trapping, fishing, and gathering. Specifically, the land users most typically active within the land use LSA include harvesters from Bathurst Inlet, Omingmaktok, and Cambridge Bay. Harvesters track wildlife throughout the land use LSA using different routes as dictated by weather conditions, the purpose of the trip and other variables. Within the LSA, caribou was the most commonly hunted species in both winter and summer. However, wolf and wolverine are also commonly harvested species within the land use LSA.

Beechey Lake, which is outside of the land use LSA, is a common destination for Inuit harvesters who hunt and fish as they travel south of Bathurst Inlet. Once harvesters reach the Beechey Lake area and set up a camp, harvesting takes place in a larger area from Beechey Lake; that is within an approximate 20 km circumference, including portions of the LSA. Activities within this area include hunting, trapping, fishing, gathering, camping, and egg gathering. The area is known as especially good for bird harvesting; eider duck and Canada goose are species of focus.

Baseline studies indicate that Cambridge Bay, Bathurst Inlet, and Omingmaktok harvesters consider areas within the land use LSA as portions of their larger hunting areas. Grizzly and fox may also be hunted within the land use LSA, however, on a more opportunistic basis. Finally, seal are hunted throughout Bathurst Inlet, including areas within the northern portion on the land use LSA.

Overall, land use within the LSA reflects current land use patterns throughout the western Kitikmeot region. Land users indicated specific locations of use within the land use LSA but also use the surrounding areas to conduct harvesting activities.

4.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Information on Traditional Knowledge (TK) was accessed and used to inform the selection of valued socio-economic components (VSECs), as well as the spatial and temporal boundaries for the assessment of potential Project effects on land use. TK was also used in the effects assessment itself, and in the development of mitigation and adaptive management to minimize potential adverse effects of the Project.

In Nunavut, TK is encompassed by the concept of Inuit Qaujimajatuqangit (IQ). IQ is described as "[t]he traditional, current, and evolving body of Inuit values, beliefs, experience, perceptions, and knowledge regarding the environment, including land, water, wildlife and people, to the extent that people are part of the environment" (Qikiqtani Inuit Association 2009) or literally translates to "that which the Inuit know and have always known." Because land use is intimately connected to the environment and the Inuit people's relationship with the environment, the incorporation of TK was an important aspect of the assessment of the potential effects of the Project on land use VSECs.

4.2.1 Incorporation of TK for Existing Environment and Baseline Information

The information provided in the TK report (KIA 2012) was reviewed as a reference point from which to interpret information gathered in land use focus groups conducted in the Kitikmeot in 2012. The analysis of this information highlighted the way in which land use activities have changed as well as the ways in which they have remained similar. Travel and harvest routes discussed in KIA (2012) are called "lifeways", a term Inuit have used to indicate the multiple elements of or connections between the routes travelled, harvesting activities, camping and generally living and experiencing life. This term aligns with recent discussions of land use activities that highlighted the holistic nature of Inuit land use. There are a number of ways in which the TK report (KIA 2012) compliments and informs the study of current land use activities. For example, KIA (2012) noted that:

- In the past, camps and cabins on the land were seasonal, spread across the landscape, and only used for a few days at a time. While more permanent camps exist today, baseline research participants (e.g., land use focus groups) frequently referred to the numerous camps and tent sites currently available for use at varying locations, alluding to knowledge deeper than the sum of one's experience.
- Travel in the past was founded on the movements and patterns of animals. Comparatively, a number of relatively new elements direct modern harvesting, for example, wage employment, food security, and access to costly equipment. Understanding the implications of this change on harvesting activities at the level of the community informs the assessment of baseline and future conditions.

Overall, KIA (2012) enabled an analysis of how harvesting activities have changed and the ways they've remained the same. Notably, some differences included:

- Greater past use of skins and other animals parts for clothing, shelter, and other tools;
- Use of different tools and modes of transportation to support harvesting activities;
- Methods of harvest (e.g., the TK report indicated that in the past, Inuit would sometimes build a rock pile to hide behind until caribou wandered by, providing an opportunity for the Inuit to shoot the animal with a bow and arrow);
- A fear of certain animals (e.g., grizzly bear) in the past; and
- Species preference (e.g., in the past muskox became a focus only when caribou were scarce, and wolverine was not hunted by Inuit prior to the introduction of the fur trade).

The similarities between past and current harvesting and land use practices are numerous; however, a select few to highlight include:

- Species harvested and popular or successful locations targeted for harvesting;
- Travel routes; and
- The presence or absence of species in specific areas (KIA 2012).

Other reports of both Inuit TK and ethnographic accounts by individuals who encountered Inuit groups in the past and recorded their observations provided information that was incorporated into the existing environment and baseline. These include Blower (2003), Thorpe et al. (2001), and Usher (1976).

The Blower (2003) study was conducted as part of the permitting process for the Bathurst Inlet Port and Road (BIPR) Project further confirmed the importance of the Beechey, Pellatt and Contwoyto lakes described during recent land user research. Other confirmations offered through the TK described in this report include:

- Species hunted and rationale:
  - Wolves and caribou are found in the general area and so Inuit hunting caribou are also hunting wolf (and vice versa);
  - Bird species consumed; and
  - Hare and other small mammals become species of focus when larger game is unavailable.
- Harvesting locations and methods:
  - Waterfowl along the coast and on Arctic islands;
  - Hood, Burnside, and Mara Rivers remain popular destinations for fishers; and
  - Methods for harvesting seal, fish, and other animals including tools (e.g., spears and nets for fishing).
- Division of species of focus and trading:
  - In the past, Inuit could not focus on caribou and seal simultaneously due to the differences in timing and availability of wildlife. Rather, inland Inuit focused on caribou and coastal Inuit focused on seal. The two groups would meet up to visit and would trade skins and other mammal products.

Usher (1976) also confirms and contrasts a number of past and current land use activities. For example, the report confirms:

- Caribou hunting at Pellatt and Contwoyto lakes;
- Caribou and muskox hunting as well as fishing at Nose Lake;
- Seal hunting along the coast;
- Caribou hunting along shores; and
- Contwoyto, Nose, and Pellatt lakes as frequented hunting areas.

As well, Usher (1976) detailed traditional harvesting as based on the movement of animals, which enables insight as to important times of the year for harvesting. Specifically, prior to trading posts, Inuit people followed a generalized seasonal activity cycle that included the spring hunting of seals and jigging for fish, followed by movement of the group inland to hunting migrating caribou, and then summer caribou hunting and inland fishing, which transitions into use of fishing weirs to take advantage of the char run in the fall. Next, winter caribou and seal hunting would again become a focus.

The Tuktu and Nogak Project (2001) highlights the differences between the Inuit harvesters and land use of the past with that of modern times. Based on the accounts of Kitikmeot Elders, the report details differences between the use of caribou, means through which Inuit can get caribou, and how the related social activities have changed alongside changes to the harvest of caribou.

4.2.2 Incorporation of TK for Valued Socio-economic Component Selection

The Project TK report (KIA 2012) illustrates the cultural values of the Kitikmeot Inuit which identified elements for consideration for the scoping of land use VSECs for the Project. Other sources that inform that process included consultation with local communities, regional Inuit organizations, land users, and other stakeholders (Volume 9, Chapter 1). The TK report (KIA 2012) informed the discussion and scoping of land use VSECs by describing the cultural values of the past, which provides a contextual base for the consideration of current values as described by Kitikmeot residents.

Situating current land use values within their traditional context enables a more informed analysis within baselines studies as well as a more rigorous effects assessment. KIA (2012) presents summary information 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 incorporated in the land VSECs selected.

4.2.3 Incorporation of TK for Spatial and Temporal Boundaries

KIA (2012) presented mapped information showing traditional areas of use, valued animal species, environmental components, and traditional land use activities. This information provided a context through which a deeper understanding of the location of current land use activities could be established. For example, there were many consistencies between the information presented in the Project TK report (KIA 2012) and land use activities reported and mapped in land use baseline research focus group sessions. Understanding the past highlights spatial and temporal aspects of the relationship between Inuit and the land. For example, many of the travel routes and camp or cabin sites used by harvesters today are those used by their parents and grandparents.

Understanding the land use activities of the past also highlights the changes that have taken place following settlement in the Kitikmeot communities. For example, where in the past harvesters would participate in extended multi-week or month trips on the land to harvest and participate in other cultural activities, the introduction of the wage economy has caused some harvesters to alter the extent and duration of their activities. Overall, understanding current land use within the context of traditional land use better informed the selection of spatial boundaries for the baseline study and effects assessment. In particular, the spatial boundaries for the land use effects assessment were chosen to encompass current land use activities and values that are potentially impacted by the Project, while also considering the locations of key traditional activities that have occurred in the past.

4.2.4 Incorporation of TK for Effects Assessment

The effects assessment relies on the information collected and analyzed during baseline studies. The inclusion of TK within the existing environment, and as related to the selection of land use VSECs, and spatial and temporal boundaries, all facilitate the production of a more accurate and relevant effects assessment. Inclusion of information provided in the TK report (KIA 2012) provides insight into the characteristics of land use activities many years ago, which in turn enables a deeper understanding of current land use activities and the events or circumstances that have changed or altered these activities since that time. Knowing how past events and circumstances have affected Inuit land users is invaluable to developing an understanding of how the activities of the Project that occur in the future might affect Inuit land users.

4.2.5 Incorporation of TK for Mitigation and Adaptive Management

Mitigation and adaptive management measures relevant for land use include those that seek to support and maintain current harvesting activities. Again, the Project TK report (KIA 2012) provided details of past land use activities for consideration within the broader context of current land use. The analysis

of this information enabled comparison and highlighted areas in which these activities have both changed and remained the same since settlement in the Kitikmeot Region communities, revealing events and circumstances that result in potential positive and negative outcomes for harvesters. This information provided guidance in developing mitigation and adaptive management measures that seek to maintain and enhance the harvesting activities of Inuit who become engaged in mine employment. Consideration was given to the maintenance of traditional harvesting activities and lifestyles when developing the routinized operation of the Project. For example, the fly-in/fly-out operation enables mine employees to return home during their time off work. This measure is further enhanced by the work schedule (e.g., a two-week on/two-week off rotation) that allows for longer periods of time off conducive to harvesting activities.

4.3 VALUED COMPONENTS

4.3.1 Potential Valued Components and Scoping

VSECs are aspects of the human environment considered to be of vital importance and include 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 2013a). VSECs to be examined in the assessment of the effects of the Project on land use, as an important constituent of the human environment, were selected based on the potential interaction with Project activities and informed through consultation with communities, regulatory agencies, available TK, and professional expertise (Volume 9, Chapter 1). Specifically, the determination of land use VSECs and potential effects for inclusion in this effects assessment considered and was informed by:

- the Environmental Impact Statement (EIS) guidelines (NIRB 2013a);
- the public, during public consultation and open house meetings held in the Kitikmeot communities;
- Local land users, during focus group and mapping sessions with residents of Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet;
- meetings with regional Inuit groups (for example, the KIA);
- interviews with individuals engaged in local tourism activities; and
- Kitikmeot Community Advisory Group (CAG) meetings comprised of local stakeholders (e.g., HTO representatives).

A number of additional key data sources also provided context to inform the selection of land use VSECs and effects to be assessed including the 2012 Socio-economic and Land Use Baseline Report (Appendix V8-3A; Rescan 2012), the draft NLUP (NPC 2012), Nunavut Impact Review Board (NIRB) reference and guidance documents (NIRB 2013b, 2013c), and the TK report (KIA 2012). Concerns expressed during community meetings, focus groups, interviews, and other meetings with the KIA and relevant government bodies were integrated within specific VSECs for further examination in the assessment process.

Information and results from other EIS chapters were integrated to further inform the assessment of the potential effects of the Project on land use, including Public Consultation, Government Engagement, and Traditional Knowledge (Volume 3), Atmospheric Environment (Volume 4), Terrestrial Environment (Volume 5), Freshwater Environment (Volume 6), and the Marine Environment (Volume 7). Specific chapters and sections of these volumes are referenced, where appropriate, as they are considered in the land use effects assessment.

The EIS Guidelines (NIRB 2013a) require an assessment of the potential effects of the Project on VSECs that address both traditional and non-traditional land use. Project-related changes to the environment (e.g., from noise and emissions, or direct physical impact on or displacement of animals and vegetation or their habitats) may have implications related to land access, experience of the natural environment, and the abundance of wildlife resources.

Multiple scoping sessions held by NIRB with local stakeholders and community members (i.e., the public) facilitated discussion to identify components important to land users and land use generally, as related to the Project. Comments made during these sessions were compiled and analysed as part of VSEC scoping. Notably, of 90 remarks related to the human environment, almost half were linked to subsistence land use, harvesting and land use, the importance of land, and country foods. All comments were considered during VSEC selection. A number of comments are highlighted below to showcase content considered:

> *Bathurst area is very beautiful, we go there to hunt/camp, and they should put aside some land where there should be no development. I am not against development I would just like to see some land be put aside where we can for the future be used by our young people.*
>
> *As Inuit we hunt and fish. In the spring we go into camp areas to make our preparations. I have been concerned about contaminants that go into the environment and the food that our wildlife eats.*
>
> *There are concerns about road locations, shoreline locations and barging activities. It is beautiful location with lots of wildlife, is an area where caribou move. It is a caribou migration route. There are a lot of families using the area all year round.*
>
> *The most important things in a community are health and food. It doesn't matter how much money that the community gets in the end, because it gets siphoned out. It's the land, the food, the animals, the people.*
>
> *Young people are surviving on money and wages today. In the past we lived off the land. It will be fine if this project goes ahead along as the environment is protected. That is where my livelihood is.*

Community research, specifically interview and land use focus groups held in study area communities, also informed the selection of VSECs for land use. Lodge owners and guides discussed the importance of the surrounding areas to their business and highlighted aspects of the services provided by the lodges relevant to the development of the Project. Land users participated in group discussions about their activities on the land and changes experienced over time, as well as the continuing future role of Inuit land use and harvesting activities. Further details describing the results of community research and the land use focus groups are provided in Section 4.1. The results of community research, as well as community and public consultation and scoping sessions, collectively informed the selection of VSECs for land use, as both traditional and non-traditional land users may experience changes as a result of the Project.

4.3.2 Valued Components Included in Assessment

The VSECs selected to assess the potential effects of the Project on land use in the LSA and RSA include:

- Non-Traditional Land and Resource Use; and
- Subsistence Economy and Land Use

The land use VESCs represent two types of land users present in the area and are linked to the human aspects of the Project's potential effects on the land and environment. People engaged in non-traditional land and resource use include those in the tourism industry (i.e., lodge owners, tour operators, and guides). This does not include mining exploration and development as the Project is not expected to interact with these activities with respect to land use. People engaged in the subsistence economy and land use are Inuit harvesters engaged in traditional land use activities. Both groups rely on wildlife, fish, bird, and vegetation populations and, inherently, the terrestrial and aquatic environments that support those populations. These VSECs are broadly defined to be inclusive of varying aspects of land use that exist in the LSA and RSA.

4.3.2.1 Potential Land Use Effects Included in the Assessment

Examination of the potential effects of the Project resulted in the identification of three potential effects that interact with current land use activities to be carried forward for further consideration and assessment. The three potential effects have been defined in a way that enables the reader to understand the direct effects of the Project (e.g., reduction in access to land) and the implications of these effects for land use activities conducted in the area. The three potential effects included in this assessment are:

- changes in access to land and resources;
- changes to the experience of the natural environment; and
- changes to the abundance and distribution of resources.

The review of potential effects identified through the various sources detailed in Section 4.3.1, in some instances, refined the effect to enable a more focused analysis; that is, where no interaction between the Project and the VSECs (*non-traditional land and resource use* and *subsistence economy and land use*) can occur, that aspect of the effect was scoped out. For example, if an effect considered the implications of the Project for both fishing and camping and there was no potential for implication for fishing, the effect was refined to only consider camping. The aim of this approach was to clearly define the effect, how the effect is linked to the Project, and how the Project-induced effect interacted with either non-traditional or subsistence land use.

Changes in Access to Land and Resources – this potential effect is defined as the loss of use of an area of land and its resources within the land use LSA. This effect includes consideration of areas for hunting, fishing, traveling, and commercial recreational activities potentially affected as a result of Project development, including consideration for Project roads and marine shipping. This effect has the potential to impact both traditional and non-traditional land users. The discussion of change in access to land and resources will also consider any change to currently used travel routes. The ability to travel near the Project area by skidoo and boat was noted as a concern during some public consultation meetings with the Kitikmeot Inuit. Access to land and marine areas for hunting and travel were noted as important during consultation with local communities.

Changes to the Experience of the Natural Environment – this potential effect is defined as changes to the character and sensory experience associated with use of the land and includes changes to visual and aesthetic resources. The development of the Project may alter land users experience of the natural environment within the land use LSA and RSA by causing changes to levels of noise, emissions (e.g., dust and exhaust) and vibrations. Wildlife and bird populations may also be affected by these changes; however, as this was noted as important in public meetings, changes to the abundance and distribution of resources (e.g., wildlife and birds) as a result of the Project is assessed as a separate effect.

Direct and indirect statements linked to the experience of the natural environment were noted during public consultation meetings in the Kitikmeot communities. The appearance and natural elements of an area were noted as important to land users. Activities supported by a natural environment were also noted as important.

In addition to changes to visual and aesthetic resources, there are three main changes to characteristics of the natural environment that may change how it is experienced. These include noise, vibration, and air quality which are anticipated as a result of:

- blasting, drilling, and processing activities;
- operation of heavy equipment, including noise and emissions;
- traffic, including noise and emissions from vehicles; and
- construction of facilities, roads, and other mine infrastructure.

The scope of this effect is reduced by location as notable changes to noise, vibration, and air quality are expected at only two of the three Project locations within the land use LSA (see Volume 4, Atmospheric Environment). Specifically, this effect is only anticipated at the George and Goose Properties and not at the Marine Laydown Area (MLA). However, baseline studies did not identify non-traditional land and resource use in the vicinity of the George and Goose Properties. Therefore, there is no interaction between non-traditional land and resource use and changes to the experience of the natural environment at the George and Goose Properties and this effect will not be further assessed. However, there remains a potential for an effect due to Project-related air and marine traffic and changes to the visual and aesthetic environment at the MLA. Baseline studies did indicate non-traditional land and resource use, including camping associated with Bathurst Inlet Lodge, at Fishing Creek and Bathurst Lake. Fishing Creek is located adjacent to the MLA within the land use LSA. The winter road connecting the George and Goose Properties to the MLA extends through the length of Bathurst Lake.

- *Fishing Creek* - Although changes to noise, vibration, and air quality are expected to be minimal at the MLA, non-traditional land and resource use activities that occur near this site (associated with the Bathurst Inlet Lodge) and depend on the natural environment and lack of development in the area. As a result, changes to the experience of the natural environment effecting non-traditional land and resource use at the MLA will be further assessed (Section 4.5.2).
- *Bathurst Lake* - Baseline studies indicate there is a camp at Bathurst Lake associated with the Bathurst Inlet Lodge. Camps of this nature typically provide access to tent rings, meat drying racks, and meat caches. Traffic on the winter road is not expected to affect potential visitors to the camp at Bathurst Lake as the lodge operates from June to September, a time during which the winter road would not be in use. Therefore, changes to the experience of the natural environment for non-traditional land and resources users will not be further assessed for use at Bathurst Lake as a result of the development and use of the winter road.

Baseline studies also indicated use of areas near the George and Goose Properties by local hunters, as well as in the vicinity of the MLA and winter roads. The effect changes to the experience of the natural environment as related to the VSEC “subsistence economy and land use” will be further assessed (Section 4.5.2).

Changes to the abundance and distribution of resources – this potential effect considers the consequences of changes to the abundance and distribution and resources for land use. The term resources refers to wildlife, fish, and bird populations and includes changes to caribou and other

harvested terrestrial species, birds and their eggs, fish , and vegetation. This effect is relevant for both non-traditional and subsistence land users who rely on these resources. Consideration is given to the potential effects of the Project on the accessibility of caribou and other terrestrial wildlife species for harvesters where such may be affected by reductions in habitat and herd sizes and/or expected changes to migration patterns. Effects to caribou migration patterns were noted as particularly important during consultation with the Kitikmeot Inuit. This effect includes consideration of impacts to marine wildlife of cultural or practical importance to northerners. Consideration is also given to other changes affecting these resources including, for example, water quality and air quality.

Numerous statements were made during public consultation meetings and research with land users to highlight the importance of wildlife, birds, fish, and vegetation to Inuit. Non-traditional and subsistence land users rely on these populations for their livelihood and have a vested interest in understanding the effects of the Project as well as the associated mitigation and monitoring measures.

4.3.2.2 Potential Land Use Effects Excluded from Further Assessment

Additional potential effects on land use are identified by the 2013 EIS guidelines (NIRB 2013a), and further reflect issues and concerns raised through public consultation and research activities. In a number of instances, effects have been excluded from further evaluation as stand-alone potential Project effects and instead are considered as part of one of the three effects noted above that are included in the assessment. In other cases, individual effects are excluded because Project activities are not predicted to substantially interact with the identified VSECs resulting in the effect in question. An explanation for the exclusion of specific land use effects is provided and the reader is encouraged to review additional content provided elsewhere in the EIS supporting the conclusion. Potential effects or changes caused by the Project that are not expected to interact with non-traditional or subsistence land use activities, or that do interact but are not assessed as part of the potential effects defined for assessment (Section 4.3.2.1), include:

1. Potential changes to the accessibility of areas for marine harvesting;
2. Changes to commercial fisheries;
3. Changes to perceptions of the natural environment;
4. Changes to the accessibility of areas for religious activities;
5. Changes to sustainable resource use, such as country food availability and accessibility of carving stone deposits;
6. Changes that the contamination of traditional food sources (including those trapped, fished, hunted, harvested, or grown for subsistence or medicinal purposes) may cause for individuals, families, communities, and the general ability of Inuit to engage in traditional lifestyles;
7. Changes to non-traditional land and resource use including protected areas;
8. Interactions between project development and land use activities by local residents;
9. Changes to the tourism industry as a result of the Project's effects on the wilderness experience; and
10. Increased access to land and resources by non-local individuals.

The rationale for the exclusion of each of these effects is provided in Table 4.3-1.

Lastly, measures taken to maintain compliance with Nunavut's *Official Languages Act* (2006) are described in the socio-economic effects assessment (Section 3.8.3) as part of the Back River Socio-economic Management Plans (i.e., the Human Resources Plan, Volume 10, Chapter 28).

Table 4.3-1. Potential Effects on Land Use Excluded from the Assessment

Potential Land Use Effect	Rationale for Exclusion
Potential changes to the accessibility of areas for marine harvesting as a result of Project development	• Project-related shipping will only occur during summer months and will be of limited intensity. As such, shipping is not anticipated to have a notable effect on Bathurst Inlet marine mammal and fish populations. See Volume 7, Marine Environment. • The addition of three to five ships per summer during Project operation to an area presently used for shipping is not expected to cause notable changes to marine harvesting. As a result, this potential effect is not further assessed.
Changes to commercial fisheries	• Baseline studies indicated there were no commercial fisheries operating within the land use LSA and RSA. There is one fisheries licence located within the Bathurst Inlet; however, this fishery is not currently active. To establish a commercial fishery Health Canada requires there be a processing plant within one hour (or 30 to 35 miles) from the point of harvest (Kitikmeot Foods 2011; Back River Project Research Program 2012). This requirement deems the development of a commercial fishery not economically feasible at this time. As a result, this potential effect is not further assessed.
Changes to perceptions of the natural environment	• The development of the Project may alter one's experience of the natural environment within the land use LSA or may change their perception of the area generally. It is not feasible to meaningfully evaluate changes to perceptions of the natural environment as a result of the Project. The way in which individuals perceive the natural environment is complex and likely linked to a number of variables. However, the potential effect "changes to perceptions of the natural environment" is instead evaluated as part of the more tangible effect "changes to the experience of the natural environment" as it can be related to the potential for changes in the visual environment, air quality, noise, and vibrations.
Changes to the accessibility of areas for religious activities	• Baseline studies and TK information (KIA 2012) did not indicate any use of land within the land use LSA and RSA for religious activities. Therefore, the effect of changes to accessibility and land used for religious activities will not be further assessed.
Changes to sustainable resource use, such as country food availability and accessibility of carving stone deposits	• The Project is not anticipated to significantly affect the availability or quality of country foods (Country Foods Volume 8, Chapter 5). Further discussion and evaluation of potential Project effects on food security is assigned to the socio-economic effects assessment (Chapter 3). • Carving stone deposits have not been identified within the land use RSA and so are not expected to be impacted by the Project. If during Project activities, earth works uncover carving stone deposits, Sabina will endeavour to set aside these deposits for communities, where practicable. Changes to sustainable resource use are not anticipated to result from the Project; therefore, this potential effect will not be assessed further.
Changes the contamination of country foods may cause and the ability of Inuit to engage in traditional lifestyles	• The Project is not anticipated to cause significant changes to the level of contaminants in country foods (see country foods effects assessment, Volume 8, Chapter 5). As a result, this effect is not assessed further. • The ability of Inuit to engage in harvesting activities is further assessed as a component of the effect "changes to the abundance and distribution of resources" and "changes to land access and resources."
Changes to non-traditional land and resource use including protected areas	• There are no protected areas within the vicinity of the Project. Huikitak River Conservation Area is the closest conservation area and is located approximately 88 km from the George Property; the Queen Maud Gulf Migration Bird Sanctuary is located approximately 109 km from the Goose Property; and Wilberforce Falls is located approximately 144 km from the George Property. Further information about protected areas in the region is provided in Appendix V8-3A. The Project is not anticipated to have an effect on protected areas so this potential effect is not assessed further.

(continued)

Table 4.3-1. Potential Effects on Land Use Excluded from the Assessment (completed)

Potential Land Use Effect	Rationale for Exclusion
Interactions between project development and land use activities by local residents of the RSA	• Interactions between land users and Project components at the site are considered for safety reasons and will be managed as described in the Human Resources Plan (see Socio-economic Effects Assessment, Section 3.8.3). • "Changes in access to land and resources," "changes to the experience of the natural environment," and "changes in the abundance and distribution of resources" and how these changes affect land use will form the basis of this assessment. To avoid duplication, this potential effect as stated here will not be carried forward for further assessment as a stand-alone effect.
Changes to the tourism industry as a result of the Projects effects on the wilderness experience	• Changes to the tourism industry as a result of Project effects on the wilderness experience will be assessed as part of "changes in access to land and resources," "changes to the experience of the natural environment," and "changes to the abundance and distribution of resources." To avoid duplication, this potential effect as stated here is not carried forward for further assessment as a stand-alone effect.
Increased access to land and resources by non-local individuals	• Change in access to land and resources may occur upon completion of the potential winter road to Contwoyto Lake. Although the road would be private and not open for public use, it is reasonable to expect some level of unauthorized use. The Project will monitor use of the winter road and make reasonable efforts to enforce the public use restriction. Should individuals otherwise access the private road, the increase in access to local land and resources there could result in increased pressure on resources. However, given operation of the winter road as a private road, limited duration of operation in the winter, and the remoteness of the location, this potential effect involves, at most, a relatively small number of individuals with infrequent access over a large land area. Consequently, this potential effect is not assessed further.

4.4 SPATIAL AND TEMPORAL BOUNDARIES

4.4.1 Spatial Boundaries

The land use RSA was defined as the area of land and water that encompasses the Project and is consistent with the largest boundary of the wildlife, regional marine, and terrestrial study areas as defined by those disciplines (Figure 4.4-1). The RSA is 2,115,813 ha in size. This boundary is chosen because of the strong link between these environmental components and traditional use activities.

For the effects assessment, a land use LSA was also defined. Greater focus is provided within the land use LSA, an area that encompasses the Project Development Area (PDA) and areas immediately surrounding the physical Project infrastructure (Figure 4.4-1). The LSA was chosen as the area for which direct Project effects on land use may be experienced due to activities associated with the PDAs, consisting of the Goose Property Area, the George Property Area, the MLA, and the winter road corridors. The land use LSA is 226,042 ha in size.

4.4.2 Temporal Boundaries

The temporal boundaries for each VSEC are defined in relation to planned activities over the life cycle of the Project within which a reasonable expectation of interaction can be predicted. The temporal boundaries for the Project phases are defined as follows:

- Site Preparation: 2 years
- Construction phase: 2 years
- Operational phase: 10 years

- Reclamation and Closure phase: 10 years
- Post-closure phase: 5 years
- Other Phases:
  - Temporary Closure: less than 2 years
  - Care and Maintenance Phase: 2 to 10 years

4.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

This assessment of effects was informed by a methodology (Volume 9, Chapter 1) used to identify and assess the potential land use effects of the Project and is consistent with the requirements of Section 12.5.2 of the NLCA and the EIS guidelines (NIRB 2013a).

4.5.1 Methodology Overview

Effects are changes to current aspects of the environment or human activities that occur as a result of the Project. This effects assessment involved a process of identifying the effects of the Project that would result in changes to the environment that, in turn, would have implications for current land use activities.

This assessment follows the general methodology provided in Volume 9, Chapter 1. The analysis of effects considered the information provided in the following sources:

- 2012 Socio-economic and Land Use Baseline Report (Appendix V8-3A);
- Inuit TK (Usher 1976; Thorpe 2001; Blower 2003; KIA 2012);
- land use focus group sessions;
- interviews with individuals engaged in local tourism activities in the western Kitikmeot;
- Kitikmeot Community Advisory Group (CAG) meetings; and
- the EIS Guidelines (NIRB 2013a).

This assessment was further informed by the draft NLUP (NPC 2012), the results of public consultation and open house meetings held in the Kitikmeot communities, and professional judgement.

4.5.1.1 Identification of Residual Effects and Significance

The effects assessment process comprises a step-wise method to assess potential effects of the Project on land use, as follows:

1. Identification of potential interactions between the Project and land use, which includes: “non-traditional land and resource use,” and “subsistence economy and land use.”
2. Characterization of the potential effects that could result from these interactions.
3. Identification and description of mitigation and management measures that will be taken to eliminate or reduce the potential effects.
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied.
5. Assessment of defined attributes to rate the significance of residual effects, including: direction, magnitude, geographic extent, frequency, duration, reversibility, and probability (Volume 9, Chapter 1).

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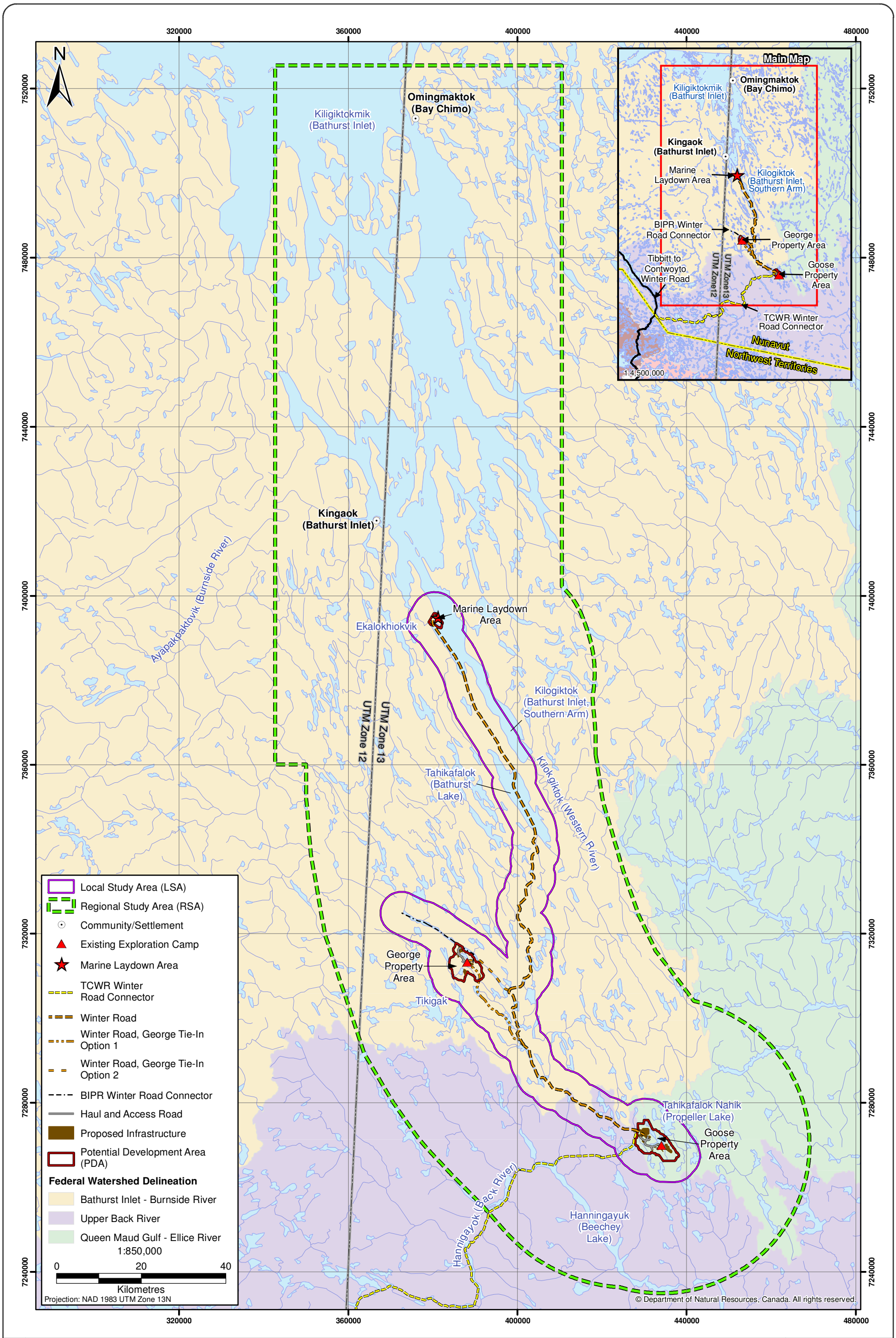


Figure 4.4-1

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Local Study Area and Regional Study Area for Land Use

Figure 4.4-1

Rescan an ERM company

Each Project component is evaluated for land use for the defined project phases: Site Preparation, Construction, Operational, Reclamation and Closure, Post-closure, Temporary Closure, and Care and Maintenance. For each potential effect on land use, the nature of the effect is characterized. First, the direction of a residual effect is determined to be positive or negative. All effects are then assessed according to several criteria. The magnitude of the effect, duration, and geographic extent were used as the primary criteria; the reversibility and frequency of the effect as secondary criteria. Combined with the probability that the effect will occur, the significance of the effect was rated as positive, negative and Not Significant, or negative and Significant. Finally, the level of confidence (certainty) in the rating was provided as a qualifier. The rating of residual land use effects is based on the attributes summarized in Table 4.5-1. In considering the magnitude of each residual effect on land use, definitions are referenced to designate each effect as having either a low, moderate or high magnitude, as defined in Table 4.5-2.

Table 4.5-1. Summary of Attributes to Inform the Significance Rating of Effects

Attribute	Definition
Direction	The direction of an effect can be positive, negative, or variable. The determination of the direction of an effect is based on information provided and values expressed during community research, in TK, and through existing documentation (e.g., past experience with resource development projects).
Geographic Extent	The geographic extent of an effect designates whether the effect will be experienced in the land use LSA, RSA, or beyond.
Magnitude	The magnitude of an effect is the level of change relative to the baseline condition, and is rated as "low," "moderate," or "high."
Frequency	The frequency of an effect provides an indication of how commonly the effect will occur during the Project, and is rated as "once" (infrequent, occurring only occasionally), "sporadic" (intermittent or occurring only at periodic points in the Project), or "continuous" (occurring throughout the phase of the Project).
Duration	The duration of an effect indicates how long an effect will continue to affect those who experience it and is rated as "short term" (over a period of up to four years), "medium term" (greater than four years and up to 25 years, the combined duration of Site Preparation, Construction, Operational, and Closure phases), or "long term" (beyond the life of the Project).
Reversibility	The reversibility criterion considers the likelihood of recovery from an effect, specifically, considering the application of adaptive management and active management interventions that may be required to bring the effect to an acceptable level. The reversibility ratings are defined as follows: Immediately reversible - effect reverses within an acceptable time frame and with no intervention. Reversible with a cost/effect, management required - active intervention is required to bring the effect to an acceptable level. Irreversible - effect will not be reversed.

Table 4.5-2. Definitions of Magnitude Ratings for Land Use Effects

Magnitude	Descriptor of Magnitude
Low	Effect is expected to result in slight changes from baseline conditions, causing minimal disturbance to land users and land use activities.
Moderate	Effect is expected to result in a notable change from baseline conditions, similar to historic changes or variability that has occurred previously without the Project, and is likely to cause land users to modify or alter their activities.
High	Effect is expected to result in extreme changes as compared to baseline conditions, beyond historic changes that have occurred previously without the Project, that substantially modify or eliminate current land use activities.

Overall significance of a residual effect is derived from the available information and the experience and professional judgment of the practitioners who prepared the assessment and considering the ratings of the attributes that contribute to significance (Tables 4.5-1 and 4.5-2). Both quantitative and qualitative evaluation of the degree to which residual effects are predicted to cause changes to land use were used to determine the ratings for each attribute. Again, residual effects to land use were characterized as positive, negative and Significant, or negative and Not Significant as guided by the definitions provided in Table 4.5-3. For example, an effect receives a rating of "negative and Not Significant" if it is evaluated as one or more of the following: low in magnitude, confined mainly to the Proposed Development Area or the LSA, or of short duration.

Table 4.5-3. Definitions of Significance Ratings for Land Use Effects

Significance	Descriptor of Significance
Positive	Effect is predicted to result in overall improvements in land use relative to the baseline within the RSA, as measured primarily by the magnitude and duration of the positive effect on land use.
Negative and Significant	Effect is expected to result in an overall decline in land use in comparison to baseline conditions, with the negative effect widespread across the RSA and beyond and of at least moderate magnitude and medium term in duration.
Negative and Not Significant	Effect may result in a decline or change in land use activities limited mainly within the LSA or of low magnitude or short duration relative to baseline conditions.

The following sections present the land use effects assessment of the Project. First the potential for interactions between Project components or activities with current land use activities are discussed and characterized. Second, the mitigation measures applicable to each effect are presented. This is followed by an analysis and examination of effects that remain following mitigation, which are characterized as residual effects to be rated for significance.

4.5.2 Potential Interactions with Project and Characterization

This section describes the nature of the potential interactions between Project components or activities and the land use VSECs, *non-traditional land and resource use* and *subsistence economy and land use*. Potential effects were identified in the scoping of Project effects (Section 4.3.1.2). Of the potential effects arising from the Project, three were identified as interacting with current land use activities (both non-traditional and subsistence), including:

- **Changes in access to land and resources** – Project activities may impede land users from executing typical patterns of land use and travel routes as access to the PDA will be restricted. Individuals present in the area include both non-traditional land users and subsistence land users traveling through while hunting, trapping, fishing, and gathering.
- **Changes to the experience of the natural environment** – the Project is located in an area characterised as remote wilderness relatively undisturbed by humans. The level of current activity in the land use LSA is minimal, yet may be impacted by the visual presence of the Project. In addition, Project-related noise, emissions, and vibrations will likely alter the character of the area for land users that do use the LSA.
- **Changes to the abundance and distribution of resources** – the presence of Project infrastructure and activities may deter wildlife populations. The loss of vegetation and habitat caused by infrastructure development may cause area resources (e.g., wildlife, fish, and bird populations) to reduce in abundance and/or relocate to other areas. These Project-related changes to the abundance and distribution of wildlife, fish, and plant populations may have implications for non-traditional and subsistence users who rely on these resources.

The potential effects examined are related to each other as they are all linked to the Project's components (e.g., shipping, air traffic, mining and processing activities, and vehicle traffic) and the direct impacts of those components on noise, vibration, and air quality levels. However, each effect represents a key topic described as important by Inuit harvesters and lodge owners and warrant individual discussion, examination, and assessment.

The characterization of the potential effects of the Project on land use is dependent on the results of the assessment of the potential effects on wildlife, birds, fish, and vegetation. These assessments are provided in Volumes 5, 6, and 7, the conclusions from which are referenced throughout Section 4.5.2.

4.5.2.1 Non-traditional Land and Resource Use

This section describes each of the three potential effects on non-traditional land and resource use as they are predicted to occur for each phase of the Project.

Changes in Access to Land and Resources

Site Preparation, Construction, Operations, Reclamation and Closure, Post-closure, and Temporary Closure/ Care and Maintenance

The presence of infrastructure and barriers within the land use LSA may decrease the total land area available to non-traditional land users. Project-related activities such as land clearing and vehicle traffic have the potential to cause land users to restrict or alter their normal land use activities. Non-traditional land and resource users active within the land use RSA include lodge owners, wilderness tour guides, and their clients. Typical activities conducted include, for example, the sport hunt, fishing, wildlife viewing, and hiking, kayaking, and canoeing. The Project may reduce the amount of land available for these purposes and may also displace access to some resources (e.g., streams, other waterbodies, wildlife, fish, and plants) at specific locations within the land use LSA; namely within the PDA that consists of the George and Goose Properties and the MLA.

There are two lodges operating within the Project RSA: the Elu Inlet Lodge and the Bathurst Inlet Lodge. Both are operated by local Inuit.

- The Elu Inlet Lodge conducts operations and tours within an area approximately 300 km north of the Project. Loss of access to land and resources within the LSA is not anticipated to affect the Elu Inlet Lodge as it is not located near the Project and baseline studies indicated individuals associated with the Elu Inlet Lodge do not travel to the southern end of the Bathurst Inlet.
- The Bathurst Inlet Lodge is located at Bathurst Inlet, approximately 160 km from the Goose Property, 100 km from the George Property, and 20 km from the MLA. The Bathurst Inlet Lodge offers fully guided tours that typically take place on the Burnside, Mara, and Hood Rivers located northwest of the Project (see Figure 4.1-2). Wilderness guides lead clients on trips to the Fishing Creek, Bathurst Lake, Pellatt Lake and on the Burnside, Mara, and Hood Rivers. In addition to the lodge at Bathurst Inlet, clients are taken to camps in the area including those at Fishing Creek (about 15 km south of Bathurst Lodge), Bathurst Lake, Burnside Lake, and Pellatt Lake, and while at the camps clients explore the surrounding areas (see Figure 4.1-2). The lodge offers outfitting services and equipment rental for purchase such as kayaks, canoes, and gear for camping. The lodge is accessible by air travel from Yellowknife, operates between June and September, and can comfortably accommodate 30 people. In 2012, an owner of the lodge estimated there were approximately 100 clients that year, whereas historically the lodge has received around 100 to 130 clients per year.

A review of the various destinations used for day trips by individuals associated with the Bathurst Inlet lodge places two in close proximity of the Project. The two day trips identified, to Fishing Creek and Bathurst Lake, are two of approximately a dozen alternative day trips offered by the lodge.

The Fishing Creek trip is a full day trip to the area which includes an outpost camp; facilities at this location include tent rings, drying racks, hunting hides, meat caches, and fox traps. Activities available in the Fishing Creek area include experiencing Inuit culture by viewing the previously mentioned facilities, fishing (catch and release fishing of lake trout and Arctic char, as well as fly-fishing, spin-casting, or trolling), hiking to Window Falls, as well as viewing the landscape, vegetation, and wildlife the area has to offer. Viewing wildflowers, wildlife (musk-ox, caribou, wolf, or grizzly), and birds (golden eagles, gyrfalcons, peregrines, or ravens) is described as an attractive aspect of this day trip.

The Project's MLA is located approximately 3 km east of Fishing Creek. However, the MLA does not overlap Fishing Creek and the actual laydown pad and buildings or structures are located some distance from Fishing Creek. Therefore, the effect "changes in access to land and resources" will not be assessed further with respect to Project interactions with activities of the Bathurst Inlet Lodge at Fishing Creek.

There is also a lodge camp located at Bathurst Lake. The proposed winter road extends the length of Bathurst Lake but will only be used during winter months (December to April), while the lodge operates between June and September. Further, trips to the outpost camp location at Bathurst Lake are thought to be uncommon. As a result of the timing and low frequency of trips to the outpost camp at Bathurst Lake, Project effects on access to this site are not predicted.

In sum, while the development of the Project may represent a reduction in the total amount of areas available for use by non-traditional land users, the Project is not expected to cause changes in access to land and resources at known areas of use, in particular Fishing Creek or Bathurst Lake. Further, these areas are two of approximately a dozen that are utilized by lodge guides and clients, and the terrain and resources within the LSA have not been described as unique or exclusive. In other words, there are other comparable land and resource areas available for use. As a result, this effect is not further assessed with respect to non-traditional land and resource use.

Changes to the Experience of the Natural Environment

Site Preparation and Construction

The Project is predicted to cause changes to the experience of the natural environment, specifically in the vicinity of the Fishing Creek area. Non-traditional land and resource users associated with the Bathurst Inlet Lodge participate in wilderness day trips to Fishing Creek, located adjacent to the MLA. Bathurst Inlet Lodge guides and clients may experience some degradation to their experience of the natural environment due to changes to the aesthetic characteristics and the presence of increased air and ship traffic associated with the construction of the MLA.

The MLA would be developed on an estimated 5 ha of land to house a number of different structures and facilities, including the following: storage areas, emergency spill and response facilities, a maintenance building, a waste management building, a workshop, a 100-person camp facility with kitchen, dry, and recreational facilities, office facilities, water and sewage treatment systems, a diesel power plant, and an airstrip.

Airstrips will be constructed at the George and Goose Properties for which there would be an estimated ten flights per day during the site preparation and construction of the Project. During Construction, it is likely that the majority of these flights would be transporting employees to work camps at the George and Goose Properties; these flights are not predicted to interact with lodge operations at

Fishing Creek. Air traffic at the MLA will be associated with an ice airstrip during the winter months and float planes that land on water during the summer months. During the Construction phase there will be an estimated three flights per week to the MLA during sealift and winter road haulage. Shipping for the Project would include 5 to 10 ships annually during Construction, over the open-water season (June to September).

Changes to the experience of the natural environment are likely to be most notable during the Construction phase of the Project. Individuals associated with the lodge may be aware of increases to air and marine traffic. However, changes to air quality, noise, and vibration are expected to negligible at the MLA due to the minimal level of Project activities (further explanation provided in Volume 4). The activity level at the MLA is characterized as minimal because:

- blasting, drilling, and processing will not occur in this area;
- traffic on the winter road will be minimal;
- equipment use will be minimal; and
- shipping activities will be minimal, between 5 to 10 ships annually, during open-water months only (June to September; see Volume 4).

During the Construction phase, a winter road would be established to connect the George and Goose Properties to the MLA. The development of a winter road typically does not result in changes to air quality as ice roads do not produce dust. However, traffic on the winter road will produce some emissions. During Construction, the winter road would be used between January and April to transport materials and equipment from the barge landing to the Project site. Non-traditional land users associated with the Bathurst Inlet Lodge are not present in the area during the winter months. Therefore, the development of the winter road is not anticipated to cause changes to the experience of the natural environment for non-traditional land users.

Some wildlife, such as caribou, are expected to avoid Project areas as a result of the presence of people and loss of vegetative ecosystems and habitat while other species, such as grizzly bear are not. Should a reduction in the presence of wildlife occur in the general area around Fishing Creek, non-traditional land users are expected to experience some degradation to their ability to participate in wildlife viewing at this location and hence, their experience of the natural environment. Wildlife viewing generally occurs by chance as predicting the exact location of animals with extremely large range can be difficult. It is likely the experience cannot be guaranteed to all clients of the Bathurst Inlet Lodge.

Overall, the primary disturbance to non-traditional land users at the MLA is predicted to be visual, as a result of Project facilities at the MLA and increased air and marine traffic nearby. For this reason, lodge owners and guides may choose to minimize their use of the Fishing Creek area for wilderness trips. However, this change is not anticipated to discourage clients from frequenting the Bathurst Inlet Lodge as there are various other locations that provide similar wilderness experiences. The Bathurst Inlet Lodge offers a variety of day trips to other locations that offer a similar experience. For example, the day trip to the Seal Cache Island provides viewing of wildflowers and ancient Thule tent rings and meat caches, kayak racks, and algal limestone stromatolites. However, there is still a potential for non-traditional land users to alter their behaviour to avoid areas, in particular near the MLA, to avoid interactions with the Project.

Operations

Changes to the experience of the natural environment that occurred during Construction and Site Preparation are expected to continue throughout the Operation phase, although at a reduced level. Operation will require fewer employees and will follow a more consistent routine of daily activities, as compared to the Construction phase. Specific changes expected during the Operation phase at the MLA are related to air and marine traffic and the presence of workers and facilities affecting the experience of the natural environment including wildlife viewing.

Project-related vehicle traffic is expected on winter roads during the Operation phase. The winter road connecting the George and Goose Properties to the barge landing at the MLA will be used January through April to transport fuel, equipment, supplies, and material from Bathurst Inlet to the mine sites. During the Operation phase there may be up to 164 truck trips per day. However, vehicle traffic on the winter road is not anticipated to affect non-traditional land and resource users (i.e., guides and clients associated with the Bathurst Inlet lodge) as the road will be in use between January and April and non-traditional resource use occurs between June and September.

Operational phase activities that may cause changes to the experience of the natural environment for non-traditional land users active near the MLA include shipping and air traffic, specifically:

- shipping will continue during open-water months, at a rate of three to five ships per summer; and
- air traffic at the MLA will continue at approximately three flights per week float planes during the summer months.

Underground and open pit mining including drilling, blasting, and processing activities will not occur at the MLA. Rather, these activities will occur at the George and Goose Properties. These activities are not expected to affect non-traditional land users as this type of use was not documented at or near these sites.

Reclamation and Closure

During the Reclamation and Closure phase changes to the experience of that natural environment associated with lodge operations at Fishing Creek as a result of the MLA are expected to continue while Project facilities remain in place. This phase is characterized by a reduction in the number of Project employees on site (as low as 40 to 50 people at each mine property) and corresponding reductions to use of heavy machinery. Project facilities will be removed during this phase; however, airstrips, winter roads, and a minimal number of Project facilities will be retained to support post-closure and on-going environmental monitoring of the area. Air, marine, and vehicle traffic will also be notably reduced during this phase, (e.g., one flight per week to the MLA) minimizing any negative effect on non-traditional land and resource use.

Post-closure

The Post-closure phase will be characterized by a minimal amount of disturbance to the experience of the natural environment. During this phase, all activities associated with the operation of the Project (e.g., drilling, processing, operation of large equipment) are discontinued, large equipment will have been removed, and the remediation of the site including the removal of many facilities associated with the Project will be completed. Workers on-site will include those employed to continuously monitor environmental conditions. Negative effects on lodge operators and their clients associated with the use of the Fishing Creek camp near the MLA is predicted to continue but at much reduced levels due to minimal Post-closure phase activities.

Temporary Closure/ Care and Maintenance

Should the Project close temporarily or enter Care and Maintenance the effects on non-traditional land and resource use are anticipated to be limited to the continued alteration of the visual environment. Activities associated with operation (e.g., processing, drilling, transport of material and supplies) would be discontinued. The Project site and facilities would be maintained and environmental monitoring would be continued, but noise and emissions are expected to be minimal. During a Temporary Closure phase, there would be fewer ships for resupply and fewer flights transporting workers to and from the Project. Negative effects on lodge operators and their clients associated with the use of the Fishing Creek camp near the MLA is predicted to continue but at much reduced levels due to minimal Project activities.

Changes to the Abundance and Distribution of Resources

Site Preparation, Construction, and Operations

Construction phase may result in changes to the abundance and distribution of resources as a result of changes to air quality (dust, emissions), noise, and vibration levels linked to blasting and drilling activities, the operation of heavy equipment, traffic, and the construction of facilities, roads, and other mine infrastructure. However, most of these activities will take place at the George and Goose Properties, where there is no interaction with non-traditional land use.

During the Construction phase, there is potential for the Project to result in changes to the abundance and distribution of resources a result of the development of Project infrastructure, for example the 100 camp and related facilities at the MLA (Main Volume, Chapter 5). This is the only location for which there is a potential interaction between Project activities and non-traditional land use.

This discussion focuses on non-traditional land and resource use at the northern end of the land use LSA, at the PDA associated with the MLA. The potential effect of changes to the abundance and distribution of resources at the George and Goose Properties as it may affect non-traditional land and resource use will not be further assessed.

The MLA includes among other facilities, a winter airstrip built on ice, a 100-person camp, a barge landing, and a winter road that connects to the George and Goose Properties. Changes to the abundance and distribution of resources located proximally to the MLA may occur as a result of:

- loss of terrestrial and marine habitat;
- the presence of workers and land-based activities at the MLA; and
- addition of air and ship traffic at the MLA.

As previously discussed, the Bathurst Inlet Lodge operates from June to September and provides services connected to the presence of wildlife, fish, birds, and vegetation, for example, wildlife and wildflower viewing, fishing, guided tours, and hiking. Loss of habitat and vegetative ecosystems is unavoidable within PDAs, including the MLA. However, non-traditional land users associated with the Bathurst Inlet Lodge do not participate in hunting activities and do not otherwise harvest within the MLA. Rather land use at Fishing Creek is focused on fishing Arctic char and wildlife viewing.

The Project is not expected to result in changes to fishing opportunities at Fishing Creek, as no significant Project-related effects are anticipated on water quality, sediment quality, fish habitat, or fish community in Fishing Creek (see Figure 5.1-1 in Volume 7, Chapter 5). Any possible Project-related impacts to marine fish habitat in the vicinity of the MLA will not propagate upstream against the direction

of Fishing Creek's flow into Bathurst Inlet. However, it is possible for effects on members of the marine fish community that travel or migrate between the marine environment and freshwater waterbodies, such as Fishing Creek. That is, the population abundance of Arctic char may be directly affected in the marine environment by Project activities (see Volume 7, Chapter 5). Though direct effects of these impacts are not anticipated to occur in Fishing Creek, they could have indirect effects on the population abundance of Arctic char in Fishing Creek as a result of population declines in Bathurst Inlet and/or reduced migrations into Fishing Creek. As described in Volume 7, Chapter 5, this potential residual effect (i.e., shipping noise) was assessed to have an overall effect on Arctic Char that was predicted to be **Not Significant** after consideration of mitigation (Volume 7, Chapter 5). Therefore, while there is potential for the development of the MLA to result in changes to fish resources available at Fishing Creek that are important to non-traditional land users, it is expected that this change will be minimal. That is, it is anticipated that fishing opportunities at Fishing Creek will not be impacted by this negligible change.

Non-traditional land and resource uses may experience changes to the wildlife viewing opportunities typically available to them at Fishing Creek as a result of the development of the Project. That is, some species, such as caribou, typically avoid built structures and noise (Volume 5, Chapter 5), while other species, such as grizzly and wolf, can actually be attracted to these elements (Volume 5, Chapters 6 and 8). Additionally, non-traditional land users associated with the Bathurst Inlet Lodge do not participate in harvesting activities. As such, the only effect that may be experienced by non-traditional land and resource users as a result of changes to the distribution and abundance of resources is changes in wildlife viewing opportunities, which is considered as part of the effect 'changes to the experience of the natural environment'.

Overall, changes to fishing opportunities at Fishing Creek are not anticipated and changes to wildlife viewing opportunities are assessed as part of the effect 'changes to the experience of the natural environment'. As a result, 'changes to the abundance and distribution of resources' is not anticipated to affect non-traditional land use within the land use LSA and, as such, this effect is not further assessed.

4.5.2.2 Subsistence Economy and Land Use

This section describes each of the three potential effects on subsistence economy and land use as they are predicted to occur for each phase of the Project.

Changes in Access to Land and Resources

Site Preparation and Construction

The construction of the Project may cause changes in access to land and resources for subsistence land users. Travel routes, harvesting locations, and access to cabins and camps used during trips on the land may be affected due to the physical presence of project infrastructure and activities within the land use LSA (mainly the PDAs). Subsistence land use is based on the abundance and distribution of wildlife as Inuit harvesters follow the movements of wildlife throughout the region.

Baseline research indicates subsistence use of land and resources within the land use LSA and RSA includes the following (Figures 4.1-1 to 4.1-3):

- Numerous travel routes, including travel in the winter over ice by snow machine and in the summer over water and land by boat, ATV, and other methods;
- Cabins and camps; and
- Harvesting activities.

Construction activities and how they are predicted to affect each of these subsistence uses of land and resources due to changes in access to land is discussed in detail below.

Travel Routes

Travel from Cambridge Bay to the mainland typically starts during the last week of October or the first week of November (recently has been as late as the first week of December). Travel from Cambridge Bay to the southern end of Bathurst Inlet typically includes an overnight stay at Omingmaktok or potentially elsewhere along the route. The end point of this travel is often Beechey Lake. Travel to this area can be hindered by:

- *Ability* - few individuals continue to have the ability to withstand winter conditions in the Arctic (e.g., few can build an igloo). These skills are necessary for those intending to overnight on the land to facilitate extensive trips in winter months. A notable portion of Inuit youth have not continued these traditions and do not use areas located a ways from their community.
- *Global Warming* - Further complicating travel to this area from Cambridge Bay are warmer conditions in the Arctic generally, causing a later freeze and earlier melt of the sea ice required for winter travel.
- *Means* – costs associated with travel on the land (e.g., snow machine, fuel, maintenance, guns, and other necessary equipment) are considerable and increasing over time. Baseline studies indicated those with the means to participate in extensive trips are employed and typically don't have the extended periods of time off to spend on the land.

During the Construction phase, the development of Project infrastructure is expected to reduce or alter access to land and resources available for use by harvesters in the land use LSA, which may in turn alter activities in the RSA. Project infrastructure expected to restrict land access for harvesters includes the George and Goose Properties, the MLA, and winter roads connecting the Properties to the MLA and to Contwoyto Lake and the Tibbitt Contwoyto Winter Road (TCWR). Loss of access to land is expected within the PDAs at the George and Goose Properties and at the MLA. Between the three sites, access to land will be restricted during the development and use of winter roads established in December and in use from January to April during the Construction phase.

Harvesters also travel by boat in the summer months along the shores of Bathurst Inlet. While the Project would represent an increase in shipping activities in Bathurst Inlet, this change is not anticipated to affect travel by boat. Shipping already occurs in the Inlet for community resupply and Project related shipping equates to approximately one additional ship per month in the Inlet.

Camps and Cabins

There are camps and cabins within the land use LSA and RSA that are used by Inuit harvesters to facilitate their activities on the land. Camps and cabins range in age and infrastructure including some newer cabins built or renovated in recent years, older cabins with provisions limited to shelter, and camp sites that include tent rings and meat drying racks. There is one newer cabin located within the land use LSA on Fishing Creek that is used by Cambridge Bay harvesters. The frequency of access also varies: newer cabins may be visited more frequently (e.g., semi-annually) and older cabins and camp sites may only be visited out of utility, dependent on the location of animals being tracked. Inuit often travel to their camps in the spring to prepare for summer hunting and fishing activities.

Harvesting

Baseline studies indicate that there are 10 to 20 harvesters who were former residents of Bathurst Inlet and Omingmaktok, as well as well as a number of Cambridge Bay harvesters that continue to use the

land use LSA and RSA to participate in subsistence harvesting activities. The trip from Cambridge Bay is over 300 km, typically requiring a few days for travel which includes crossing the Queen Maud Gulf either by boat or over ice and overnighting along the way.

The number of individuals that have the ability to continue to participate in lengthy trips on the land reportedly diminishes each year; however, trips on the land, harvesting, and country foods are an integral part of Inuit culture and the subsistence economy. A large portion (estimated to be 80 to 95%) of Kitikmeot residents continue to participate in subsistence harvesting for both nutritional and economic means. Inuit harvesters that use land and resources within the land use LSA and RSA also use other areas outside of these study areas for harvesting activities. The land and resources present in the land use LSA are not known to be unique to the area and can be found elsewhere.

Baseline studies indicate that harvesting activities can in many ways be thought of as a foundational component of Inuit culture as it is through harvesting activities that the following occur:

- transfer of cultural knowledge;
- modelling of gender, social and cultural roles or norms;
- development of the ability to prepare and hunt animals;
- opportunity to receive and share country foods;
- consumption of country foods;
- execution of Inuit norms related to sharing; and
- development of Inuit self-reliance and sense of pride via providing for family and community.

Inuit that continue to harvest, typically conduct harvest activities near to their home community (i.e., not within the land use RSA). The closest communities to the Project are Bathurst Inlet and Omingmaktok. Bathurst Inlet is located approximately 160 km from the George Property, 100 km from the Goose Property, and 20 km from the MLA, while Omingmaktok is located approximately 250 km from the Goose Property, 200 km from the George Property, and 120 km from the MLA. Members of both communities currently reside in Cambridge Bay, returning to visit and participate in harvesting activities at select times throughout the year. Baseline studies indicate that there are currently no permanent residents in either community and that there are approximately 10 to 20 active harvesters that return to the areas within the land use RSA to participate in harvesting activities. Additionally, these harvesters participate in harvesting activities on Victoria Island near Cambridge Bay.

Baseline studies indicate that the frequency of harvesting activities on Victoria Island is higher as compared to the frequency of harvesting activities conducted in and near the Bathurst Inlet. Harvesters face a number of challenges to participate in harvesting activities on the mainland in the Project area, including:

- later freeze up of the sea ice at times prohibits travel to the mainland in October, November, and December (until the ice is solid enough to travel on);
- harvesters travelling to the Inlet must be prepared to overnight at Omingmaktok, as travel from Cambridge Bay to this point typically takes about eight hours and is dependent on weather conditions;
- costs associated with this type of trip, including owning a snow machine, purchasing gas, guns, and ammunition, as well as the necessary winter gear;
- time and ability or skill; and
- the need to pull a sled or trailer to haul the necessary equipment (e.g., fuel, guns, food).

In instances when the sea ice is late to freeze, harvesters have continued their activities on the Island and generally rely on those areas around Cambridge Bay throughout the year to conduct their activities and to obtain county foods for themselves, their families, and the community. Therefore, it is expected that the harvesters that have continued to use areas within the land use LSA for harvesting in addition to their harvesting activities near Cambridge Bay, may alter their activities within the land use RSA as a result of the Project. Specifically, it is anticipated that these harvesters may alter the location of their activities to elsewhere within the RSA or may further increase the frequency of their harvesting activity in areas near their primary residence (i.e., Cambridge Bay).

Operations

Changes in access to land and resources for harvesters are anticipated to continue throughout the Operational phase. These changes will primarily be brought about by the following activities:

- Project-related vehicle traffic on the winter roads;
- Shipping activities during summer months;
- Presence of Project facilities.

During Operation there will be Project-related vehicle traffic on the winter roads connecting the George and Goose Properties to the MLA and potentially on the TCWR. The winter road from George and Goose Properties to the MLA will be used January through April to transport fuel, equipment, supplies, and material from Bathurst Inlet to the mine sites. During the Operational phase there may be up to approximately 164 truck trips per day on this road. The winter road connecting the George and Goose Properties to Contwoyto Lake and the TCWR may also be in use from January to April annually.

During Operation, shipping will occur three to five times per year during the open-water season (June to September) to resupply the Project with needed materials and equipment. Air traffic for the Project will include an estimated six flights per day to transport Project employees to and from the mine sites as well as an additional three flights per week to the MLA during sealift and winter road haulage. There will also be regular traffic on winter roads as described earlier and occasional helicopter traffic (Main Volume, Chapter 3).

These physical presence of these Project elements are expected to cause harvesters to change their travel routes and use of cabins within the land use LSA (and potentially the RSA), and to change land and marine areas accessed for harvesting. Overall, during the Operation phase, harvesters will continue to be restricted in their access of lands and resources within the land use LSA as discussed in the Construction phase section. Access to the land use LSA will be restricted by Project infrastructure and related activities.

Reclamation and Closure

During the Reclamation and Closure phase, Project activities (e.g., processing, drilling, etc.) will be discontinued and the beginning of remedial work including the removal of Project facilities will begin. During this phase some Project employees will remain on-site to begin the process of remediation of the site. Air traffic for the Project will be limited to one flight per week to each of the PDAs for a total of three flights per week during the reclamation and closure phase. Due to the continued presence of some workers (approximately 40 to 50) and facilities, restrictions on access to land and resources within the land use LSA are anticipated to continue.

Post-closure

The Post-closure phase will be characterized by a minimal amount of disturbance as Project equipment and facilities have been removed and the remediation of the site is completed. Workers on-site include those employed to continuously monitor environmental conditions. The decrease in access to land and resources experienced during the Operation phase will be somewhat improved during the Post-closure phase; however, the remaining Project facilities such as the TIA and camps will continue to act as barriers to land access in some areas.

Temporary Closure/ Care and Maintenance

Should the Project close temporarily or enter Care and Maintenance, the effects of the Project are anticipated to largely continue. During a temporary closure phase, the number of employees on-site will be reduced and Operation activities, such as use of heavy equipment, drills, and processing plants will be discontinued; however, all facilities remain in-tact. The decrease in access to land and resources experienced during the Operation phase would continue during the temporary closure as all facilities would remain and continue to act as barriers to land access as previously described.

Changes to the Experience of the Natural Environment

Site Preparation and Construction

Project activities are expected to cause changes to harvesters' experience of the natural environment, including those harvesters who have a cabin in proximity to the northern edge of the land use LSA. Specifically, the experience of the natural environment as related to the effects of the Project is thought to be dependent on the following:

- Visual aesthetics – what an area looks like including the presence or absence of light;
- Noise – levels and types of sound in an area;
- Air quality – levels of dust and emissions in an area; and
- Vibration – presence and level of vibration.

For harvesters, a large component of their experience of the natural environment is dependent on the presence of resources (wildlife, birds, fish, and vegetation) which determines their ability to participate in traditional livelihoods, engage with the subsistence economy, contribute to food security, and to regenerate Inuit culture. For Inuit harvesters, any change to the presence of wildlife resources is a multifaceted issue that requires dedicated consideration. Therefore, changes to the abundance and distribution of resources is discussed in detail and separately from the effect "changes to the experience of the natural environment", although it is noted here that the presence of resources contributes to the experience of the natural environment.

Changes to the visual aesthetics are expected to occur at each of the three PDAs (the Goose and George Properties and the MLA). Project-related changes to noise, vibration, and air quality are anticipated within the PDAs at the George and Goose Properties. At the MLA, these changes are expected to be minimal resulting in negligible effects (assessment details are provided in Volume 4, Chapters 1 and 2). At the George and Goose Properties, activities that produce noise and vibration include blasting, the operation of heavy equipment, and the use of aircrafts.

Increased noise and vibration levels, as well as changes to air quality (see Volume 4, Atmospheric Environment), are expected to degrade the experience of the natural environment for subsistence harvesters using the area. However, as noted earlier these changes are also anticipated to have an effect on the distribution and abundance of some species. For example, it is anticipated that caribou will avoid

areas near the Goose and George Properties. As a result, harvesters tracking caribou are expected to change the area of their activities based on changes to the location of caribou. Therefore, changes to the experience of the natural environment by harvesters tracking caribou are expected to be based on changes in the location of their activities, rather than on increases to noise and vibration levels. Harvesters tracking wolves or grizzly may be led to areas near the Project and may experience some degradation to their experience of the natural environment based on increased levels of noise and vibration.

In addition to changes to noise, vibration, and air quality there are three Project activities that may affect harvester's experience of the natural environment, including shipping activities, air traffic, and winter roads and associated traffic. How each of these Project components may affect harvesters' experience of the natural environment include:

- **Shipping activities** - changes would be limited to the open-water season (June to September) and would represent an increase of five to ten ships per year during Construction and three to five ships per year during Operation. This increase in shipping activities is not expected to cause subsistence harvesters to reduce or notably alter their harvesting activities.
- **Air traffic** – during Construction there will be a total of ten flights per day to the George and Goose Properties as well as an additional three flights per week to the MLA during sealift and winter road haulage. During Operation the number of flights per day will be reduced to a total of six to the George and Goose Properties and the three flights per week to the MLA will continue. Occasional helicopter traffic is anticipated for both the Construction and Operation. Currently, the number of flights that can typically be viewed from the area is limited as there is no regularly scheduled service to the communities of Bathurst Inlet or Omingmaktok.
- **Winter Roads** - the presence of roads and traffic (164 truck trips per day) during the winter is expected to have an effect on harvesters' experience of the natural environment and to also have implications for the abundance and distribution of wildlife (see Volume 5).

The TCWR would run along the Back River (Hannigayok) from the Goose Property to Contwoyto Lake, if utilized. The winter road will be in established in December for use from January to March/April and skirts the northwestern end of Beechey Lake. Beechey Lake is a common destination for Inuit harvesters travelling from Cambridge Bay or Bathurst Inlet (Section 4.1). The presence of the road will not restrict access to this area but may alter the experience of the natural environment at Beechey Lake.

However, the number of harvesters using the area is estimated to be small (from approximately 10 to 20 individuals) as there are no longer permanent residents at Bathurst Inlet or Omingmaktok. Rather, former Bathurst area residents and Cambridge Bay residents travel to the Inlet at select periods throughout the year. Difficulties associated with travel were described earlier and include ability, expense, and changes to ice conditions. Further, former Bathurst area residents and Cambridge Bay residents also engage in harvesting activities on Victoria Island and elsewhere on the mainland. Harvesters may alter the pattern and location at which they choose to conduct their activities as a result of Project activities but are not likely to reduce or discontinue their activities as a result of Project construction.

Operations

The effects discussed above for the Construction phase are anticipated to continue for the duration of the Operation phase. As Project activities begin, vehicle traffic will increase, as will the operation of heavy equipment associated with mining and processing of mine ore. These activities are expected to result in changes to air quality, noise and vibration levels and visual quality in the land use LSA and RSA (primarily with respect to summer marine shipping and air traffic) which, in turn, are expected to affect

local resources and harvester's experience of natural environment. Changes to the location of some wildlife and bird species would alter the experience of harvesters traveling in the land use LSA and RSA.

In addition to blasting, processing, and aesthetic changes at the George and Goose Properties, the main Project activities causing changes to harvester's experience of the natural environment within the land use LSA and RSA during Operation include shipping, air traffic, and winter road traffic. Specifically, shipping will occur three to five times annually in open-water months (June to September) and air traffic will include six flights per day to the George and Goose Properties as well as three flights per week to the MLA during sealift and winter road haulage and occasional helicopter traffic. Winter roads will be in use to facilitate up to approximately 164 truck trips per day. Finally, changes to the visual characteristic of the landscape are expected to further affect the experience of the natural environment for subsistence land users.

Operation of the Project is expected to alter subsistence harvester's experience of the natural environment at certain times of year in specific locations including within the land use LSA and potentially extending into the RSA. Shipping activities will occur from June to September, air traffic will be throughout the year, and winter road traffic will occur from January to April. The seasonality of certain Project activities limits the extent of the effect on harvesters. For example, harvesters travelling in the winter are not expected to experience adverse effects as a result of the increased number of ships in the area, as shipping will only occur summer months. Additionally, harvesters travelling in summer months are not expected to experience adverse effects as a result of winter road traffic, as traffic on the winter roads will only occur from January to April. Overall, this is expected to limit the extent of changes to harvester's experience of the natural environment.

Reclamation and Closure

The Reclamation and Closure phase of the Project will include the cessation of Project activities and the beginning of reclamation work including the removal of Project facilities. During this phase mining and processing activities (e.g., drilling, hauling of rock and ore, crushing) will not occur; however, some Project employees will remain for reclamation work. Air traffic for the Project will be limited to one flight per week to each PDA for a total of three Project related flights per week during Reclamation and Closure. Due to the continued presence of some workers and buildings, changes to the experience and/or receptions of the natural environment within the land use LSA are likely to continue.

Post-closure

The Post-closure phase of the Project will be characterized by very minimal amount disturbance as all activities associated with the operation of the Project will have ceased, large equipment will have been removed, and the remediation of the site including the removal of many facilities associated with the Project will be completed. Workers on-site will include those employed to monitor environmental conditions if required. However, the experience of the natural environment is likely to remain affected, but limited mainly to visual effects from the remaining infrastructure and ground disturbance.

Temporary Closure/ Care and Maintenance

Should the Project close temporarily or enter Care and Maintenance, the effects of the Project are anticipated to continue until sometime after site remediation. During a temporary closure phase, the number of workers on-site will be reduced and Operation activities, such as use of heavy equipment, drills, and processing facilities will be discontinued; however, all facilities remain in-tact. Disturbances related to noise, vibration, and air quality would be reduced as Project-related mining and processing would not occur. Changes to the experience of the natural environment will likely remain in the event of the temporary closure of the Project, limited to primarily a visual effect as equipment and facilities will remain.

Changes to the Distribution and Abundance of Resources

Site Preparation and Construction

Inuit land users that participate in the subsistence economy rely on wildlife, bird, fish, and vegetation populations to support these activities. The development of the Project may contribute to a change in the distribution and abundance of these populations. Project components that may interact with the natural environment during the Construction phase include the development of Project facilities, winter roads, shipping, air traffic, the operation of large machinery, and presence of workers. The Project may also cause changes to the abundance and distribution of resources as a result of air traffic, shipping, and winter road traffic. Specifically:

- Airstrips at the George and Goose Properties will be used for approximately six flights per day during the Operation of the Project and ten flights per day during Construction, as well as occasional helicopter traffic. Air traffic at the MLA will be facilitated by an ice airstrip constructed each winter and float planes capable of landing on water during the summer months. There will be a maximum of approximately three flights per week to the MLA during both Construction and Operation.
- Shipping for the Project would occur over the open-water season (June to September) and would include five to ten ships annually during Construction followed by three to five ships annually during Operation.
- Winter roads connecting the George and Goose Properties to the MLA, as well as the potential for connection to the TCWR, will be used for up to 164 truck trips per day.

These Project activities will result in changes to noise, vibration, and air quality levels, which in turn have implications for the local resources (e.g., animal disturbance and habitat availability and hospitability) and may cause changes to the distribution and abundance of resources (e.g., wildlife, birds, and fish). This change may be partly linked to a loss of vegetation within the PDA. Project-related changes to noise, vibration, and air quality are anticipated at the George and Goose Properties. At the MLA, these changes are expected to be negligible and are not predicted to result in an effect (assessment details provided in Volume 4, Atmospheric Environment).

Those who participate in the subsistence economy will be affected by changes to the distribution of abundance of resources within the land use LSA. Inuit have traditionally hunted caribou throughout the region. If changes to caribou movements occur as a result of the Project, this would have additional implications for Inuit harvesters and would be dependent on the extent of the change. Ultimately, the construction of the Project may require Inuit to alter their hunting, trapping, fishing, and gathering activities within the land use LSA. These effects are anticipated to be species dependent. That is, some species are expected to maintain their current distribution within the land use LSA while others are anticipated to avoid Project infrastructure and activities.

As discussed in previous sections, the number of Inuit that continue to use this area is estimated to be small. Residents of Bathurst Inlet and Omingmaktok have relocated to Cambridge Bay, returning to the area periodically throughout the year. There are a number of Cambridge Bay land users that continue to the use Bathurst Inlet and area for subsistence harvesting, many being older more experienced land users capable of spending extended periods of time on the land during harsh winter conditions. Most Inuit continue to participate in subsistence harvesting near their home communities. Wildlife resources present within the land use LSA are also present in other areas within the southwestern and western Kitikmeot. That is, habitat within the LSA is not unique or exclusive and, thus, there will continue to be other opportunities for harvesters throughout the RSA and larger region.

Operations

Changes to the distribution and abundance of resources are anticipated to continue to affect harvesters throughout Operation. As Project activities begin, vehicle traffic will increase, as will the operation of heavy equipment and processing of mine ore. These activities are expected to result in changes to air quality, noise and vibration levels in the land use LSA which, in turn, are expected to affect the distribution and abundance of resources (i.e., specific wildlife and bird species). Inuit harvesters track animals, for example caribou, throughout the area. Consequently, any changes to local resources also affect harvesters accustomed to traveling in the land use LSA to engage in subsistence activities.

Mining and processing activities will occur during the Operation phase and will produce noise and vibration as a result of blasting, the operation of heavy equipment, and the use of aircrafts. Noise and vibration are expected to cause some wildlife (specifically caribou) and birds to alter their distribution in order to avoid the noise and vibration of the Project.

During Operation, shipping will occur in open-water months (June to September) between three to five times per year. Air traffic for the Project will include six flights per week to the Project sites and occasional helicopter traffic as well as three flights per week to the MLA during sealift and winter road haulage. Winter roads will facilitate the presence of traffic and may affect the abundance and distribution of resources as a result of reductions to available habitat and presence of noise and other disturbances. Lastly, a small number of wildlife fatalities are anticipated as a result of winter road-related traffic.

During Operation there will be Project-related vehicle traffic on the winter roads connecting the George and Goose Properties to the MLA, and potentially to the TCWR (should it be used). The winter road from George and Goose Properties to the MLA will be used January through April to transport fuel, equipment, supplies, and material from Bathurst Inlet to the mine sites. During Operation of the Project, it is estimated there will be approximately 164 truck trips per day on this road, or approximately one every ten minutes. The winter road connecting the George and Goose Properties to Contwoyto Lake and the TCWR may be in use from January to April.

Reclamation and Closure

During the Reclamation and Closure phase, Project activities will stop and the beginning of remedial work including the removal of Project facilities, will begin. During this phase, drilling, processing, and the operation of heavy machinery will not occur; however, some Project workers will remain on-site to begin the process of remediation. There will continue to be one flight per week to each of the PDAs for a total of three project related flights per week during Reclamation and Closure. Due to the continued presence of some workers and buildings, as well as reclamation work activities, changes to the distribution and abundance of resources within the land use LSA are likely to continue.

Post-closure

The Post-closure phase of the Project will be characterized by a very minimal amount disturbance as all activities associated with the operation of the Project (e.g., drilling, processing, operation of large equipment) are discontinued, large equipment will have been removed, and the remediation of the site including the removal of many facilities associated with the Project will be completed. Workers on-site will include those employed to continuously monitor environmental conditions. However, changes to the abundance and distribution of wildlife, bird, fish, and vegetation are expected to continue, although to a lesser degree compared to previous Project phases due to reduced activity and reclaimed landscapes. The reclaimed areas will re-vegetate naturally over time. It is expected that during Post-closure and Reclamation the Goose and George Properties will return to practicable, self-sustaining ecosystems that are compatible with a healthy environment and human activities (see Volume 5, Terrestrial Environment).

Temporary Closure/ Care and Maintenance

Should the Project close temporarily or enter Care and Maintenance, the effects of the Project are anticipated to continue. During a temporary closure phase, the number of workers on-site will be reduced and Operation activities, such as use of heavy equipment, drills, and processing plants will be discontinued, traffic on the winter roads would be greatly reduced. However all facilities and some staff remain in-place. Disturbances related to noise and vibration and air quality would be negligible as the Project would not be operating; however, changes to the distribution and abundance of resources are expected to continue in the event of the temporary closure of the Project, as Project-related-equipment and facilities will remain.

4.5.3 Identification of Mitigation and Management Measures

The following section details mitigation and management measures designed to enhance Project benefits and reduce or eliminate adverse Project effects. Once these are taken into account, the end results or expected residual Project effects on land use are detailed in Section 4.5.4.

Mitigation involves taking tangible actions to avoid, minimize, and restore on-site or offset Project effects. Mitigation measures that are recommended to reduce an adverse effect are technically, environmentally, and economically feasible and aim to avoid, reduce, control, eliminate, or offset potential project effects. The Project has been designed to reduce adverse effects by optimizing alternatives, incorporating specific design changes, following best practices, and enhancing Project benefits.

Mitigation measures have been developed to address the potential effects of the Project on land use. There is one potential Project effect predicted on non-traditional land and resource use; that is, changes to the experience of the natural environment. There are three potential Project effects predicted on subsistence economy and land use, including:

- Changes in access to land and resources;
- Changes to the experience of the natural environment; and
- Changes to the distribution and abundance of resources.

The following sections detail mitigation proposed to reduce the potential Project effects on the VSECs *non-traditional land and resource use* and *subsistence economy and land use*.

4.5.3.1 Non-traditional Land and Resource Use

Changes to the Experience of the Natural Environment

Changes to the experience of the natural environment are based on Project-related sensory disturbances, for example, changes to visual and aesthetic resources, air quality, and noise. Mitigation measures established to address these changes include:

- A Noise Abatement Plan which outlines the Noise Abatement Mitigation and Monitoring Program, within the Wildlife Mitigation and Monitoring Plan. The plan will be carried out during all phases of the Project and is further detailed in Volume 10, Chapter 20.
- An Air Quality Monitoring and Management Plan which is detailed in Volume 10, Chapter 17. Relevant measures aim to eliminate or reduce the potential for adverse effects on air quality.
- Additional measures for wildlife and other receptors such as monitoring of air quality, dust and other emissions

The adaptive management approach enables sources identified during monitoring that require mitigation to be addressed using the above mitigation or additional engineered controls as appropriate. Noise reduction and air quality mitigation methods employed will be documented and reported in monitoring reports.

4.5.3.2 Subsistence Economy and Land Use

Changes in Access to Land and Resources

Changes in access to land and resources within the PDA cannot be avoided, as an amount of land is required to develop the Project. However, the area in which the Project is located is one of many areas available for subsistence resource use. To minimize the effect of changes in access to land and resources on subsistence harvesters the Project aims to enhance or promote continued subsistence use through other means. Specifically, the Project has been designed to incorporate the following:

- **Open-water shipping only** – there will be no ice breaking associated with the Project and, therefore, no related disruption of harvester travel routes or caribou migration routes.
- **Improved work rotation schedule** –the two weeks on two week off schedule has been selected to enhance the ability of those engaged in Project employment to continue to participate in harvesting activities and the subsistence economy by providing long periods of time off.
- **Fly-in/fly-out operation of the Project** - including no-cost commuting from points of hire. The fly-in/fly-out operation of the Project coupled with the improved worker rotation schedule aims to provide Inuit employees with enough time off in their home communities to continue to participate in subsistence harvesting activities and spend time with family while employed with the Project.
- **No Hunting/Fishing** – Project employees will not be allowed to hunt or fish at the Project sites in order to maintain current wildlife and bird populations.

Other elements of the Project have been assessed as resulting in positive effects, namely the provision of employment and income (Volume 8, Chapter 3, Socio-economic Effects Assessment). Increased participation in harvesting activities may be facilitated by enabling harvesters employed with the Project to purchase the equipment and supplies necessary for trips on the land. So while the Project is anticipated to negatively interact with current subsistence land-use activities such as harvesting, travel, and camping, affecting the ability of harvesters to conduct these activities with the land use LSA, the employment and income benefits of the Project are expected to provide mitigation that enhances the ability of individuals to participate in land use activities by helping to reduce financial barriers.

Changes to the Experience of the Natural Environment

Changes to the experience of the natural environment are based on Project-related sensory disturbances, including changes to visual and aesthetic resources, air quality, noise, and vibration. Mitigation has been identified as it specifically applies to noise and vibration, and air quality. Project induced sensory disturbance may also impact local resources (wildlife, birds, fish, vegetation); consequently, this mitigation also applies to the potential negative effect of changes to the abundance and distribution of resources (Section 4.5.3.3).

Mitigation measures discussed here, as related to changes to the experience of the natural environment for subsistence land use are linked to local biological resources but have implications for land users in the area. For example, helicopters will operate at a minimum height and will not fly close to caribou herds if possible. In addition to reducing the effects of the Project on local resources, these

measures are important to and have implications for the activities of land users and, further, were a noted concern during community consultation.

In order to reduce the adverse effects of increase noise levels as a result of the Project, an approved Noise Abatement Plan outlines the Noise Abatement Mitigation and Monitoring Program, within the Wildlife Mitigation and Monitoring Plan. The plan will be carried out during all phases of the Project and is further detailed in Volume 10, Chapter 20.

To reduce Project-related changes to the experience of the natural environment by subsistence land users, measures may be established as part of the Air Quality Monitoring and Management Plan which is detailed in Volume 10, Chapter 17. These measures aim to eliminate or reduce the potential for adverse effects on air quality.

In addition, for wildlife and other receptors, air quality, dust and other emissions will be monitored. The adaptive management approach enables sources identified during monitoring that require mitigation to be addressed using the above mitigation or additional engineered controls as appropriate. Noise reduction and air quality mitigation methods employed will be documented and reported in monitoring reports.

Changes to the Distribution and Abundance of Resources

Change to the abundance and distribution of resources as related to the Project may be a result of changes to air quality, noise, and vibration, or loss of habitat. Many of the mitigation measures relevant to both land users and wildlife resources have been discussed in the previous section in relation to change to the experience of the natural environment (Section 4.5.3.2). Those mitigations are similarly relevant to local wildlife, bird, fish, vegetation species but are not repeated here (further details provided in the Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20).

4.5.4 Characterization of Residual Effects

4.5.4.1 Non-traditional Land and Resource Use

One residual effect is predicted for non-traditional land and resource use: changes to the experience of the natural environment.

Changes to the Experience of the Natural Environment

The Project is expected to cause changes to the experience of the natural environment during Site Preparation, Construction, Operation, Reclamation and Closure, and Temporary Closure/ Care and Maintenance phases. As indicated in baseline research, non-traditional land and resource use within the land use LSA is undertaken by wilderness guides and their clients. The MLA is the only point of interaction between the Project and non-traditional land and resource use during all phases of the Project.

Bathurst Inlet Lodge guides and clients may change the location of their non-traditional land and resource use to avoid changes to their experience of the natural environment at Fishing Creek. As noted previously, potential changes to the experience of the natural environment include changes to visual ascetics and wildlife viewing opportunities. The potential for the Project to cause changes to the experience of the natural environment for non-traditional land users at Fishing Creek is evaluated as a residual effect.

4.5.4.2 Subsistence Economy and Land Use

Residual effects on subsistence economy and land use are predicted with respect to: changes in access to land and resources; changes to the experience of the natural environment; and changes to the abundance and distribution of resources.

Changes in Access to Land and Resources

As described in Section 4.1, baseline researched indicated that subsistence land users travel through and to areas located in and near the land use LSA and RSA. Specifically, experienced harvesters from Cambridge Bay and former residents of Bathurst Inlet and Omingmaktok continue to travel to the area to participate in subsistence harvesting (Figures 4.1-1 to 4.1-3). Areas that will be unavailable for use include those within the land use LSA, or more specifically, the PDAs at the George and Goose Properties and the MLA.

While changes in access to land and resources are anticipated to affect subsistence land users with respect to use of the land use LSA, these changes are not expected to have a broader effect on the subsistence economy generally. Land and resources within the land use LSA are not unique and are accessed elsewhere. It is expected that subsistence harvesters will continue to harvest in other locations and near their home communities and elsewhere in the RSA. Mitigation measures have been established to promote continued participation in harvesting by Project employees and Kitikmeot residents (Sections 3.5.3 and 4.5.3). However, restrictions on access to the land and resources will represent a reduction in the land area available to harvesters in the region. As a result, a residual negative effect is predicted on subsistence economy and land use due to changes in access to land and resources.

Changes to the Experience of the Natural Environment

Changes to the experience of the natural environment for subsistence land users are predicted. For some harvesters, notably former residents of Bathurst Inlet and Omingmaktok and Cambridge Bay residents who reported harvesting activities within the land use LSA, changes to the locations at which they conduct their harvesting activities are predicted to occur. These harvesters currently conduct their activities in a variety of areas in addition to the land use LSA and RSA. Project-related changes to the experience of the natural environment including visual quality are expected to deter harvesters from using areas mainly within the land use LSA (as well as the RSA to a limited extent as it relates to summer marine shipping, winter road traffic, and air traffic) for travelling, hunting, trapping, fishing, gathering, and camping. As a result, a residual negative effect is predicted.

Changes to the Distribution and Abundance of Resources

Changes to the distribution and abundance of resources as a result of the Project is expected to have a negative effect on subsistence land users accustomed to using the Bathurst Inlet area within the land use LSA to participate in harvesting activities. However, this effect is not expected to alter the frequency of harvesting or the subsistence economy in the western Kitikmeot. A majority of Kitikmeot residents have continued to participate in harvesting activities at many different locations, and commonly in proximity to communities. The subsistence economy is resilient and it is not uncommon for harvesters to seek out different locations for harvesting based on the location of wildlife resources.

Mitigation associated with the Project aimed at enhancing harvesting opportunities and employment opportunities with the Project (Section 3.5.3) together have the potential to result in increased participation in subsistence harvesting. That is, community research indicated that lack of income often acts as a barrier to participation in harvesting activities. Project-related employment coupled with the specific work rotation schedules may serve to facilitate participation in harvesting activities. However, subsistence land users that are active in or near the land use LSA will likely experience a negative effect as a result of changes to the distribution and abundance of resources. A residual effect is predicted.

4.5.5 Significance of Residual Effects

One residual adverse effect has been identified for non-traditional land and resource use and three residual negative effects have been identified for subsistence economy and land use. The following assesses the significance of these effects. The effects assessment methodology is detailed in Volume 9, Chapter 1 and is also summarized in Section 4.5.1 above.

4.5.5.1 Non-traditional Land and Resource Use

There is potential for Project activities at the MLA to affect the experience of the natural environment for non-traditional land users due to their use of the Fishing Creek area. No residual effects are anticipated to non-traditional land and resource use at the George and Goose Properties. Non-traditional land users that are expected to experience an effect include those associated with the Bathurst Inlet Lodge. The following explains the significance rating for each of the anticipated residual effects, which are listed in Table 4.5-4.

Changes to the Experience of the Natural Environment

This effect is anticipated to be negative, as the addition of industrial development to a wilderness area generally degrades the wilderness experience. The geographic extent of the effect is anticipated to be limited to the land use LSA in the immediate vicinity of the MLA and Fishing Creek. The magnitude of this effect is expected to be moderate as there would be a change from baseline conditions. The frequency of this effect is anticipated to be sporadic as the interaction will only occur a discrete number of times during the summer operating season of the Bathurst inlet Lodge, when operators choose to use the Fishing Creek location. The duration of changes to the experience of the natural environment are anticipated to be medium term. This effect is expected to be reversible; as Project infrastructure is removed non-traditional land users will regain access to the areas that will be reclaimed and are expected to redevelop natural environment characteristics. The effect is likely to occur with a high level of confidence.

Changes to the experience of that natural environment near the MLA/Fishing Creek area are expected to occur during the Construction, Operational, Reclamation and Closure, and Temporary Closure/Care and Maintenance phases of the Project. During the Post-closure phase, it is predicted that the area will be reopened for use and in time, following the removal of Project infrastructure and remediation, Project effects to the experience of the natural environment will be largely discontinued. The effect of changes to the experience of the natural environment at near the MLA/Fishing Creek area is considered **Not Significant** for all Project phases, as the effect is sporadic and reversible.

4.5.5.2 Subsistence Economy and Land Use

The following changes are anticipated to result in residual effects to subsistence economy and land use within the land use LSA, including: changes in access to land and resources; changes to the experience of the natural environment; and changes to the abundance and distribution of resources.

Subsistence land users that are expected to experience an effect include Inuit who are former residents of Bathurst Inlet and Omingmaktok and also Inuit residing in Cambridge Bay who have continued to participate in subsistence activities within the land use LSA and RSA in recent years. This is estimated to include 10 to 20 land users. The following explains the significance rating for each anticipated residual effect listed in Table 4.5-5.

Table 4.5-4. Summary of Residual Effects and Overall Significance Rating for Non-traditional Land and Resource Use

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	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)
Changes to the Experience of the Natural Environment	Negative – development in wilderness area	Moderate – change from baseline conditions	Medium – change occurs throughout life of the Project	Sporadic – occurs at discrete times during summer months	Local/Footprint – changes anticipated for footprint and land use LSA	Reversible. With Effort – effect will be reversed upon closure of the Project	Likely – to occur if Project is developed	High	N – geographic extent is confined to the Project footprint or land use LSA

Table 4.5-5. Summary of Residual Effects and Overall Significance Rating for Subsistence Economy and Land Use

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effect	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)
Changes in Access to Land and Resources	Negative – no longer available for use	Moderate – change from baseline conditions	Medium – change occurs throughout life of the Project	Sporadic- occurs periodically throughout the year	Local/Footprint – land no longer available is in use by the Project	Reversible. With Effort – effect will be reversed upon closure of the Project	Likely – to occur if Project is developed	High	N – geographic extent is confined to the Project footprint or land use LSA
Changes to the Experience of the Natural Environment	Negative – development in wilderness area	Moderate – change from baseline conditions	Medium – change occurs throughout life of the Project	Sporadic- occurs periodically throughout the year	Local/Footprint – changes anticipated for footprint and land use LSA only	Reversible. With Effort – effect will be reversed upon closure of the Project	Likely – to occur if Project is developed	High	N – geographic extent is confined to the Project footprint or land use LSA
Changes to the Abundance and Distribution of Resources	Negative – changes to habitat	Moderate – change from baseline conditions	Medium – change occurs throughout life of the Project	Sporadic- occurs periodically throughout the year	Local – changes anticipated in the LSA and also vary by species	Reversible. With Effort – effect will be reversed upon closure of the Project	Likely – to occur if Project is developed	High	N – the effect is reversible with in time and is limited in geographic extent

Changes in Access to Land and Resources

Land within the three PDAs (the George and Goose Properties and the MLA) and along all winter roads associated with the Project will no longer be available for use by subsistence harvesters while in use by the Project. This negative effect of changes in access to land and resources is predicted to be moderate in magnitude as it represents a change from baseline conditions and sporadic in frequency as it will occur periodically throughout the year. This effect is limited to the removal of specific areas of use for subsistence activities and travel. Subsistence activities are expected to continue unaffected at other locations within the RSA and the broader western Kitikmeot. The duration of this effect is anticipated to be medium term and include the life of the Project. This effect is expected to be reversible with time and effort as the area will be reopened during the Post-closure phase following reclamation work.

The residual effect of changes in access to land and resources on subsistence land use is expected to occur during the Construction, Operation, Reclamation and Closure, and Temporary Closure/Care and Maintenance phases of the Project. The effect of changes in access to land and resources on subsistence land use is assessed as **Not Significant** for all Project phases, as the effect will be limited to areas within the land use LSA and affect a relatively small number of hunters.

Changes to the Experience of the Natural Environment

As described earlier, the residual effect of changes to the experience of the natural environment is predicted to be negative, as the addition of industrial development to a wilderness area is expected to alter the wilderness experience for hunters. The geographic extent of the effect is predicted to be limited primarily to the land use LSA (within the RSA as it applies to the potential use of the TCWR connector in winter, air traffic, and summer marine shipping). The magnitude of this effect is predicted to be moderate as there will be a change from baseline conditions within the land use LSA. The frequency of this effect is predicted to be sporadic, while the duration of changes to the experience of the natural environment is predicted to be medium term. This effect is expected to be reversible over time. The effect is likely to occur and a high level of confidence is provided.

Changes to the experience of the natural environment are expected to occur during the Construction, Operational, Reclamation and Closure, and Temporary Closure/Care and Maintenance phases of the Project. During the Post-closure phase of the Project the area will begin to be reopened for use with no notable residual effect. The effect of changes to the experience of the natural environment is considered **Not Significant** for all Project phases, as the effect will be largely limited to within the land use LSA and affect a relatively small number of hunters.

Changes to the Abundance and Distribution of Resources

The residual effect of changes to the abundance and distribution of resources is predicted to be negative due to the loss of habitat and likely relocation of resources (e.g., wildlife, birds) to areas outside the land use LSA. The change in wildlife resource distribution and abundance is expected to cause a change in harvesting patterns for subsistence harvesters active within the LSA but is not expected to reduce the overall levels of harvesting that occur in the RSA and the broader region. The magnitude is anticipated to be moderate as there will be a change from baseline conditions.

The geographic extent of this effect is predicted to occur mainly within the land use LSA and is dependent on the species of focus. For some species, and consequently the harvesters that track them, the geographic extent of the Project effects is predicted to remain within the land use LSA, while for other species (e.g., caribou) the effects of the Project are expected to occur mainly within the LSA but may have implications that extend into the land use RSA (refer to Volume 5, Chapter 5 for further

details). Essentially, changes to harvesting patterns will mirror changes to the distribution and abundance of wildlife resources. Further information clarifying which species are expected to avoid the Project and which are expected to remain in the area is provided in Volumes 5, 6, and 7. The frequency of this effect is anticipated to be sporadic and the duration is likely to be medium term. The effect is expected to be reversible in time following reclamation activities to occur during the Post-closure phase. This effect is likely to occur and a high level of confidence is provided.

Changes to the abundance and distribution of resources are expected to occur during the Construction, Operational, Reclamation and Closure, and Temporary Closure/Care and Maintenance phases of the Project. The effect of changes to the abundance and distribution of resources on subsistence economy and land use is considered **Not Significant** for all Project phases, as the effect is expected to be mainly restricted to within the land use LSA and affect a relatively small number of hunters.

4.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

The Project is anticipated to have no significant residual effects on non-traditional and subsistence land users. The residual effects of the Project are considered as part of the Cumulative Effects Assessment (CEA). The effects assessment indicated the Project is expected to result in one residual effect on non-traditional land use and three residual effects on subsistence economy and land use. The effect changes to the experience of the natural environment will be included in the CEA for non-traditional land use. Residual effects on subsistence economy and land use included in the CEA are:

- changes in access to land and resources;
- changes to the experience of the natural environment; and
- changes to the abundance and distribution of resources.

For each identified residual Project effect, a cumulative effect may occur if the same group of land users is affected by additional projects or human activities that have similar effects. More specifically, this assessment focuses on other Projects that may affect non-traditional and subsistence land users who are expected to be affected by the Project.

4.6.1 Methodology Overview

The CEA was carried out in compliance with Section 7.11 of the EIS guidelines (NIRB 2013a) and follows a process similar to that used for the effects assessment (see Volume 9, Chapter 1). Consideration was given to the following factors when conducting the CEA:

- a regional spatial boundary (i.e., the western Kitikmeot, rather than limited to land use RSA);
- a longer temporal scale – the CEA will examine potential effects with past activities whose effects have already occurred, existing activities whose effects are known, and future activities, who effects are uncertain but have a reasonable potential to interact with the effects of the Project;
- consideration for the land use VSECs and residual effects; and
- evaluation of significance of identified cumulative effects.

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 judgement was used (based on previous experience in similar geographic locations) to approximate expected environmental conditions. Project and activities to be considered in the CEA for the 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) project and activities occurring within the outer geographical limit of possible interaction with the Project.

Data sources that contributed to the identification of projects to be considered in the CEA included: the draft NLUP (NPC 2012); registered exploration mining permits; active projects on NIRB's website; projects listed on the Mackenzie Valley Environmental Impact Review Board website; the Canadian Centre for Energy Information; Natural Resources Canada website; AANDC website; and individual resource development company and project-specific websites (see General Assessment Methodology Volume 9, Chapter 1).

Land use activities in the area were also considered and identified by review of the *2012 Socio-economic and Land Use Baseline Report* (Appendix V8-3A), and the Project TK report (KIA 2012). Major land use activities include:

- 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 stop overs, and Inuit and northern culture and history;
- sports hunting and fishing, including guided hunting and fishing excursions; and
- mineral and diamond exploration.

4.6.1.1 Approach to the Cumulative Effects Assessment

As described in the General Effects Assessment Methodology (Volume 9, Chapter 1), the CEA followed a series a steps prescribed by Hegmann et. al. (1999) in the *Cumulative Effects Assessment Practitioners Guide* and included the following:

- defining boundaries – within which the residual effects of this Project might interact with the residual effects of other Projects and human activities;
- identifying other relevant activities – to identify other Projects and human activities whose effects may interact with the residual effects of the Project;
- scoping of effects – determine the potential for Project-related residual effects to interact with residual effects from other human activities and projects within the specified assessment boundaries;
- designing mitigation – to eliminate, avoid, reduce, control, offset, or compensate for potential cumulative residual effects; and
- significance – analyse cumulative residual effects that remain after mitigation and define each effect by providing a significance rating.

The CEA will focus on land users from Cambridge Bay, Omingmaktok, and Bathurst Inlet, as these were the groups currently engaged in land use activities in the land use RSA. As indicated in Section 4.1, land users from Kugluktuk do not regularly travel as far as the Bathurst Inlet to conduct typical land use

activities. Therefore, Projects that interact with the land use of Kugluktuk residents are not evaluated as part of this assessment.

Non-traditional and subsistence land use are both considered in the CEA. Project effects on non-traditional land use that may interact with the effects of other projects are limited to the land use LSA near and within the MLA, as this was the only area of non-traditional use that interacts with the activities of the Project.

4.6.1.2 Spatial and Temporal Boundaries used for the Cumulative Effects Assessment

The spatial boundary used for the CEA include those project's and human activities in the western Kitikmeot considered to have potential effects within the land use RSA that are relevant to current land use activities (see map in Volume 9, Chapter 1). That is, projects whose effect cannot reasonably interact with the land use effects of the Project due to their location have not been included in this assessment.

The temporal boundary used for the CEA includes those projects and human activities considered to have residual effects that may act on current land use (non-traditional and subsistence) activities that are also affected by the Project as defined by the phases of the Back River Project (i.e., there is temporal overlap). Finally, projects currently in remediation are not included. Volume 9, Chapter 1 details the selection of projects considered in the CEA.

4.6.1.3 Scoping of Past, Existing, and Future Projects for Inclusion in the Cumulative Effects Assessment

Cumulative effects on non-traditional and subsistence land use can occur when potential residual effects of the Project combine with the past, current, or future effects of other projects and/or human activities relevant to the study area. When effects from the Project and other activities combine, the consequences of the initial effect may be more extensive. For example, multiple projects that are not individually a major source of noise may collectively comprise a major source of noise when combined that would produce different, notably larger, effects on wildlife, as compared to those predicted for each individual project.

This section identifies the past, present, reasonably foreseeable future activities that, along with the Project, were assessed to determine potential cumulative effects on non-traditional and subsistence land users. The CEA will be further focused to projects and activities where is there is an anticipated cumulative interaction with the residual effects of the Project. The following sections provide a review of other projects potentially relevant to the CEA and rationale for their inclusion or exclusion in the evaluation of cumulative effects.

Past Projects and Activities

A number of past projects in both Nunavut and the Northwest Territories (NWT) have had effects that require consideration related to the potential effects of the Project and non-traditional and subsistence land use activities (see Table 4.6-1)

Based on the review of projects listed in Table 4.6-1, no past projects are relevant for the VSEC non-tradition land and resource use, as the location of effects do not overlap with non-traditional areas of land use or with the land use RSA involving the same user group. There are two past Projects that are relevant to the VSEC subsistence economy and land use: Lupin and Jericho.

Table 4.6-1. Past, Existing and Future Projects and Activities Whose Effects May Interact with Residual Effects of the Project

Project	Location/ Development Type	Company/ Organization	Location/ Coordinates	Distance to Goose Property	Description	Operational Period	Status
PAST PROJECTS AND ACTIVITIES							
Lupin	Nunavut - 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 use if Ulu deposit is developed.
Jericho	Nunavut - Diamond Mine	Shear Diamonds Ltd.	65° 59' N 111° 28' W	238 km	Former diamond mine located 255 east of Kugluktuk	2006 to 2008	Currently in care and maintenance. All project work has been halted.
Roberts Bay and Ida Bay	Nunavut - Silver Mine	Quantum Murray LP	68° 10' 45" N 106° 33' 29" 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.
Tundra	NWT - Gold Mine	Indian and Northern Affairs Canada	64° 11' N 111° 33' W	290 km	Underground mine workings, mill, tailings containment	1964 to 1968; reopened briefly in 1990s	Care and maintenance. Remediation plan is being developed
Salmita	NWT - Gold Mine	Giant Yellowknife Mines Limited	64° 36' N 114° 21' W	297 km	Underground mine workings	1984 to 1989	Remediated.
EXISTING PROJECTS AND ACTIVITIES							
Doris North (Hope Bay Belt)	Nunavut - Gold Mine	TMAC Resources	68° 09' N 106° 40' W	279 km	Airstrip, accommodation buildings, dock for shipping, tailings facility	Mine site construction 2009 to 2011	Currently in care and maintenance
Ekati	NWT - Diamond Mine	Dominion Diamond Ekati Corporation (Dominion Diamonds, Chuck Fipke and Stu Blusson)	64° 44' N 110° 36' W	226 km	Canada's first and largest diamond mine, 310 km NE of Yellowknife. Open pit and underground. Mine life to 2019. Workforce of approx. 1,500.	1998 to 2020	News release updated Q1 results for Dominion. Reserves released April 24.
Diavik	NWT - 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 in 2012. Workforce approx. 1,000.	2003 to 2025	Diavik produced 1.9 million carats from 0.5 million tonnes of ore in Q4, bringing 2012 production to 7.2 M carats from 2.1 million tonnes of ore processed (up from 6.7 million carats from 2.2 million tonnes of ore processed in 2011 - Rio Tinto cancelled plans to sell diamonds business.
Snap Lake	NWT - Diamond Mine	De Beer Canada Inc.	63° 35' N 111° 15' W	310 km	Canada's First all underground diamond mine. 220 km NE of Yellowknife. Mine life to 2028. Workforce approx. 750	Construction began In 2005. Mine officially opened on July 2008. 22 year mine life	Commercial production began January 2008 and the official mine opening took place July 2008
FUTURE PROJECTS AND ACTIVITIES							
Bathurst Inlet Port and Road (BIPR)	Nunavut - 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	Construction expected to begin 2017 Operation for 20 years	In NIRB process. Updated DEIS to be submitted in 2013.
Hackett River	Nunavut - Base metal mine - 25 km spur road to BIPR road	Glencore Xstrata	65° 55' N 108° 30' W	94 km	Proposed open pit mine. 104 km SSW of Bathurst Inlet. Access road from BIPR; estimated construction jobs: 900; estimated mine jobs: 500	Estimated 15 year mine life	Pre-feasibility and environmental baseline studies. DEIS submission currently on hold.
Hope Bay Belt (Phase 2)	Nunavut - Gold Mine-Extension of Doris North Gold Mine	TMAC Resources	68° 09' N 106° 40' W	279 km	Proposed gold mines 130 km S of Cambridge Bay. Estimated mine jobs: 300	15 years of operation	Project Description submitted in 2011 DEIS guidelines issued in 2012. NIRB confirms reassignment of Project Certificate for Doris North to TMAC April 2013.
Izok Corridor Project (Grays Bay Port, High Lake, Izok)	Nunavut - 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° 25'9 W (Dock)	288 km -Izok/High Lake 309 km -Grays Bay Port	Two mine Properties – High Lake and Izok. Estimated construction jobs: 1,140. Estimated mine jobs: 710	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 examining alternative designs to reduce costs, add value, and improve economic viability of the Project, and are to provide a revised project description by December 2013.
Canadian High Arctic Research Station (CHARS)	Nunavut - Arctic Science and Technology Centre	Aboriginal Affairs and Northern Development 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. Development includes sub-division to house employees and their families	Design and Construction 2011-2017; Operations 2017 and onwards	Government of Canada announced commitment to a world class high Arctic research station and residential sub-division in November of 2007. Feasibility study issued in March 2011. Cambridge Bay community met with the Project architects in June 2013.
Gaucho Kué	NWT - Diamond Mine	De Beers and Mountain Province	63° 30 N; 109° 30' W	257 km	Proposed open-pit mine approx. 180 km ENE of Yellowknife, NT. Estimated mine jobs: 360	Construction to begin 2014. Est. 11 year mine life.	Gaucho Kué Joint Venture and NWT Gov't signed socio-economic agreement June 28.
Courageous Lake	NWT - Gold Mine	Seabridge Gold	64° 11 N	290 km	Proposed open pit mine 240 km NE of Yellowknife. 6.5 million oz. proven and probable reserves. (Positive Preliminary Feasibility Study July 2012).	Construction expected to begin in 2014. Estimated 11 year mine life. Prefeasibility	New 5-year land use permit issued December 28 to allow up to 700 drill holes.

The Lupin and Jericho projects are included in the CEA because Inuit harvesters potentially affected by the Project may also have been affected by these projects. This could occur through changes in access to land and resources and changes to the abundance and distribution of harvested species. Subsistence harvesters that may be affected by the Back River Project also participate in harvesting activities at Contwoyto Lake, where the Lupin and Jericho projects are located.

The Roberts Bay and Ida Bay Project are excluded from the CEA as the sites are currently in remediation. The Tundra and Salmita projects, both of which have been inactive for over two decades, are also excluded from the CEA as both are located in areas that do not overlap with the land use RSA. The Tundra Project is currently in care and maintenance and the Salmita Project has concluded remediation.

Existing Projects and Activities

A number of existing projects in both Nunavut and the NWT have been reviewed to determine whether their effects may act cumulatively with the effects of the Back River Project. Each of these projects is summarized in Table 4.6-1.

Based on review of the projects listed in Table 4.6-1, there are no existing projects relevant to the CEA for the VSEC non-traditional land and resource use, as the location of effects do not overlap with the land use RSA or have the potential to affect the same user groups. Further, the effects of these projects do not overlap with non-traditional areas of land use. There is one existing project that is relevant to the CEA for the VSEC subsistence economy and land use:

- Doris North – this project may cause further changes in access to land and resources for subsistence land users potentially affected by the Back River Project because of the potential for a residual effect on travel routes and activities from the Doris North Project near and extending into the land use RSA.

The EKATI and Diavik projects are excluded from the CEA because subsistence land users that may be affected by the Back River Project do not typically travel as far south as to enter an area of influence associated with these projects. The EKATI and Diavik projects are not likely to have an effect on wildlife (i.e., caribou) within the southwestern Kitikmeot Region as currently used by subsistence harvesters affected by the Back River Project. Further information detailing the effect of the Project on caribou is provided in Volume 5, Chapter 5. As a result, the potential cumulative effect is not further assessed. Snap Lake is also excluded from further consideration in the CEA as it is outside the land use RSA and areas typically accessed by subsistence land users potentially impacted by the Project.

Foreseeable Future Project and Activities

A number of foreseeable future projects in both Nunavut and the NWT have been reviewed to determine the potential for cumulative effects with the Back River Project. Each of these is summarized in Table 4.6-1. There are three future projects relevant to the CEA for the VSEC non-traditional land and resource use as well as the VSEC subsistence economy and land use. These are:

- BIPR;
- Hackett River; and
- Hope Bay Belt (Phase 2).

The BIPR and the Hackett River projects are relevant to non-traditional land users as both would increase activities in and near Bathurst Inlet, near to the Bathurst Inlet Lodge. These two projects are also relevant to subsistence land users potentially affected by the Back River Project as the projects

overlap with current areas of subsistence land use. Further, the potential for notable increases to shipping activities in the Inlet may result in adverse effects for subsistence land users and the Bathurst Inlet Lodge.

The Hope Bay Belt Phase 2 project is included in the CEA in order to consider potential cumulative effects on access to land and resources for subsistence land users because of the potential for a residual effect on travel routes and activities from the Hope Bay Belt Phase 2 project near and extending into the land use RSA. Other potential cumulative effects with the Back River Project are not anticipated as the location of this project is not within the land use RSA or areas of use identified by other user groups potentially affected by the Back River Project.

Izok Corridor has been excluded from the CEA as neither non-traditional nor subsistence land users potentially affected by the Back River Project access this area on a regular basis. Gaucho Kué and Courageous Lake are also excluded due to their increased distances from the Back River Project (more than 250 km) and are not anticipated to have effects that would interact with effects of the Project. Land users affected by the Project do not access the areas of influence of these projects.

4.6.2 Potential Interactions of Residual Effects with other Projects

The Project is expected to have non-significant residual effects on non-traditional land and resource use and subsistence economy and land use. The effect "changes to the experience of the natural environment" is relevant to the assessment of cumulative effects on non-traditional land and resource use, and the following three effects are relevant to the assessment of cumulative effect on subsistence economy and land use including:

- Changes in access to land and resources;
- Changes to the experience of the natural environment; and
- Changes to the abundance and distribution of resources.

The Hackett River and BIPR projects were the only two projects whose development may have implications for non-traditional land users potentially affected by the Back River Project. With respect to subsistence land users, the Lupin, Jericho, Doris North, Hackett River, BIPR, and Hope Bay Belt (Phase 2) projects have the potential to contribute to cumulative effects. Table 4.6-1 provides a listing of all reviewed projects. The following sections consider the residual effects of the Project in relation to the effects of projects identified for inclusion in the CEA.

4.6.2.1 Non-traditional Land and Resource Use

Should the BIPR and Hackett River projects be approved and developed, non-traditional land users (i.e., those associated with the Bathurst Inlet Lodge) would likely experience additional changes to their experience of the natural environment, within the proximity of the lodge and other locations of their operations. An additional marine facility and roads, as well as increased vehicle, air and ship traffic may intensify the non-significant residual effects of the Back River Project.

Changes to the Experience of the Natural Environment

Changes to the experience of the natural environment for non-traditional land users are anticipated to be intensified by the BIPR and Hackett River projects, but are limited to activities associated with ports on the Bathurst Inlet, roads linking those projects to the Inlet, and increases to shipping activities.

The experience of the natural environment near the lodge has historically been based on the isolated nature of the area, lack of development, lack of human presence, and the wildlife viewing opportunities. The presence of additional project infrastructure and development is anticipated to detract from the experience of the natural environment. It is predicted that the experience of individuals associated with the Bathurst Inlet Lodge would be adversely affected should the BIPR and Hackett River projects be developed.

4.6.2.2 Subsistence Economy and Land Use

Past mining projects, existing mine projects, and foreseeable future mine projects have been reviewed to determine their potential for cumulative interaction with effects of the Back River Project on subsistence land users. Six projects are considered for the CEA with respect to subsistence economy and land use:

- Past: Lupin and Jericho;
- Existing: Doris North; and
- Future: BIPR, Hackett River, and Hope Bay Belt (Phase 2).

These projects have the potential to cause increased restrictions on land access and additional pressure on local resources caused by changes to noise, vibration, and air quality levels affecting the experience of the natural environment by the land users and the abundance and distribution of resources. The effects of the Back River Project on subsistence land use including hunting, trapping, fishing, gathering, and camping may be intensified by the presence of these additional projects.

Changes in Access to Land and Resources

Restrictions on land use caused by the Back River Project may add to the past effects of the Lupin and Jericho projects, which are located near Contwoyto Lake. This is an area used by subsistence harvesters who are likely to experience changes in access to land and resources as a result of the Project. These two projects may have placed restrictions on access to land and resources in their immediate areas of influence affecting active subsistence users. Therefore, the development of the Project may further restrict land access causing a cumulative effect on subsistence land users already affected by the Lupin and Jericho projects.

However, subsistence land users potentially affected by the Project have continued to access land near the Lupin site since project activities were halted in 2005 (Appendix V8-3A). Baseline studies indicate that harvesters have not experienced restrictions on access to land as a result of the Lupin mine as access to the land near the site has been reported in recent years. As a result, cumulative residual effects with the Lupin mine are not anticipated. Both the Jericho and Doris North projects are currently in care and maintenance and restrictions to land access are expected to have continued. As such, changes to land access caused by the Project may intensify restrictions caused by the Jericho and Doris North projects. The Doris North project is located along a commonly used travel route used by harvesters traveling from Cambridge Bay. However, as noted in Section 4.5, the number of harvesters that continue to engage in extensive trips on the land is relatively small. Restrictions to land access caused by the Lupin, Jericho, and Doris North projects are not known to have resulted in notable changes to subsistence activities and the changes to land access caused by the Project are also anticipated to be minimal. Baseline research indicated that land users have adapted to the presence of the Doris North Project, often stopping at the site during trips on the land to obtain food and shelter while travelling. Overall, changes in access to land and resources caused by existing projects or facilities have been incorporated in the baseline and cumulative effects with the Project and are not expected as related to the Jericho and Doris North projects.

Hackett River, Hope Bay Belt (Phase 2), and BIPR are future projects that may intensify the effects of the Back River Project by further restricting access to land and resources, including travel routes. For example, the Hackett River Project may require additional winter or all-weather roads to connect the project site to a port at Bathurst Inlet, further restricting access within the land use RSA. For subsistence land users, travel from the community of Bathurst Inlet to the Beechey or Contwoyto lakes may be further disturbed by the presence of traffic. This may intensify the effects of restricted land access for subsistence use. Additionally, shipping activities associated with these projects may intensify effects associated with Project shipping activities, resulting in greater than anticipated effects to marine access for harvesters.

Changes to the Experience of the Natural Environment

The Project is expected to contribute to changes to the experience of the natural environment within the land use LSA during the Construction, Operation, Reclamation and Closure, and Temporary Closure/Care and Maintenance phases. This change is expected to result from Project induced changes to noise, vibration, and air quality levels, as well as visual and aesthetic changes. These changes may alter the activities of subsistence land users accustomed to their previous experiences of the natural environment.

The Project may contribute to the effects of the Lupin, Jericho, BIPR, and Hackett River projects, specifically on changes to harvesters' experience of the natural environment, as these projects are located in an area used by harvesters potentially affected by the Back River Project. Therefore, the non-significant residual effects of the Project may act cumulatively with the changes to the experience of the natural environment caused by these past projects.

The Project is not expected to contribute to changes to subsistence harvesters experience of the natural environment caused by the Doris North or Hope Bay Belt (Phase 2) projects, as the area in which this project is located is not an area of focus for harvesters affected by the Project.

Changes to the Abundance and Distribution of Resources

The Back River Project may contribute to changes to the abundance and distribution of resources that have already occurred as a result of the Jericho and Lupin projects. The development of the Jericho and Lupin projects may have contributed to changes to the abundance and distribution of resources over time. Subsistence harvesters potentially affected by the Project also use the Contwoyto Lake area and use of areas associated with the Lupin Project during time spent on the land. However, any changes to the abundance and distribution of resources associated with the Lupin and Jericho projects are reflected in baseline studies and are part of the existing environment (see Section 4.1). Therefore, this is taken into account in the Project effects assessment and it is not anticipated that harvesters would experience cumulative changes as a result of these past projects in combination with the development of the Project.

Areas surrounding the Doris North Project were not frequently reported as areas used for harvesting by individuals potentially affected by the Back River Project. It is not anticipated that there will be a cumulative effect with respect to changes in abundance and distribution of resources with respect to the use of the land use RSA.

Subsistence harvesters may experience cumulative effects related to the abundance and distribution of resources as a result of the development of BIPR, Hackett River, and Hope Bay Belt (Phase 2) projects in addition to the Back River Project. The BIPR and Hackett River projects are located in close proximity to the Project. The BIPR project consists of a road and port within 50 km of the Project, while the Hackett River Project consists of an underground mine and road within 50 km of the George Property.

Harvesters are inherently linked to wildlife. The development of these projects combined with the effects of the Back River Project may result in greater or more intensified changes to the distribution and abundance of resources for subsistence harvesters currently using the area. Harvesters affected by the Project may also experience cumulative effects to their use of the marine environment if the BIPR and Hackett River projects proceed as each would result in additional shipping activities.

4.6.3 Identification of Mitigation and Management Measures

Mitigation measures for cumulative effects involve taking further action, where possible, to avoid or minimize cumulative effects on land use VSECs. Cumulative effects typically result from the combined effects of multiple developments and as a result the responsibility for their prevention and management is shared among the various projects that contributed to them. It is usually beyond the capacity of one party to implement all of the measures needed to reduce or eliminate cumulative effects. Key approaches to avoid, reduce, control, or eliminate, offset, or compensate potential cumulative effects include:

- Optimizing alternatives – preventing or reducing adverse cumulative effects by changing aspects of the Project. For example, should the BIPR Project be approved and available, the Back River Project would change its design and use this road rather than establishing project-specific winter roads. In other words, the Project has been designed with flexibility related to BIPR to reduce the effects of the multiple roads.
- Design changes – preventing or reducing adverse cumulative environment effects by redesigning aspects of the Project. For example, the use of winter roads which help to avoid impacts to migrating caribou.
- Management Practices – eliminating, minimizing, controlling, or reducing adverse cumulative effects on VSECs through management practices. For example, consulting with non-traditional land users to facilitate undisturbed day trips, where feasible. One further example, as a result of issues identified during community based research, the Project will only ship during the open-water season and will not break the ice in Bathurst Inlet.
- Compensation – offsetting remaining cumulative effects that cannot be prevented or reduced through remedial actions, so that the net effect is neutral or beneficial. For example, the fish offsetting program will establish new fish habitat to offset overall losses.
- Enhancement – providing measures to enhance a beneficial effect. An example of this is found in the fish out program through which the fish in lakes to be dewatered are studied and provided to local communities. As a result, greater research on the function of lake ecosystems is facilitated, valued country food is not wasted, and positive relationships with local communities are promoted.

Changes to the experience of the natural environment and changes to the abundance and distribution of resources are linked to the presence of mine projects, as well as changes to noise, vibration, and air quality level and changes to visual aesthetics. Mitigation measures to reduce these effects of the Project are provided in Section 4.5.3. Management plans, monitoring, and adaptive management will be implemented to mitigate these disturbances, including an Aquatic Effects Management Plan (Volume 10, Chapter 19), Air Quality Monitoring and Management Plan (Volume 10, Chapter 17), and Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

The purpose of the Site Water Monitoring and Management Plan (Volume 10, Chapter 7) is to minimize the number and magnitude of pathways through which Project activities can adversely affect the aquatic

environment. The Air Quality Monitoring and Management Plan includes a number of mitigations to reduce dust and emissions.

The Wildlife Mitigation and Monitoring Plan includes noise abatement measures for wildlife (Volume 10, Chapter 20) to ensure that noise and vibration levels are acceptably low for human and wildlife receptors during all phases of the Project.

Overall, and as applicable to the effect "changes to the abundance and distribution of resources," the Wildlife Mitigation and Monitoring Plan proposes to first avoid wildlife sensitive areas, and where that is not possible to minimize the disturbance to these areas by monitoring caribou abundance, distribution, and movement relative to the winter roads and project roads to determine whether mitigation strategies need to be adjusted. For further information on the Wildlife Mitigation and Monitoring Plan, see Volume 10, Chapter 20.

It is expected that other projects would establish comparable mitigations to eliminate or reduce the effects of those projects in terms of noise, vibration, and air quality levels as well as visual aesthetics. It can also be expected that other developments must comply with relevant government legislation with respect to these disturbances.

4.6.4 Characterization of Cumulative Residual Effects

With the additional effects of other projects in the area, residual cumulative effects on non-traditional land and resource use and subsistence land use are anticipated. In the characterization of cumulative residual effects, it is assumed that other resource development projects in the southwestern Kitikmeot would adopt mitigation and management measure similar to those of the Back River Project, where applicable.

4.6.4.1 Non-traditional Land and Resource Use

Changes in the Experience of the Natural Environment

Non-traditional land users, specifically those associated with Bathurst Inlet Lodge, are expected to be affected by changes to their experience of the natural environment at Fishing Creek and in the surrounding areas as a result of the Project. The BIPR and Hackett River projects may cause further changes to their experience across a larger area because each would:

- require or share a port facility, increasing activity at the Inlet;
- require or facilitate additional shipping activities;
- result in changes to the visual aesthetics because of additional infrastructure within the land use RSA;
- result in changes to noise, vibration, emissions, and air quality levels at the Inlet and other project development locations; and
- overall contribute to a level of development at the Project sites.

As a result, a cumulative residual effect is assessed for changes to the experience of the natural environment for non-traditional land and resource users. This residual cumulative effect is a result of nibbling loss as well as spatial and temporal crowding.

4.6.4.2 Subsistence Economy and Land Use

Changes in Access to Land and Resources

The BIPR, Hackett River, and Hope Bay Belt (Phase 2) projects are also expected to decrease land and marine access or place further restrictions on access in areas used by harvesters potentially affected by the Project. Components that may further intensify restrictions on land access include:

- the presence of an additional mines (Hackett River, Hope Bay Phase 2);
- the presence of additional roads and increased traffic (BIPR, Hackett River, and Hope Bay Phase 2); and
- increased shipping activities in Bathurst Inlet (BIPR and Hackett River).

These project components may further restrict land access for subsistence users also affected by the Project.

Subsistence land users, specifically former residents of Bathurst Inlet and Omingmaktok and residents of Cambridge Bay are expected to be affected by restrictions to land access as a result of the Project. However, harvesters potentially affected by the Project identified a number of travel routes available for use which are dependent on a number of variables, for example, weather conditions, species of focus, and planned duration of the trip. The BIPR and Hackett River projects' infrastructure would be located near to the Back River Project infrastructure and are expected to further restrict land access. The Hope Bay Phase 2 project is located much further from the Project but within areas used as travel routes by harvesters potentially affected by the Project. Therefore, a cumulative residual effect is assessed for changes in access to land and resources for subsistence land users. This residual cumulative effect is a result of nibbling loss of land use to development.

Changes to the Experience of the Natural Environment

Subsistence land users, specifically former residents of Bathurst Inlet and Omingmaktok and residents of Cambridge Bay are expected to be affected by changes to the experience of the natural environment as result of the Project. The BIPR and Hackett River projects may result in further changes to the experience of the natural environment. These changes are expected as a result of changes to noise, vibration, and air quality levels, as well as changes to visual aesthetic resources associated with the projects within or proximate to the land use RSA as relied upon for subsistence land users. Components that may further intensify these changes include:

- the presence of additional mine activities and related noise and emissions (Hackett River);
- the presence of additional roads and increased traffic (BIPR and Hackett River); and
- increased shipping activities in Bathurst Inlet (BIPR and Hackett River).

As a result, a cumulative residual effect is assessed for changes to the experience of the natural environment for subsistence land users. This residual cumulative effect is a result of nibbling loss as well as spatial and temporal crowding.

Changes to the Abundance and Distribution of Resources

Subsistence land users, specifically former residents of Bathurst Inlet and Omingmaktok and residents of Cambridge Bay are expected to be affected by changes to the distribution and abundance of resources as result of the Project. The BIPR, Hope Bay Phase 2, and Hackett River projects are also expected to cause changes as a result of their presence and changes to noise, vibration, and air quality levels. These changes

would be in addition to changes caused by the Back River Project and are expected to further intensify this effect on subsistence land users. Project components that could cause these changes include:

- the presence of an additional mine activities and related noise and emissions (Hackett River and Hope Bay Phase 2);
- the presence of additional roads and increased traffic (BIPR, Hope Bay Phase 2, and Hackett River); and
- increased shipping activities in Bathurst Inlet (BIPR and Hackett River).

These project components are expected to result in additional effects for local wildlife, birds, fish, and vegetation, further intensifying changes to the abundance and distribution of resources used by subsistence harvesters potentially affected by the Project. As a result, a cumulative residual effect is assessed for changes to the abundance and distribution of resources for subsistence land users. This cumulative residual effect is a result of spatial and temporal crowding.

4.6.5 Significance of Cumulative Residual Effects

The following section provides the significance rating for each of the cumulative residual effects for non-traditional land and resource use and subsistence land use.

4.6.5.1 Non-traditional Land and Resource Use

Non-traditional land users affected by the Project may also be affected by the development of the BIPR and Hackett River projects. Specifically, this includes those non-traditional land users associated with the Bathurst Inlet Lodge – owners, guides, and eco-tourism clients. A summary of predicted residual cumulative effects is provided at in Table 4.6-2.

Changes to the Experience of the Natural Environment

The direction of this cumulative residual effect is predicted to be negative, as the presence of projects is expected to degrade the experience of the natural environment for non-traditional land and resource users. The magnitude of change is anticipated to be moderate, as changes to noise, vibration, and air quality levels caused by the Project alone constitute a moderate change from baseline conditions, and the addition of the BIPR and Hackett River projects is expected to overall add only marginally to the negative effects across the land use RSA thus still resulting in a moderate magnitude of change. The duration is anticipated to be medium term, as changes in access to and experience of the natural environment are expected to be restored following closure of the projects.

The frequency is anticipated to be sporadic as the interaction will only occur during the summer operating season of the Bathurst Inlet Lodge. The geographic extent is beyond the land use LSA within the RSA. Changes to the experience of the natural environment are expected to be improved or reversed once the Project area following reclamation. This effect is likely to occur, with medium confidence in the conclusion (as many variables of future projects are unknown). As a result, this effect is assessed at **Not Significant** due to the effect being of sporadic frequency, generally limited in geographical extent (not widespread), and reversible.

4.6.5.2 Subsistence Economy and Land Use

Residual cumulative effects are anticipated for subsistence land users in terms of changes in access to land, changes to experience of the environment, and changes to the abundance and distribution of resources. The following section provides the rationale for the significance ratings provided in the summary table of predicted residual cumulative effects (Table 4.6-3).

Table 4.6-2. Summary of Cumulative Residual Effects and Overall Significance Rating for Non-traditional Land and Resource Use

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Cumulative Residual Effects	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)
Changes to the Experience of the Natural Environment	Negative – development in wilderness area	Moderate – change from baseline conditions	Medium Term – changes may occur throughout the life of the projects	Sporadic– occurs at discrete times during summer months	Regional – changes anticipated for the RSA	Reversible – once projects are remediated, experience of the area will be improved	Likely – to occur if additional projects are developed	Medium	N – effect is sporadic, reversible and not widespread

Table 4.6-3. Summary of Cumulative Residual Effects and Overall Significance Rating for Subsistence Economy and Land Use

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Cumulative Residual Effects	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)
Changes in Access to Land and Resources	Negative – no longer available for use	Moderate – change from baseline conditions	Medium term – change occurs throughout the life of the Project	Sporadic– occurs periodically throughout the year	Regional– land no longer accessible due to infrastructure barriers in multiple locations	Reversible – once projects are completed, restrictions on access will be removed	Likely – to occur if all projects are developed	Medium	N – effect is sporadic, reversible and not widespread
Changes to the Experience of the Natural Environment	Negative – development in wilderness area	Moderate – change from baseline conditions	Medium term – change occurs throughout the life of the Project	Sporadic– occurs periodically throughout the year	Regional– changes anticipated for land use RSA	Reversible – once projects are remediated, experience of the area will be improved	Likely – to occur if all projects are developed	Medium	N – effect is sporadic, reversible and not widespread
Changes to the Abundance and Distribution of Resources	Negative – changes to habitat	Moderate – change from baseline conditions	Medium term - change occurs throughout the life of the Project	Sporadic– occurs periodically throughout the year	Local/Regional – changes anticipated for land use RSA	Reversible – once projects are remediated, the quality of habitat may be restored	Likely – to occur if all projects are developed	Medium	N- effect is sporadic, reversible and not widespread

Changes in Access to Land and Resources

The direction of this cumulative residual effect is anticipated to be negative, as the expectation is for decreases in access to land currently used by subsistence harvesters. The magnitude of change is anticipated to be moderate, as the restrictions on land use that would result from the development of the BIPR, Hope Bay Phase 2, and Hackett River projects would constitute a notable change from baseline conditions but are within a much larger land area used for subsistence activities and are not likely to affect overall levels of land use. Rather the addition of these projects is expected to result in a reduction in the variety of land areas available for use. The duration is anticipated to be medium term, as restrictions on access to land and resources would be reduced and then removed following the reclamation and closure of projects.

The frequency is anticipated to be sporadic as the interaction between harvesters and the Project will occur periodically throughout the year. The geographic extent is regional, as access would be reduced at multiple locations across the landscape as a result of infrastructure barriers associated with the projects. Restrictions on access to land and resources are expected to be reduced and then reversed in the closure phases of projects. This effect is likely to occur and medium confidence is provided (as many variables of future projects are unknown). Therefore, this effect is assessed as **Not Significant** due to sporadic frequency, generally limited geographical extent (not widespread), and reversible nature of the effect.

Changes to the Experience of the Natural Environment

The direction of this cumulative residual effect is anticipated to be negative, as the presence of projects is expected to degrade the experience of the natural environment for subsistence land users accustomed to the current state of the environment. The magnitude of change is anticipated to be moderate and the duration is anticipated to be medium term, as changes to the experience of the natural environment persist throughout the life of these projects.

The frequency is anticipated to be sporadic and the geographic extent is the land use RSA. Changes to the experience of the natural environment are expected to be reversed once land access is reopened and the area is improved from the state of previous development activity. This effect is likely to occur and medium confidence is provided (as many variables of future projects are unknown). Therefore, this effect is assessed as **Not Significant** due to the sporadic frequency, generally limited geographical extent (not widespread), and reversible nature of the effect.

Changes to the Abundance and Distribution of Resources

This cumulative effect is species specific, as some species are expected to avoid the Project while the behaviour of other species is not anticipated to change. As a result, a harvester tracking wolves, for example, may not experience any change as a result of the projects; however, those tracking caribou, a species expected to avoid mine infrastructure, may in turn alter their land use activities.

The direction of this cumulative residual effect is anticipated to be negative, as the presence of projects is expected cause changes to noise, vibration, and air quality levels affecting wildlife and other resources important to and used by subsistence harvesters. The magnitude of change is anticipated to be moderate as there will be a notable difference in comparison to baseline conditions; however, the change is not anticipated to result in overall lower levels of harvesting. Rather, the addition of future projects may cause changes to the locations at which harvesting activities occur. The duration is anticipated to be medium term, as areas associated with the projects would be open for use by wildlife species and other resources following the closure and reclamation of projects.

The frequency is anticipated to be sporadic, as the effect may occur periodically throughout the year as harvesters travel through and use the land use RSA. Again, the geographic extent of this effect on land users is species and location specific. Changes to the abundance and distribution of resources are expected to be reversed in time. This effect is likely to occur and medium confidence is provided (as many variables of future projects are unknown). Therefore, this effect is assessed as **Not Significant** due to the sporadic frequency, generally limited geographical extent (not widespread), and reversible nature of the effect.

4.7 TRANSBOUNDARY EFFECTS

Transboundary effects are defined by NIRB 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 EIS guidelines (NIRB 2013a) require that consideration be given to the potential for transboundary impacts which may result from interactions between the effects of the Project within the NSA and the effects of the other projects which may be located outside the NSA. Further, the potential for transboundary impacts related to cumulative effects associated with the Project must also be addressed.

Although the Project is located entirely within the NSA, transboundary effects from the Project can occur when animals move across jurisdictional boundaries or when the Project activities themselves, or their zone of influence, cross jurisdictional boundaries. Transboundary effects of the Project have the potential to act cumulatively with other projects and activities outside the NSA.

For the Project, transboundary effects of concern are outlined by the AANDC Minister's decision (December 17, 2012) and focus on the effects upon affected communities and groups that depend on the Bathurst and Ahiak[1] caribou herds. Hence, the following transboundary effects assessment (TEA) focuses on those key concerns as related to the land use VSEC subsistence economy and land use. This characterization of the potential transboundary effects of the Project on land use is dependent on the results of the assessment of the potential transboundary effects on caribou which have been included within the caribou CEA (see Volume 5, Chapter 5, Section 5.7).

The caribou CEA employs a regional boundary that includes portions of the NWT and shows the potential for the Project to have cumulative transboundary effects on the Bathurst and Ahiak (Beverly) caribou herds. The caribou CEA concludes that the Project will have non-significant residual cumulative effects on caribou, specifically in terms of habitat loss, disturbance, and reduction in reproductive productivity (Volume 5, Chapter 5, Table 5.6-11). Caribou are large contributors to the livelihoods of subsistence harvesters in the Kitikmeot Region. That is, any effect of the Project on caribou is expected to also affect the harvesters who track caribou. The caribou CEA concludes the Project will have the following effects on caribou that are relevant to the assessment of transboundary effects on subsistence land users:

- A non-significant residual cumulative effect on caribou is anticipated as a result of habitat loss. The effect is expected to be regional and, therefore, transboundary (as the RSA used for the caribou CEA extends into the NWT).
- A non-significant residual cumulative effect is anticipated in terms of disturbance to caribou. The effect is expected to be local and, therefore, not transboundary.

[1] [1]The Ahiak herd is also known as the Beverly herd. The term Ahiak is used by Inuit harvesters active in the areas and as such within the Land Use Effects Assessment to reflect their use of this term.

- A non-significant residual cumulative effect on caribou is anticipated as a result of the reduction in reproductive productivity. The effect is expected to the regional and, therefore, transboundary (as the RSA used for the caribou CEA extends into the NWT).

Therefore, the assessment of transboundary effects on subsistence land users focuses on changes to the abundance and distribution of caribou as a result of habitat loss and the reduction in reproductive productivity. These two effects have potential implications for the number and location of caribou available to Inuit harvesters.

4.7.1 Potential Land Use Valued Socio-economic Components and Effects Included in the Transboundary Effects Assessment

VSECs and effects examined in the TEA of the Project on land use were selected based on the potential interaction with the residual effects of the Project and informed through consultation with the Kitikmeot communities, as well as consultation conducted with the Dene and Métis communities in the NWT, regulatory agencies, available TK information, and professional expertise. Specifically, the determination of land use VSECs and potential effects for inclusion in this TEA considered and were informed by:

- the EIS guidelines (NIRB 2013a);
- the public, during public consultation and open house meetings held in the Kitikmeot;
- the public, during NIRB and Sabina led public consultation and open house meetings held in Yellowknife, NWT; and
- engagement of NWT Aboriginal organizations in November 2013 including the Yellowknives Dene First Nation, Tlicho Government, Lutselk'e Dene First Nation, Deninu Kue First Nation, and the North Slave Métis Alliance.

NIRB scoping meetings in Yellowknife included discussion that led to the identification of components important to the Dene and Métis communities as related to the Project. Comments made during these sessions were compiled and analyzed as part of VSEC and effect scoping. A number of comments are highlighted below to showcase content considered:

> *Impacts on the Dene-Métis community needs to be taken into account, should clearly include caribou and potential impacts on herds, and transboundary effects need to be addressed* (Volume 3).
>
> *We don't have a land claim presently accepted for negotiation, but the traditional lands of the North Slave Métis extends throughout the Northwest Territories, into Nunavut, where the people traditionally occupied and traveled. This traditional land use extends up to Kugluktuk and down to Bathurst Inlet… based on present land use studies and work with elders* (Volume 3).
>
> *The proposed project is outside our Chief Drygeese Territory. But wildlife don't follow boundaries, they migrate. Since time immemorial Yellowknives Dene First Nation (YKDFN) have relied on the caribou. Since 1995, YKDFN have been impacted the most in regards to changes in the caribou herds … We have always depended on Bathurst caribou for subsistence … Elders have said the caribou are our identity … We leaders have to walk a fine line between creating economic prosperity and protecting the environment* (Volume 3).

The consideration and selection of VSECs and potential effects for the TEA was also informed by reviewing of the recommendations of the Minister of AANDC. As a result, the land use TEA will focus on the potential transboundary effects of the Project on the land use VSECs as related to

> *Impacts associated 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* (AANDC Letter to NIRB, December 17, 2012).

The TEA considers the geographic extent of the residual effect of the Project, "changes to the distribution and abundance of resources" as it applies to the land use VSEC subsistence economy and land use. This residual effect may have transboundary implications as the migration of the Bathurst and Ahiak caribou herds extend from the Kitikmeot Region to the northern NWT. Should the analysis result in a residual transboundary effect, consideration is given to potential for cumulative effects with other proximally located projects.

4.7.2 Potential Transboundary Nature of Residual Effects

4.7.2.1 Subsistence Economy and Land Use

The development of the proposed Project may cause: 1) changes to access to land and resources within the southern Kitikmeot; and 2) changes to the abundance and distribution of resources outside the NSA, specifically, to the Bathurst and Ahiak caribou herds.

First, the Back River Project may utilize the TCWR through a Nunavut-based connector winter road for resupply during some years. The TCWR connects Nunavut to the NWT which may have a transboundary effect in that access into the Kitikmeot Region is increased. That is, changes in access to land and resources for the purpose of this TEA refer to changes in access to land areas by individuals not resident in the Kitikmeot Region (i.e., increases in access to those land areas in use by harvesters potentially affected by the Project).

Specifically, the development and operation of the Project may result in the removal of natural barriers to access and may further facilitate access via Project winter roads. For example, the TCWR connector would connect to Contwoyto Lake and the winter road to the Ekati and Diavik mines, which may facilitate access to the area by individuals using that road. That is, the removal of these natural barriers could increase access for travelling, fishing, hunting, trapping, recreation, and other activities by residents of the NWT.

Second, as indicated by the Caribou EA (Volume 5, Chapter 5) the Project may have a transboundary effect on the abundance and distribution of resources, specifically the Bathurst and Ahiak caribou herds, affecting harvesting activities in the North Slave Region. Specifically, the Project may cause cumulative transboundary: 1) habitat loss, effecting the distribution or location of caribou typically tracked by harvesters; and 2) reduction in the reproductive productivity of caribou that is likely to result in a corresponding reduction to the abundance or number of caribou available to harvesters. The degree to which harvesters in the North Slave Region experience an effect is dependent on the location of their activities and changes to the migration patterns or abundance of the caribou herds caused by the Project. That is, any changes to the location or number of caribou are expected to affect those who track caribou as part of their traditional harvesting practices.

While very few Kitikmeot harvesters reported traveling to areas outside the NSA to engage in traditional harvesting practices, there are a number of Aboriginal communities in the North Slave Region located south of the Kitikmeot that are home to individuals engaged in traditional harvesting activities. The communities include Lutsel k'e, Dettah, Behchoko (Rae-Edzo), Gameti (Rae Lakes), Wekweeti, Reliance, and Whati. These communities range in size from approximately five residents in Reliance to approximately 1,900 in Behchoko (Statistics Canada 2012).

4.7.3 Identification of Mitigation and Management Measures

The Project will utilize winter roads rather than all-weather roads for land-based transportation associated with the Project (i.e., including the winter road between the PDA properties/TCWR connector). This measure reduces disturbances to migrating caribou and also reduces access to the region by non-residents. All major Project roads would be established as monitored private roads, not open to the public.

There will be an approved Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that will be carried out during all phases of the Project. This plan will directly monitor sensitive wildlife species, such as caribou, that could be adversely affected by the Project. Further information describing the mitigation and management measures expected to reduce the effects of the Project on caribou are described in Volume 5, Chapter 5 and Volume 10, Chapter 20.

4.7.4 Characterization of Residual Transboundary Effects

4.7.4.1 Subsistence Economy and Land Use

The Project is not expected to have a residual transboundary effect related to increased access to land and resources in the Kitikmeot Region. The winter roads would only be available for use from December through to April each year and, as part of the mitigation and management of Project roads, winter roads would be established as private roads, not open to the public (Section 4.8). Temperatures in the southern Kitikmeot range from daily averages of minus 33 to minus 21 over that time period and the distance between the Ekati and Diavik mines and Contwoyto Lake is over 100 km, followed by another approximate 150 km to extend into the Kitikmeot Region. Travel into the Kitikmeot using this route would require an extended period of time and use of a vehicle equipped to travel that distance in harsh weather on winter roads. Therefore, a negative effect due to greater access to areas used by harvesters potentially affected by the Project is predicted to be negligible.

Second, the Project is not anticipated to have a residual transboundary effect on subsistence harvesters as a result of changes to the distribution and abundance of resources, specifically that of the Ahiak and Bathurst caribou herds. Volume 5, Chapter 5 indicates that the development of the Project, in combination with existing and future projects, may cause caribou to relocate within the RSA established for the caribou CEA. Overall, a reduction in the caribou population is not anticipated and while caribou may relocate within the area, this is not expected to hamper subsistence harvesting as this activity is typically varied in location and involves the tracking of wildlife within their large habitat ranges. Consequently, changes to the land use activities of harvesters residing in the North Slave Region that rely on the Bathurst and Ahiak caribou herds are not anticipated (see Caribou Effects Assessment, Chapter 5, Volume 5 for supporting information).

Further, as there is no residual transboundary effect predicted, cumulative transboundary effects with other projects in the NWT are similarly not predicted.

4.8 MITIGATION AND ADAPTIVE MANAGEMENT

4.8.1 Non-traditional Land and Resource Use

There are several best practice management and mitigation measures in place which serve to reduce potential adverse effects of the Project, while maximizing the potentially beneficial outcomes as they relate to non-traditional land and resource use within the LSA and RSA. The management and mitigation measures can be found in both built-in Project design components, as well as specific additional measures that were developed based upon identified needs. The Project recognizes that further steps are required and developed the following best practice management measures to mitigate remaining potential negative or adverse effects. Together the best practice management and mitigation measures work towards maximizing potentially positive and beneficial outcomes and also to reduce and, where possible, eliminate negative or adverse effects upon non-traditional land and resource users within the Project area.

4.8.2 Subsistence Economy and Land Use

There are several management and mitigation measures in place, which serve to mitigate impacts to the subsistence economy as it relates to land use within the LSA and the RSA. The mitigation and management plans include mitigation by Project design and best practice management measures. Best management practices serve to reduce potential adverse effects of the Project on the subsistence economy and land use. Together the built in project design mitigation measures and the best practice management measures will serve to maximize the potential beneficial outcomes and minimize the negative effects related to the Project.

Mitigation measures have been developed to address the following potential Project effects on the subsistence economy and land use:

- Changes in access to land and resources;
- Changes to the experience of the natural environment; and
- Changes to the distribution and abundance of resources.

Changes in access to land and resources within the Project Development Area cannot be avoided, as an amount of land is required to develop the Project. To minimize the effect of changes in access to land and resources on subsistence harvesters the Project aims to enhance or promote continued subsistence use through other means. Specifically, the Project has been designed to incorporate the following:

- Open-water shipping only – there will be no ice breaking associated with the Project and, therefore, no related disruption of harvester travel routes or caribou migration routes.
- Improved work rotation schedule –the two weeks on two week off schedule has been selected to enhance the ability of those engaged in Project employment to continue to participate in harvesting activities and the subsistence economy by providing long periods of time off.
- Fly-in/fly-out operation of the Project - including no-cost commuting from points of hire. The fly-in/fly-out operation of the Project coupled with the improved worker rotation schedule aims to provide Inuit employees with enough time off in their home communities to continue to participate in subsistence harvesting activities and spend time with family while employed with the Project.
- No Hunting/Fishing – Project employees will not be allowed to hunt or fish at the Project sites in order to maintain current wildlife and bird populations.

Other elements of the Project have been assessed as resulting in positive effects, namely the provision of employment and income (Volume 8, Chapter 3, Socio-economic Effects Assessment). Increased participation in harvesting activities may be facilitated by enabling harvesters employed with the Project to purchase the equipment necessary for trips on the land, and by adoption of a worker rotation schedule that makes allowances for this. So while the Project is anticipated to negatively interact with current subsistence land-use activities such as harvesting, travel, and camping, affecting the ability of harvesters to conduct these activities with the land use LSA, the employment and income benefits of the Project are expected to provide mitigation that enhances the ability of individuals to participate in land use activities by helping to reduce financial barriers.

Subsistence harvesters utilize the natural environment as part of their livelihood. Changes to the experience of the natural environment are based on Project-related sensory disturbances, for example, changes to visual and aesthetic resources, air quality, noise, and vibration. Mitigation has been identified as it specifically applies to noise and vibration, and air quality in the Noise Abatement Mitigation and Monitoring Program, within the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17). Project induced sensory disturbance may also impact local resources (wildlife, birds); consequently, this mitigation also applies to the potential negative effect of a change to the abundance and distribution of resources.

4.8.3 Summary Table of Mitigation and Adaptive Management Measures

Table 4.8-1 provides a summary of the mitigation and management developed to address the potential effects of the project on land use.

Table 4.8-1. Land Use Mitigation and Management Measures Summary

Mitigation Category	Mitigation Measures
Mitigation by Project Design	Open-water season shipping only (no ice-breaking), thus avoiding potential interactions with winter ice-related activities such as travelling and hunting. Fly-in/fly-out operation using direct routes from point-of-hire communities, minimizing layovers during the transport of northern workers and use of an appropriate worker rotation schedule.
Best Management Practices	As a best practice, Community Advisory Groups (CAGs) have been established in Cambridge Bay and Kugluktuk in order to optimize communication and engagement with communities. Other best management practices for subsistence economy and land use and non-traditional land and resource use include the following: • Subsistence Economy and Land Use - facilitate ongoing subsistence land use activities through the provision of the worker rotation schedule, fly-in/fly-out Project operation, and support of land users and the development of knowledge. Specific activities include: - advise all mine employees of the "no hunting" regulation for mine employees while in the course of their employment at the mine site; - facilitate continued harvesting by local Inuit near their home communities through the provision of an appropriate worker rotation schedule; - promote harvesting and related cultural activities for youth through corporate contributions to youth initiatives; - provide orientation to all employees describing the nature and sensitivities of the Arctic environment in order to encourage the development of an understanding and respect for the local environment; and - allow land users travelling through the region access to camp, while ensuring compliance with safety measures enforced at the camps.

(continued)

Table 4.8-1. Land Use Mitigation and Management Measures Summary (completed)

Mitigation Category	Mitigation Measures
Best Management Practices *(cont'd)*	• Non-traditional Land and Resource Use - communication of shipping schedules and routing, and ensuring vessel travel takes place on routes as planned, to minimize an interaction with existing non-traditional land and resource uses. Best Management Practices are also in place to avoid or minimize potential negative effects to fish and wildlife (see Volume 10, Chapters 17, 18, 19, 20, and 21).
Adaptive Management	Ongoing communication with local individuals and communities will be facilitated by regular public meetings and meeting with the Cambridge Bay and Kugluktuk CAGs. Feedback will be obtained from mine employees, local land users, the community HTOs and hamlets, as well as from the CAGs themselves in order to provide ongoing updates and make adjustments to management practices as needed.

4.9 PROPOSED MONITORING PROGRAMS

4.9.1.1 Non-traditional Land and Resource Use

Monitoring programs will seek to obtain relevant and timely information with respect to their effects in the land use LSA and RSA and as it relates to the non-traditional land and resource use. There are several relevant monitoring and management plans that outline the methods through which the potential adverse effects of the Project are maintained at acceptable levels. With respect to non-traditional land and resource use the two most relevant monitoring plans are: the Aquatic Effects Monitoring Program (AEMP) and the Noise Abatement Mitigation and Monitoring that is part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). These monitoring plans will be carried out during all phases of the Project (Construction through to Closure). There will also be a Conceptual Fish Offsetting Monitoring Program for the Project which may monitor fish presence and habitat use, local density or population size estimates, habitat stability and assessment of primary productivity and the benthic invertebrate community.

The AEMP will monitor a network of lakes and streams within the LSA and rSA, including water quality, sediment quality and aquatic biology, while also monitoring fish populations and fish tissues. The monitoring will also extend to Bathurst Inlet, which is adjacent to the MLA. The AEMP in conjunction with the Fish Offsetting Monitoring Program seeks to maintain that fish populations which are relied upon by non-traditional land users will remain healthy, thereby enabling non-traditional land and resource use to continue within the RSA.

4.9.1.2 Subsistence Economy and Land Use

The main mitigation and monitoring programs that are relevant to subsistence economy and land use include the AEMP and the Wildlife Mitigation and Monitoring Plan (which includes a noise abatement plan). These programs outline the methods through which baseline conditions will be monitored and changes over time will be tracked. It will further maintain that the mitigation and management measures in place are effective. If changes are observed, timely decisions can be made to address any potentially negative or adverse effects. Further details of the Wildlife Mitigation and Monitoring Plan are provided in Volume 10, Chapter 20.

In addition, the Socio-economic Monitoring Program (SEMP) for the Project (Volume 10, Chapter 23) will help ensure that the Project fulfills best practices in social responsibility as it relates to community engagement, capacity building, and realization of benefits from the Project, especially for

Inuit. Equally, monitoring will provide relevant and timely information to enable Project managers and community leaders to respond proactively to potential risks and adverse socio-economic effects.

The Socio-economic Monitoring Program includes proposed indicators for monitoring the effects of the Project on the VSEC "subsistence economy and land use". Specifically, the focus on monitoring is on the participation of Project employees in land activities, unauthorized use of Project roads, and utilization of Project camp facilities by harvesters. Thresholds for each indicator will be determined in consultation with NIRB, through consultation with the public, and the Back River Project Socio-economic Monitoring Committee (see Socio-economic Monitoring Program, Volume 10, Chapter 23). For all indicators, management action will be triggered when annual performance is below threshold. Specific actions will be determined in consultation with NIRB. This will involve an evaluation of the existing mitigation and management measures, and identification of appropriate adjustments to mitigation.

Through the above monitoring programs the Project will be able to identify any changes to baseline conditions at an early stage and take required steps to mitigate in consultation with stakeholders.

4.10 IMPACT STATEMENT

The Project has the potential to alter non-traditional and subsistence land and resource use within the land use LSA as a result of activities during Site Preparation, Construction, Operation, Post-Closure, and Reclamation and Closure, as well as Temporary Closure or Care and Maintenance phases of the Project. Two land use VSECs were selected to assess the effect of the Project based on values identified by local land users, interviews with lodge owners, Project scoping meetings, and public consultation.

The assessment concluded the Project would have implications for the two land use VSECs identified: 1) non-traditional land and resource use; and 2) subsistence economy and land use. The second land use VSEC was refined as the Project is not anticipated to result in changes to the subsistence economy; rather, Project induced changes are expected to relate more to locations at which harvesters conduct activities. The non-significant residual effects of the Project on non-traditional land use were limited to changes to the experience of the natural environment. Residual effects on subsistence land use include: 1) changes in access to land and resources, 2) changes to the experience of the natural environment, and 3) changes to the abundance and distribution of resources. The effects of the Project are geographically limited to the land use LSA. The effect "changes to the abundance and distribution of resources" reflects the conclusions of the assessments of Projects effects on wildlife and fish, as any change to the number or location of wildlife, bird, and fish also has an effect on harvesters. That is, if for example, caribou avoid mine infrastructure and activities, harvesters will experience effects to the location of their harvesting activities. It is expected that harvesting activities will continue, albeit at different locations outside the land use LSA throughout the life of the Project. It is also expected that the area will be reopened for potential use following the Reclamation and Closure phase. As a result, residual effects are assessed as **Not Significant**.

The CEA considered the effects of past, present, and future projects on the land use VSECs. The CEA concluded there was potential for non-significant residual cumulative effects associated with the BIPR, Hope Bay Phase 2, and Hackett River projects. While the non-significant residual cumulative effects described have the potential to occur should the development of all future projects come to pass, land use is but one component of many valued by Inuit, northerners, and those invested in Nunavut. That is not to say that uses of land have not changed over time and that future changes to land use are undesirable. Rather, changes within the land use LSA in terms of access to land, experience of the land, and the abundance and distribution of wildlife resources represent a temporary change for non-traditional and subsistence harvesters that in many ways is tempered by economic growth and

employment for residents of the Kitikmeot Region. The benefits of the Project may, in actuality, serve to maintain traditional subsistence land use to a greater extent than would be possible without the economic growth and employment associated with the Project. The Project will invest in the Kitikmeot Region and in the maintenance of land use and harvesting activities that promote the transfer of knowledge and skills between generations. Regional economic growth has the potential to enable further investment in the maintenance of harvesting activities, as well as in other areas, for example, language, food security, education, and skills development. Employment and economic growth may also serve to enhance opportunities generally, for individuals able to harvest as well those who are not.

5. Country Foods

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5. Country Foods

5.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

Country foods are animals, plants, and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation (Health Canada 2010e). These foods are an important part of a healthy diet, have medicinal qualities, and are of high cultural and traditional importance.

The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water, and vegetation). Chemicals accumulated from the environment may be present in the edible tissue portions of the country foods consumed by people. The potential for adverse effects in human consumers due to chemicals present in country foods depends on the concentration of the chemical, which type and portion of the country food is eaten (e.g., roots or leaves, muscle tissue or liver), life stage of the consumer (e.g., toddler or adult), quantity of food consumed, and frequency of consumption.

A country foods baseline risk assessment report was completed using environmental data collected during baseline studies in order to assess the level of risk associated with country foods prior to development of the proposed Project. The full report is available in Appendix V8-5A (Rescan 2013f), with an overview provided here. The baseline assessment consisted of five main phases:

- problem formulation, to identify contaminants of potential concern (COPCs) and human receptor characteristics;
- exposure assessment, to determine the estimated daily intake (EDI) of COPCs based on the concentrations of COPCs in various environmental media and human consumption patterns;
- toxicity assessment, to determine the acceptable exposure concentrations for each COPC that will be protective of human health;
- risk characterization, to compare estimated daily intake of COPCs to acceptable exposure concentrations, calculate exposure ratios (ERs), recommended maximum weekly intake (RMWI), and incremental lifetime cancer risk (ILCR); and
- uncertainty analysis, to describe assumptions made throughout the assessment and uncertainties associated with the data or conclusions.

The study area used in the country foods baseline risk assessment was exactly the same as the local study area (LSA) that was selected for the DEIS (see Section 5.4.1, Spatial Boundaries). The use of the same study area, methodology, and analysis in both the country foods baseline risk assessment and in the DEIS effects assessment (based on a predictive country foods risk assessment) will allow the direct comparison of country foods quality under baseline and future conditions. It allows the assessment of incremental change in country foods quality due to Project-related activities and development.

A summary of the findings of the baseline country foods risk assessment is provided in the following sections (Sections 5.1.1 to 5.1.5), while a summary of the findings of the effects assessment for country foods can be found in Section 5.5. Additional details of the predictive country foods risk assessment can be found in the Human Health Risk Assessment (Volume 8, Chapter 6).

5.1.1 Problem Formulation

5.1.1.1 Selection of Country Foods for Evaluation

Based on focus groups and interviews conducted in November 2012 with local hunters and trappers (Rescan 2013a, Appendix V8-3A) and the *Nunavut Wildlife Harvest Survey* (Priest and Usher 2004), a list of country foods collected by local residents was compiled, which is summarized in Table 5.1-1.

Table 5.1-1. Country Foods Hunted or Collected within the Project Land Use Local Study Area

Terrestrial Wildlife	Marine Wildlife	Fish	Birds	Vegetation and Berries
caribou	**ringed seal**	arctic char	ptarmigan	**blueberries**
arctic wolf	breaded seal	**lake trout**	**Canada goose**	crowberries
timber wolf	narwhal	whitefish	lesser goose	cloudberries
wolverines	beluga whales	arctic grayling	brandt goose	sweet leaves
moose	clams	arctic cisco	snow goose	**bog cranberry**
muskox	**mussels**	wolfish	eider duck	Labrador tea
fox	sea urchin	black cod	trumpeter swan	licorice root
weasel	crabs	burbot	red throated loons	willow bark
martin	starfish	sculpin	common loons	mountain sorrel
muskrat		halibut	seagulls	seaweed
lynx		flounder		alpine berry
arctic hare				
ground squirrel				
grizzly bear				

Note: country foods shown in bold were selected for inclusion in the baseline risk assessment

It is noted that Table 5.1-1 may include country foods that are not collected within the Project country foods LSA specifically, since the interviews and harvest survey considered country foods consumption practices in a much larger geographic area. However, this information does provide guidance on the type of country foods that could potentially be collected by local residents and provides a starting point for the scoping and focusing of the country foods risk assessment.

In addition to the muscle, different organs of country foods may be consumed as part of the Inuit diet (Nancarrow 2007). For example muscle, fat, bone marrow, and organs such as tongue, kidneys, liver, stomach, and intestine of caribou, and muscle, blubber, kidneys, liver, heart, flippers, and blood of ringed seals are included in the Inuit diet and provide a valuable nutritional source (Nancarrow 2007). Although this assessment does not estimate the risk of consumption of individual organs, consumption frequencies and portion sizes related to caribou meat and ringed seal meat and blubber were selected to reflect the risk from consumption of these country foods as a whole.

It is not always feasible to assess all country foods due to the large number of species that are harvested and their seasonal availability due to migration patterns of the harvested populations or accessibility to hunting grounds. Wherever possible, country foods with the highest consumption frequency were selected. A species that represents the highest consumption level, and therefore results in the most exposure to COPCs, was selected within each of these groups. Theoretically, if foods that represent the highest rate of exposure are deemed safe for consumption, then all other foods within the given group would also be considered safe for consumption. The different groups are

selected because the relative exposure of each group to the environmental media would vary with specific habitat and foraging behaviours.

In total, the quality of seven country foods from seven different groups was estimated prior to development of the potential Project, and thus provided an estimate of the country foods quality under baseline conditions. The country foods evaluated included: a large terrestrial mammal (caribou, *Rangifer tarandus*), a small terrestrial mammal (Arctic ground squirrel, *Spermophilus parryii*), a bird species (Canada goose, *Branta canadensis*), fish (lake trout, *Salvelinus namaycush*;), a shellfish species (bay mussel, *Mytilus trossulus*), a marine mammal (ringed seal, *Phoca hispida),* and berries (bog cranberry, *Vaccinium vitis-idaea* and bog blueberry, *Vaccinium uliginosum* combined).

5.1.1.2 Contaminants of Potential Concern Selected for Evaluation

The COPCs selected for this assessment were metals, which occur naturally at elevated concentrations in environmental media (e.g., water, soil, sediment) due to local physical and geological processes. Specific metals were selected as COPCs if they met at least one of the following four criteria:

1. The maximum metal concentration in soil measured during the soils baseline study (Rescan 2013d, Appendix V5-3A) exceeded the Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for residential and park land (CCME 2012b).
2. The maximum total metal concentration in surface waters measured during the freshwater (Rescan 2012a, Appendix V6-3B; 2012b, Appendix V6-3C) and marine (Rescan 2013b, Appendix V7-2A) baseline studies and exceeded its CCME water quality guideline for the protection of aquatic life. Data from 2010 to 2012 collected from streams and lakes were included in the assessment (Rescan 2012a, 2012b). Water and sediment data collected from Bathurst Inlet in 2012 were also included in the screening process (Rescan 2013b, Appendix V7-2A).
3. The maximum metal concentration in sediment measured during the freshwater (Rescan 2012a, 2012b), marine (Rescan 2013b), and wetland (Rescan 2013f) baseline studies exceeded the CCME sediment quality guideline for the protection of aquatic life (CCME 2012a).
4. The metal has a potential to bioaccumulate in organisms or biomagnify in food webs, such that there could be significant transfer of the metal from soil to plants onto higher trophic levels. Information on the bioaccumulation/biomagnification potential of each metal of interest was obtained from a review of relevant documents from the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the US EPA (JECFA 1972, 1982; US EPA 1997; JECFA 2000; US EPA 2000; JECFA 2005, 2007a, 2007b, 2011).

Based on the above criteria, the following metals were selected for inclusion in the country foods baseline assessment: aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc.

5.1.1.3 Human Receptor Characteristics

Both adults (older than 19 years of age) and toddlers (six months to four years of age) were evaluated for susceptibility to selected COPCs (Health Canada 2010b, 2010c). Among adults, pregnant women and breastfeeding mothers are considered to be a sensitive group for exposure to some metals, particularly mercury (methylmercury). Toddlers are often considered the most susceptible life stage for effects due to chemical exposures because of their higher relative ingestion rates per unit body weight and their rapid adsorption and metabolic rates during this important growth period, compared to adults.

The human receptor characteristics used in this assessment were body weight (kg), consumption amount (serving size), and consumption frequency (number of serving per year or week of highest exposure) of the selected country foods (Table 5.1-2). The body weight for adults and toddlers were based on guidance provided by Health Canada (2010a, 2010c). The majority of data for country foods daily intake amounts and frequencies were obtained from several surveys conducted of Inuit within the Kitikmeot region (Innis, Kuhnlein, and Kinloch 1988; Coad 1994; Nancarrow 2007; Egeland 2010). No data were collected on the serving sizes of toddlers; it was assumed that a toddler would eat country foods at the same frequencies as adults and with a 43% reduction of the adult serving size (Richardson 1997).

Table 5.1-2. Human Receptor Characteristics Used in the Country Foods Baseline Risk Assessment

Parameter	Toddler[1] Consumption Rate (kg/day)	Adult[2] Consumption Rate (kg/day)	# Times Consumed per Year	Data Source
Caribou	0.12[3]	0.27[3]	365[3,4]	Nancarrow (2007), Sabina (pers. comm.)
Arctic ground squirrel	0.023	0.053	104[5]	Coad (1994)
Canada goose	0.085	0.20	5.0	Nancarrow (2007)
Lake trout	0.11	0.25	5.0	Nancarrow (2007)
Bay mussel	0.0013	0.0030	48[6]	Innis, Kuhnlein, and Kinloch (1988)
Ringed seal muscle	0.10	0.25	82	Nancarrow (2007)
Ringed seal blubber	0.037	0.087	5.0	Nancarrow (2007)
Berries	0.0056	0.013	152	Egeland (2010)

[1] *Toddler body weight is 16.5 kg*
[2] *Adult body weight is 70.0 kg*
[3] *Nancarrow (2007)*
[4] *Data obtained from communications of Sabina staff with members of community advisory group members and Hunter and Trappers Organizations in the Bathurst Inlet Area (Sabina, pers. comm.)*
[5] *Arctic ground squirrel consumption rate was assumed to be twice a week throughout the year*
[6] *Bay mussel consumption rates was assumed to be three time a week, for four months of the year*

5.1.2 Exposure Assessment

The amount of COPCs that people are exposed to from consuming country foods depend on several factors including:

- the concentration of metals in terrestrial wildlife resulting from their ingestion of environmental media (e.g., vegetation, water, and soil);
- the concentration of metals in aquatic species resulting from their uptake of metals from water, sediment, and their diet;
- the concentration of metals in vegetation resulting from their uptake of metals from environmental media; and
- human receptor characteristics (e.g., consumption amount, frequency, body weight).

These parameters are included in the exposure estimate equations to determine the EDI of each metal through the consumption of the selected country food. EDIs are based on the baseline measured metal concentrations in country foods, or modelled baseline estimates based on metal concentrations in the environmental media. The metal concentrations in the environmental media were obtained from soil (Rescan 2013d), fresh and marine water and sediment (Rescan 2012a, 2012b, 2013b), vegetation (Rescan 2013e, Appendix Vegetation and Wetlands Baseline Report), and wetland (Appendix A3-6 of Rescan (2013f)) baseline programs.

The EDI of each COPC for toddlers and adults was based on the modelled (caribou, Canada goose, Arctic ground squirrel, and ringed seal) and measured (fish, berries) tissue metal concentrations and the human receptor characteristics (for additional details see Rescan (2013f), Section 4 and Appendix B). The following equation was used to calculate the EDI of COPCs from the consumption of country foods:

$$EDI_{food} = \frac{IR \times C_{food} \times F_s}{BW}$$

where:

EDI_{food} = estimated daily intake of COPCs from country food (mg COPC/kg BW/day)
IR = ingestion rate (kg/day)
C_{food} = mean concentration of COPCs in food (mg/kg)
F_s = fraction of year consuming country food (unitless)
BW = body weight (kg BW)

The EDI of each COPC for toddler and adult receptors is presented in Table 5.1-3. An assessment of the EDIs in country foods shows that humans had the highest EDI of aluminum, chromium, copper, lead, mercury, nickel, selenium, thallium and zinc from consuming caribou, the highest EDI of cadmium from consuming mussels, and the highest EDI of arsenic from consuming berries. The lowest EDIs of COPCs were associated with the consumption of ground squirrels and ringed seals blubber.

Human health risk estimates were quantified using exposure ratios, and were calculated as:

$$\text{Exposure Ratio (ER)} = \frac{\text{Estimated Daily Intake (EDI)}}{\text{Tolerable Daily Intake (TDI)}}$$

Table 5.1-3. Estimated Daily Intake of Contaminants of Potential Concern by Human Receptors

	Caribou (mg/kg body weight/day)		Arctic Ground Squirrel (mg/kg body weight/day)		Canada Goose (mg/kg body weight/day)		Lake Trout (mg/kg body weight/day)	
COPC	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult
Aluminum	0.039	0.021	<0.00001	<0.00001	0.0059	0.0032	0.00011	0.000060
Arsenic	<0.00001	<0.00001	<0.0001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Cadmium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	0.00034	0.00019	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Copper	0.00098	0.00053	<0.00001	<0.00001	0.000048	0.000026	0.000026	0.000014
Lead	0.000011	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mercury	0.00034	0.00018	<0.00001	<0.00001	<0.00001	<0.00001	0.000019	0.000011
Nickel	0.00075	0.00041	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Selenium	0.00015	0.0000807	<0.00001	<0.00001	<0.00001	<0.00001	0.000034	0.000018
Thallium	0.000024	0.000013	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Zinc	0.0431	0.0234	<0.00001	<0.00001	<0.00001	<0.00001	0.00037	0.00020

(continued)

Table 5.1-3. Estimated Daily Intake of Contaminants of Potential Concern by Human Receptors (completed)

	Bay Mussel (mg/kg body weight/day)		Ringed Seal Meat (mg/kg body weight/day)		Ringed Seal Blubber (mg/kg body weight/day)		Bog Blueberry and Bog Cranberry (mg/kg body weight/day)	
COPC	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult
Aluminum	0.0023	0.0013	0.000043	0.000023	<0.00001	<0.00001	0.00083	0.00045
Arsenic	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00000055	0.00000030
Cadmium	0.000022	0.000012	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001
Copper	0.000021	0.000011	0.000012	<0.00001	<0.00001	<0.00001	0.00013	0.000073
Lead	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mercury	<0.00001	<0.00001	0.000042	0.000023	<0.00001	<0.00001	<0.00001	<0.00001
Nickel	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000048	0.000026
Selenium	0.000010	<0.00001	0.000019	0.000010	<0.00001	<0.00001	0.000014	<0.00001
Thallium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.0001	<0.00001
Zinc	0.00018	0.000096	0.00208	0.00113	0.0000459	0.0000249	0.00074	0.00040

Notes: COPC = contaminant of potential concern
Highlighted numbers denote country food with highest estimated daily intake for a toddler or adult of a particular COPC.

5.1.3 Toxicity Assessment

The toxicity reference value (TRV) assessment involves determining the amount of a COPC that can be taken into the human body without experiencing adverse health effects and are referred to as tolerable daily intakes (TDIs). TRVs are used for comparison with EDI values obtained from the exposure assessment. To select TRVs, Health Canada guidelines were used preferentially (i.e., Health Canada's Bureau of Chemical Safety, Chemical Health Hazard Division) unless they were not available for a COPC. Other sources of guidelines included: United States Environmental Protection Agency's (US EPA) Integrated Risk Information System (IRIS) guidelines, Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) Joint Expert Committee on Food Additives and Contaminants (JECFA) guidelines, and toxicological profiles for metals from the Agency for Toxic Substances and Disease Registry (ASTDR).

The TRVs used in this baseline assessment are presented in Table 5.1-4. It is noted that US EPA uses the term reference dose (RfD) rather than TDI, but for consistency within the report, RfDs will be reported as TDIs. For more information on TRVs, see Rescan (2013f), Section 5.

5.1.4 Risk Characterization

Health effects from chemicals are generally divided into two categories: threshold (i.e., non-carcinogenic) and non-threshold (i.e., carcinogenic) dose response relationships. Both adults (older than 19 years of age) and toddlers (six months to four years of age) were evaluated for their susceptibility to threshold chemicals. When assessing the risk from intake of methylmercury in fish, shellfish, and ringed seal an additional sensitive receptor group (women of childbearing age) was also considered.

Table 5.1-4. Toxicity Reference Values for Contaminants of Potential Concern

COPC	Tolerable Daily Intake (TDI)			Tolerable Daily Intake (TDI) Used in the Assessment
	Health Canada, Contaminated Sites Program (2010)	US EPA, Integrated Risk Information System (IRIS)	Joint FAO/WHO Expert Committee on Food Additives	
Aluminum	300[1]	-	143[2]	300
Arsenic	1,800 (oral cancer slope factor; µg/kg BW/day)	0.3	under review	0.3[3], 1,800[3]
Cadmium	1	1	0.8	1
Chromium (trivalent)	-	1,500	-	1,500
Chromium (total)	1	-	-	1
Copper	91 to 141 depending on age group	-	500	91 (toddler), 141 (adult)
Lead	Under review	under discussion	3.6	3.6
Mercury, total	0.3	-	0.47[4]	0.3
Mercury, methyl	0.47	0.1	0.23[7]	0.23[5], 0.47[6]
Nickel	11	20	-	11
Selenium	5.5 to 6.3 depending on age group	5	-	6.2 (toddler), 5.7 (adult)
Thallium	0.07[1]	under discussion	-	0.07
Zinc	480 to 570 depending on age group	300	300 to 1,000[8]	480 (toddler), 570 (adult)

Notes: COPC = Contaminant of potential concern
All units in µg/kg BW/day, unless otherwise stated.
[1] Based on Health Canada, Chemical Health Hazard Assessment Division (2011) "in house" reference source.
[2] Based on a PTWI of 1,000 µg/kg BW/week.
[3] Arsenic TDI of 0.3 is used for calculation of non-cancer risk while slope factor of 1,800 (µg/kg BW/day) is used for cancer risk calculations.
[4] Based on a PTWI of 3.3 µg/kg BW/week.
[5] For children and women of child-bearing age and pregnant women.
[6] General public.
[7] Based on a PTWI for adults of 1.6 µg/kg BW/week.
[8] Provisional daily dietary requirement/maximum tolerable daily intake.

5.1.4.1 Estimation of Non-cancer Risks

For non-carcinogenic risk, using the results of the exposure and toxicity assessments, human health risks from the consumption of country foods were quantified using exposure ratios (ER). The ER is the ratio between the EDI and the TDI and provides a measure of the risk associated with exposure to a COPC through the consumption of country foods (Table 5.1-5). ER values of greater than 0.2 suggest potential risks that may require a more detailed evaluation.

ERs of all the COPCs associated with the consumption of Arctic ground squirrel, Canada goose, lake trout, bay mussels, ringed seal (muscle and blubber tissue), and berries (bog blueberry and bog cranberry) were well below the threshold ratio of 0.2 and the risk based on the modelled and measured COPC concentrations is considered acceptable for all consumers of these country foods.

Table 5.1-5. Human Exposure Ratios Based on Predicted and Measured Tissue Concentrations

COPC	Caribou		Arctic Ground Squirrel		Canada Goose		Lake Trout		
	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]
Aluminum	0.0395	0.0214	<0.0001	<0.0001	0.00588	0.00319	0.000111	<0.0001	-
Arsenic	0.00159	0.000864	<0.0001	<0.0001	0.00372	0.000202	0.000993	0.000539	-
Cadmium	0.000622	0.000338	<0.0001	<0.0001	0.000494	0.000268	0.000227	0.000123	-
Chromium	**0.344**	0.187	<0.0001	<0.0001	0.00494	0.00268	0.00664	0.00326	-
Copper	0.00693	0.00379	<0.0001	<0.0001	0.000339	0.000184	0.000181	<0.0001	-
Lead	0.00303	0.00164	<0.0001	<0.0001	0.000828	0.000449	0.00116	0.000627	-
Mercury	**1.12**	**0.607**	<0.0001	<0.0001	<0.0001	<0.0001	0.0847	0.0225	0.0459
Nickel	0.030	0.0163	<0.0001	<0.0001	<0.0001	<0.0001	0.0000191	0.000104	-
Selenium	0.00261	0.00142	<0.0001	<0.0001	0.000838	0.000455	0.00594	0.00323	-
Thallium	**0.338**	0.183	<0.0001	<0.0001	0.00301	0.00163	0.00883	0.00479	-
Zinc	0.0755	0.00410	<0.0001	<0.0001	<0.0001	<0.0001	0.000642	0.000348	-

COPC	Bay Mussel			Ringed Seal Meat			Ringed Seal Blubber			Bog Blueberry & Bog Cranberry	
	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult
Aluminum	0.000232	0.00126	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.000835	0.000453
Arsenic	0.0583	0.0316	-	0.00012	<0.0001	-	<0.0001	<0.0001	-	0.00183	0.000995
Cadmium	0.0215	0.0117	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.00217	0.00118
Chromium	0.00106	0.00326	-	0.000868	0.000471	-	<0.0001	<0.0001	-	0.00751	0.00408
Copper	0.000146	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.000950	0.000516
Lead	0.000967	0.000525	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.000392	0.000213
Mercury	0.00110	0.000292	0.000596	0.182	0.0484	0.0989	0.00403	0.00107	0.00219	0.000252	0.000137
Nickel	0.000256	0.000139	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.00194	0.00105
Selenium	0.00180	0.000980	-	0.0033	0.00180	-	<0.0001	<0.0001	-	0.00248	0.00134
Thallium	0.000279	0.000152	-	0.00541	0.00294	-	0.000120	<0.0001	-	0.0101	0.00547
Zinc	0.000311	0.000169	-	0.00365	0.00198	-	<0.0001	<0.0001	-	0.00130	0.000703

Notes: COPC = Contaminant of Potential Concern
ER values above 0.2 are bold and shaded in gray.
[1] ERs for lake trout, mussels, and ringed seal meat and blubber are based on methylmercury concentrations rather than inorganic mercury (see Section 5.2.7 of Appendix V8-5A). Therefore, a sensitive group of adult women of childbearing age were considered separately as a human receptor group for these country foods.

The ERs for (inorganic) mercury for toddlers and adults consuming caribou were above the threshold ratio of 0.2 (ERs of 1.12 and 0.607, respectively). Studies have found high levels of mercury in Canadian arctic caribou (Gamberg et al. 2005; Tian et al. 2011). The ERs for chromium and thallium for toddlers consuming caribou were also above 0.2 (0.344 and 0.338, respectively). Given the conservative nature of the risk estimate due to the assumptions and inputs into the food chain model, the risk from consumption of caribou is likely over-estimated and it is unlikely that health effects will occur since the ERs are minor elevations over a highly protective benchmark.

Calculation of RMWIs and recommended maximum consumption rates (servings/week) of country food provided further evaluation of the potential risk for COPC intake by allowing comparison of the current weekly consumption rates of the country foods to recommended consumption rates.

The RMWIs were calculated as described by Health Canada (Health Canada 2010a, 2010d, 2010c), using the following equation:

$$RMWI = \frac{(TRV \times BW \times 7)}{C_{food}}$$

where:

RMWI = recommended maximum weekly intake of food (kg/week)
TRV = toxicological reference value (mg/kg BW/day)
BW = receptor body weight (kg BW)
7 = days/week
C_{food} = mean metal concentration in food (mg/kg)

The RMWI was then used to calculate the recommended maximum weekly number of servings by dividing by the estimated serving size of the country food. Results are summarized in (Table 5.1-6). The majority of the recommended maximum weekly consumption rates were greater than the assumed current maximum number of servings per week (Table 5.1-6) for the country foods evaluated.

Table 5.1-6. Recommended Maximum Weekly Intake and Number of Servings of Country Food

Country Food	Human Receptor	Recommended Maximum Weekly Intake (kg/week)	Serving Size (kg/serving)	Recommended Maximum Weekly Number of Servings (servings/week)	Consumption Rate Used in this Assessment (servings/week)
Caribou	Toddler	0.726[1]	0.0311[1]	23.3[1]	7.0
	Adult	3.11	0.270	12	7.0
Arctic ground squirrel	Toddler	235	0.023	10,322	2.0
	Adult	1,008	0.053	19,018	2.0
Canada goose	Toddler	1.38	0.085	16	0.096
	Adult	5.92	0.197	30	0.096
Lake trout[2]	Toddler	0.124	0.109	1.1	0.096
	Adult (general public)	1.08	0.254	4.3	0.096
	Adult (women of child-bearing age)[1]	0.530	0.254	2.1	0.096

(continued)

Table 5.1-6. Recommended Maximum Weekly Intake and Number of Servings of Country Food (completed)

Country Food	Human Receptor	Recommended Maximum Weekly Intake (kg/week)	Serving Size (kg/serving)	Recommended Maximum Weekly Number of Servings	Consumption Rate Used in this Assessment (servings/week)
Bay mussel[3]	Toddler	0.0553	0.0013	43	0.92
	Adult	0.237	0.0030	79	0.92
Ringed seal meat[2]	Toddler	0.890	0.103	8.6	1.6
	Adult (general public)	7.80	0.240	32	1.6
	Adult (women of child-bearing age)[1]	3.81	0.240	15.9	1.6
Ringed seal blubber[2]	Toddler	0.890	0.037	24	0.096
	Adult (general public)	7.80	0.087	90	0.096
	Adult (women of child-bearing age)[1]	3.81	0.087	44	0.096
Bog Blueberry and Bog Cranberry	Toddler	1.62	0.0056	289	2.9
	Adult	6.93	0.013	533	2.9

[1] RMWI and recommended maximum weekly number of servings for toddlers consuming caribou was recalculated based on a toddler specific serving size provided in Tian et al. (2011). See Rescan (2013f) for further details.
[2] RWMI for lake trout, and ringed seal meat and blubber is based methylmercury concentrations. Therefore, a sensitive group of adult women of childbearing age were considered separately as a human receptor group.
[3] RMWI for mussels is based on cadmium. Therefore, unlike lake trout and ringed seal, a sensitive group was not considered separately as a human receptor.
Shaded and bolded numbers are recommended maximum number of servings that are smaller than the consumption rate used in this report.

Toddler and adult recommended weekly number of servings for caribou, Arctic ground squirrel, Canada goose, lake trout, bay mussel, ringed seal meat and blubber, and berries, as well as the recommended weekly number of serving for caribou for adults, were greater than the estimated consumption rates (Table 5.1-6). Therefore, no risk to human health was identified due to incidental consumption of metals in country foods under baseline conditions.

5.1.4.2 Estimation of Cancer Risk

For carcinogenic risk, all life stages are susceptible. However, adults are used to evaluate carcinogenic risk because this is calculated over an adult lifespan (Health Canada 2010a). Carcinogenic risks were estimated by calculating the ILCR according to the following formula (Health Canada 2010a):

$$ILCR = Estimated\ Lifetime\ Daily\ Exposure\ in \left(\frac{mg}{\mathrm{kg}_{BW} day}\right) \times Oral\ Cancer\ Slope\ Factor\ in \left(\frac{mg}{\mathrm{kg}_{BW} day}\right)^{-1}$$

Of the COPCs evaluated, only arsenic is considered carcinogenic through ingestion. The oral slope factor for arsenic cancer risk is 1.8 $(mg/kg\ BW/day)^{-1}$ as described by Health Canada (2010b). The

following equation was used to calculate the estimated lifetime daily exposure (ELDE; (Health Canada 2010a):

$$ELDE_{country\ food} = \frac{IR \times F_s \times C_{country\ food} \times P_{as} \times YE}{BW \times LE}$$

where:

$ELDE_{country\ food}$ = estimated lifetime intake of country food (mg COPC/kg BW/day)
IR = ingestion rate (kg/day)
F_s = fraction of year consuming country food (unitless)
$C_{country\ food}$ = concentration of COPC in country food (mg/kg)
P_{as} = proportion of inorganic arsenic relative to total arsenic concentration
YE = years exposed (yr)
BW = body weight (kg BW)
LE = life expectancy (yr)

Arsenic ELDEs and ILCRs were calculated for each country food and the results are shown in Table 5.1-7.

Table 5.1-7. Estimated Daily Lifetime Exposure and Incremental Lifetime Cancer Risk for Human Receptors Exposed to Arsenic in Country Foods

Country Food	ELDE (mg/kg BW/day)	ILCR (unitless)
Caribou	2.50×10^{-7}	4.67×10^{-7}
Arctic ground squirrel	3.89×10^{-11}	7.00×10^{-11}
Canada goose	6.06×10^{-8}	1.09×10^{-7}
Lake trout	1.62×10^{-7}	2.91×10^{-7}
Bay mussel	9.49×10^{-8}	1.71×10^{-7}
Ringed seal muscle	1.90×10^{-8}	3.41×10^{-8}
Ringed seal blubber	4.19×10^{-10}	7.55×10^{-10}
Berries	2.99×10^{-7}	5.38×10^{-7}

Notes:
ILCR = incremental lifetime cancer risk
ELDE = estimated lifetime daily exposure
The oral slope factor for arsenic is 1.8 (mg/kg BW/day)$^{-1}$ (Health Canada 2010b)
An ILCR of less than 1×10^{-5} is normally considered acceptable (Health Canada 2010a)

The calculated ILCRs for arsenic from caribou, Arctic ground squirrel, Canada goose, lake trout, bay mussels, ringed seal, and berries were less than 1×10^{-5} (Table 5.1-7). These country foods can be considered safe for consumption at the current local consumption rates and the foods do not pose a significant elevated cancer risk.

5.1.5 Uncertainty Analysis

There are some uncertainties associated with the baseline assessment of health risk due to incidental metal consumption in country foods (i.e., consumption rates, measured and modelled tissue concentrations, exposure durations and frequencies, and biotransformation factors). For a detailed examination of uncertainties associated with this baseline assessment, please refer to Section 7 of Rescan (2013f). Conservative assumptions that were made to account for the uncertainties likely

resulted in an over-estimation of health risks associated with the consumption of country foods from the baseline study area.

5.1.6 Summary of Results for the Baseline Country Foods Risk Assessment

Based on calculated ERs, RMWIs, ILCRs, and recommended maximum weekly number of servings, incidental consumption of metal COPCs in caribou, Arctic ground squirrels, Canada geese, lake trout, ringed seals (muscle and blubber), bay mussels, and berries (bog blueberry and bog cranberry) were shown to not present health risks to local human receptors.

5.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

5.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available Traditional Knowledge (TK) from the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report (KIA 2012) was reviewed for country foods existing environment and baseline information. The following information is included in the TK report:

- *"The harvesting activities of Inuit were tied to the cycles of animal movements, behaviour, and availability. Tuktuk (caribou) was the preferred prey for Nunamiut and for coastal Inuit when nattik (seals) were unavailable."*
- *"Tuktuk (varren-ground caribou) were and continue to be the lifeblood of Kitikmiut. Without tuktuk, survival on the land was not possible. Tuktuk provided food, clothing, utensils, tools, and shelter. The life cycle of tuktuk was a major factor in where people travelled and where their seasonal camps were located, especially for Nunamiut."*
- *"tuktuk meat taken during the fall was either dried or cached with rocks and buried. This meat would provide the food for winter."*
- *"Small prey such as hikhik (ground squirrels) was hunted in conjunction with other activities and used as food when there was no fresh or cached meat available."*
- *"For coastal Inuit, spring was an important time to hunt the large aggregations of migrating waterfowl. In the summer, they collected eggs and hunted moulting waterfowl."*
- *"People fished the ocean by jigging mostly. Now they use a lot of gillnets. They ice fish today with fishing rods. They are Arctic charr and some trout close to the ocean. Some trout are really close to the ocean. There are also Jackfish or pike close to the mouth of Coppermine River. In the ocean there are whitefish, what they call the broad whitefish, lots of broad whitefish, and those flat fish called flounders, tomcod, Thomson eel, and sculpins…"*
- *"Lake trout, charr, whitefish, and grayling are found in lakes."*
- *"These areas (coastal parry Bay, Etibliakyok (Kent Peninsula isthmus), Kolgayok (Tingmeak River, and an area east of Fishing Creek) are fishing places. They have charr and trout… and cisco whitefish…."*
- *"Ekalukpik (Arctic charr) were the main fish species for Ocean Inuit and Kiligiktokmiut. Ekalukpik and hiugyuktok (tomcod) were the two main ocean fish. Other ocean fish included sculpins, smelt, flounders (called turbot), wolf eel, crabs, oysters, and starfish. Manamiut fished for over-wintering and land locked charr, but the main lake and river fish were ehok (lake trout), anakheek (broad whitefish), kapihilik (arctic cisco) and hulukpaugan (grayling)."*
- *"Fishing was important to feed the dogteams."*

- *"Due to the pulses of wildlife availability, a lot of effort was placed into drying and caching meat and fish so that it would be available during the winter season when animals were not available."*

Historically and currently, Inuit harvest activities are closely related to the animal migration patterns and behaviour. Caribou was the preferred country foods for inland Inuit as well as coastal Inuit if seals were not available (KIA 2012). Caribou provided vital resources to Inuit including food, clothing, and tools. Meat was dried and preserved for winter use.

Arctic ground squirrels and waterfowl were also hunted when caribou and seal availability was low (KIA 2012). Meat was dried and stored for use in the winter season when animals were not available (KIA 2012).

Historically, all lakes and rivers feeding into Bathurst Inlet were important for fishing using gillnets (KIA 2012). The freshwater fish collected were lake trout, broad whitefish, arctic cisco, and grayling. In addition to freshwater fishing, Inuit fished the ocean adjacent to mainland and island coastlines (KIA 2012). Fish included Arctic char, tomcod, sculpins, smelt, founders, wolf eel, crab, oysters, and starfish. Fishing was also important for feeding the dog teams (KIA 2012). Fish were dried and stored for use in the winter season (KIA 2012).

Although today's use of country foods has been modified by changes in Inuit lifestyle as well as wildlife behaviour, migration patterns, and food availability, Inuit still rely on country foods for sustenance and way of life (Rescan 2013c).

5.2.2 Incorporation of TK for VEC and VSEC Selection

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 Valued Ecosystem Component/Valued Socio-economic Component (VEC/VSEC) list (see Volume 9, Chapter 1). The TK report presents 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 initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site.

The Inuit culture and way of life are intrinsically connected with the land. The Inuit people of the Kitikmeot have always depended on knowledge of the land and environment, and continue to adapt to challenges posed by geography and climate (KIA 2012). Practices such as hunting, fishing, and gathering have endured over many years and remain important for maintaining social relationships and cultural identity, as they define a sense of family and community within Inuit culture (KIA 2012; Rescan 2013d). These practices link people to their histories, their present cultural settings, and provide a forward way of thinking about livelihoods (ACIA 2005).

In Inuit culture, the environment is valued as a whole: the value of one ecosystem component cannot be ranked or differentiated from the value of another (Rescan 2013c). The values that guide traditional activities and subsistence harvests are reflected in the Inuit approach to historic and contemporary land and resource use activities in the Kitikmeot Region (Rescan 2013c).

Maintaining the health of the land and the ability of the land to support the traditional subsistence economy, including hunting, trapping, fishing, and gathering, is essential to the Inuit lifestyle (Rescan 2013c). This includes ensuring the sustainability of wildlife populations in the area. Seals, fish, muskox, caribou, grizzly bear, wolf, wolverine, and Arctic ground squirrels are among the species people in the Kitikmeot Region currently rely upon and have been relied upon in the past (KIA 2012), with caribou being the most harvested terrestrial mammal (Rescan 2013c). This TK and TU information was considered when selecting the Country Foods VSEC for inclusion in the DEIS.

5.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Inuit in the Kitikmeot region had traditional camps, travel routes, hunting, and fishing areas that they used year after year (KIA 2012). The country foods LSA special and temporal boundaries were based on current use of resources within the Project; however, TK information was used to identify hunting, fishing, and gathering locations and identify country foods that may be of importance to the Inuit within the region.

Movements, behaviour, and availability of wildlife dictated Inuit harvesting activities, and hunting and trapping occurred all over the region (KIA 2012). In the west Kitikmeot, Bathurst Inlet was so rich in wildlife resources that Inuit were able to live there year-round (KIA 2012). Caribou, other large mammals, furbearing animals, and fish were abundant in Bathurst Inlet and its coastal River system. Caribou was and is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c).

Some Inuit (Nanamiut) lived together in large camps and hunted caribou during spring and fall migrations (KIA 2012). During the winter months, they trapped animals such as Arctic ground squirrels, and in spring and fall they travelled to trading post stores to see and trade furs, obtain provisions, and visit with others (KIA 2012). Arctic ground squirrels were also distributed within the MLA and George Property portions of county foods LSA, as shown in Figure 25 of KIA report (2012).

The principal caribou herds hunted in the Kitikmeot region were Island caribou and mainland caribou (Ahiak and Bathurst herds). Migratory caribou use all of Bathurst Inlet due to its proximity to the calving rounds. Bathurst caribou calving areas are present throughout the Project study area, while calving areas of Ahiak and Island caribou are east of Bathurst Inlet and on Victoria Island, respectively. Inuit TK on caribou indicated that caribou migration path in spring and fall (see Figure 12 in KIA report KIA (2012)) and calving areas (see Figure 14 in KIA report KIA (2012)) overlapped with the country foods LSA.

Coastal Inuit predominantly harvested ringed seals rather than caribou. Seals were hunted in the spring while hauled out on the sea ice and in summer by boat. Bathurst inlet is among the important spring hunting areas (see Figure 27 in KIA report KIA (2012)).

Marine fishing areas were located in the ocean adjacent to the mainland and island coastlines, and at the mouth of major rivers. Important freshwater fishin areas were all lakes and rivers feeding into Bathurst Inlet, especially Hiukkittak, lakes near Kingaok (especialy Tagionuak), Fishing Lake, Bathurst Lake, Kenyon Lake, and Beechey Lake (see Figure 30 in KIA report KIA (2012)). The country foods LSA overlaps with Inuit gathering places and travel routs as shown in Figure 8 of KIA report (2012).

5.2.4 Incorporation of TK for Effects Assessment

TK was considered when assessing the potential for effects to human health from changes in country foods quality by determining the potential overlap of traditional land use activities (e.g., hunting, fish, and gathering areas). TK was considered when determining where potential human receptors may be

located and whether country foods from within the country foods LSA may be harvested or collected based on historical or current land uses and activities. Additional information on how TK was used in the effects assessment for country foods can be found in the Human Health Risk Assessment (Volume 8, Chapter 6, Section 6.2.4).

5.2.5 Incorporation of TK for Mitigation and Adaptive Management

Mitigation and management strategies will be in place for a number of VECs and VSECs that will serve to minimize the potential effects of the Project on country foods since the quality of country foods is dependent on the quality of the surrounding environmental media (i.e., air, water, soil, and vegetation). In addition, strategies to minimize the potential for Project-related effects to wildlife and people (land use) have also been developed.

Mitigation and adaptive management strategies for VECs and VSECs and the ways in which TK was incorporated into the development of these strategies are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air quality: Volume 4, Chapter 1;
- Freshwater water quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and fish habitat: Volume 6, Chapters 6 and 7; Volume 7 Chapters 4 and 5;
- Terrestrial wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

5.3 VALUED COMPONENTS

5.3.1 Potential Valued Components and Scoping

VECs and VSECs are specific attributes of the biophysical and socio-economic environments that have scientific, economic, social or cultural significance. Valued components may be identified on the basis of perceived or real public or scientific concerns regarding their value and their potential to be affected 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 may be known to be a concern based on previous project experience.

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013). VSECs to be examined in the assessment of the Project on country foods, as an important constituent of the human environment, were selected on the potential interaction with Project activities and informed through consultation with communities, regulatory agencies, available TK (KIA 2012), and professional expertise (Volume 9, Chapter 1).

For Inuit, harvesting activities and country food link to, and in sense underpin, well-being for individuals and communities. Kitikmeot region land users harvest food from the land for themselves, their families, and their neighbours (Omingmaktok Hunter Focus Group 2012). During multiple scoping sessions held with NIRB, local stakeholders, and community members facilitated discussions to identify

components important to the land users and the land use generally, as related to the Project (see Land Use, Volume 8, Chapter 4). A large number of the comments were linked to the importance of country foods (see Land Use, Volume 8, Chapter 4).

5.3.2 Valued Components Included in Assessment

Following the assessment methodology (Volume 9, Chapter 1), based on the potential interaction with Project activities, consultation with communities and regulatory agencies, available TK (KIA 2012), and professional expertise, country foods was selected as a VSEC in this DEIS. The quality of country foods, as it relates to potential effects on human health, was assessed in this chapter.

5.4 SPATIAL AND TEMPORAL BOUNDARIES

5.4.1 Spatial Boundaries

5.4.1.1 Local Study Area

The country foods Local Study Area (LSA) for the DEIS is the same as the study area used for the country foods baseline assessment which encompassed the George Property, Goose Property, Marine Laydown Area (MLA), and the main winter road access corridors (Figure 5.4-1). Around potential infrastructure, the extent of the country foods LSA was defined as 10 km for George and Goose properties, and 3.5 km for the MLA, in northerly, westerly, southerly, and easterly directions from infrastructure. In addition, a 1-km buffer zone was included along the main winter road access corridors. The country foods LSA includes the Potential Development Area (PDA) for each area.

5.4.1.2 Regional Study Area

The country foods Regional Study Area (RSA) is the same as the RSA developed for the assessment of wildlife and was delineated based on the expected use of the region by wildlife species assessed as VECs. The RSA encompassed the PDAs and LSAs surrounding the Goose and George properties and the proposed MLA (Figure 5.4-1). The RSA extends 35 km from the Goose and George properties, the MLA, and the main winter road access corridors. The RSA was selected to reflect a larger area anticipated to provide habitat for raptors, carnivores and caribou, which have large home ranges.

5.4.2 Temporal Boundaries

The Project has an approximate planned life of 24 years (not including the Post-Closure, Temporary Closure, or Care and Maintenance phases). The temporal boundaries used for the country foods effects assessment follow the time periods of the phases of the Project as presented in Table 5.4-1.

Table 5.4-1. Life of Project

Activities	Duration
Site Preparation	2 years
Construction phase	2 years
Operational phase	10 years
Reclamation and Closure phase	10 years
Post-Closure phase	5 years
Other Potential phases:	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years

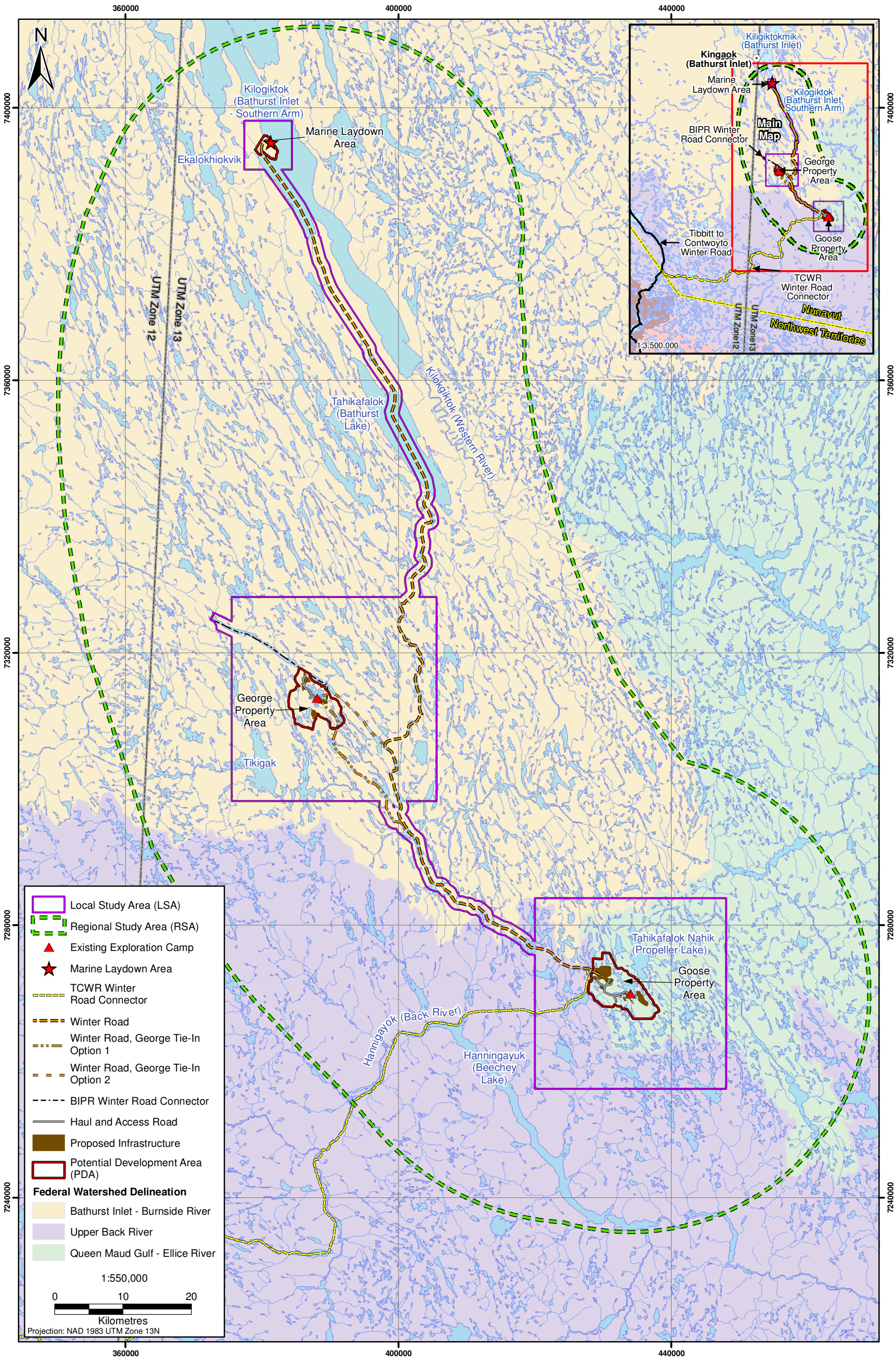


Figure 5.4-1

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Country Foods Local and Regional Study Areas

Figure 5.4-1

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5.5 POTENTIAL EFFECTS ASSESSMENT

The purpose of this step in the assessment is to identify whether there is a potential for adverse effects on human health from consumption of country foods from the country foods LSA due to Project components or activities. For an effect to occur, there must be a cause and effect relationship between a Project component or activity and human health from exposure to contaminants through consumption of country foods.

5.5.1 Methodology Overview

The methodology used in the assessment of potential effects to country foods quality is generally described in the Assessment Methodology, found in Chapter 1 of Volume 9. The analysis of effects to country foods considered the information provided in the following sources:

- *Country Foods Baseline Screening Level Risk Assessment* (Rescan 2013f; Appendix V8-5A);
- *2012 Socio-economic and Land Use Baseline Report* (Rescan 2013c);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project, Naonaiyaotit Traditional Project (NTKP)* (KIA 2012);
- Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. Revised 2012. Ottawa, ON (Health Canada 2010a);
- Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRA foods). Health Canada: Ottawa, ON (Health Canada 2010d); and
- Guidelines for the Preparation of an Environmental Impact Statement for Sabina Gold & Silver Corp.'s Back River Project (NIRB 2013).

The steps used in the effects assessment process were:

1. Identification of the potential interactions between Project components or activities and the quality of country foods;
2. Characterization of the potential effects that could result from the interactions between country foods and the Project;
3. Identification of mitigation measures to avoid, reduce, control, eliminate, offset, or compensate for potential effects;
4. Identification of where there are residual effects to the quality of country foods that could affect human health that cannot be mitigated; and
5. Determination of the significance of potential residual effects to quality of country foods, as it relates to the potential for health effects in consumers of country foods.

For the purposes of identifying Project component or activity interactions with country foods, all phases of the Project were considered. However, for the purposes of the country foods effects assessment, only the phase with the greatest potential for effects to country foods quality was assessed. This was done to represent the 'worst-case scenario' of expected Project-related changes and therefore represents the phase associated with the greatest level of risk; risk during other phases would be expected to be lower.

Based on the information available at the time of assessment, the Operational phase was considered to have the greatest potential for effects to country foods. This also aligns with the air quality assessment, which used Year 3 of the Operational Phase for Goose Property and Year 7 of the Operational phase for George Property as the worst case scenario (Volume 4, Chapter 1). The Operational phase was selected since the greatest level of Project-related activity will occur during this phase and therefore it is likely to have the greatest potential for both air and water emissions of potential contaminants that could affect the quality of country foods. If potential residual effects to country foods were noted during the Operational phase, assessment of the potential for residual effects during other phases would be required.

For determining the significance of potential residual effects, the direction of a residual effect was determined to be positive or negative; only negative potential effects were assessed for significance. The magnitude of the effect and reversibility were used as the primary criteria in the assessment; the extent, duration, and frequency of the effect as secondary criteria. The rating of residual effects to country foods was based on the attributes and definitions summarized in Chapter 1, Volume 9 for biophysical effects.

In considering the magnitude of effects on the quality of country foods, definitions to designate each effect as having either a low, moderate or high magnitude specific to country foods quality were used, as shown in Table 5.5-1.

Table 5.5-1. Definitions of the Magnitude Criterion for Country Foods Residual Effects

Parameter	Magnitude		
	Low	Moderate	High
Non-carcinogenic compounds	No change from baseline conditions or below applicable guidelines, (i.e., HQ ≤ 1)	Some change from baseline or above applicable guidelines, and health effects are possible (i.e., 1 <HQ <10)	Significant change from baseline or significantly greater than guidelines, and health effects are probable (i.e., HQ ≥ 10)
Carcinogenic compound	No change from baseline conditions or below applicable guidelines (ILCR ≤ 0.00001)	Some change from baseline or above applicable guidelines, and health effects are possible (i.e., 0.00001 < ILCR < 0.0001)	Significant change from baseline or significantly greater than guidelines, and health effects are probable (i.e., ILCR ≥ 0.0001)

The evaluation of significance also considered the likelihood of occurrence of the effect (probability) and level of confidence in the data available for analysis (certainty). Where available, quantitative measures of the degree to which residual effects could cause changes to the quality of country foods were used to determine the magnitude of residual effects. When quantitative data was not available, qualitative assessment was done using best professional judgement.

To assess the overall significance of residual effects, the attributes described above (direction, magnitude, extent, frequency, duration, probability, confidence level) were used. For example, a residual effect would receive a rating of 'not significant' if it is expected to be one of the following: low magnitude, confined to the Project Footprint, the PDA, or the LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). Overall significance of an effect was derived based on experience and professional judgment and considering the rankings of the attributes that contribute to significance. Residual effects to country foods were characterized as significant or not significant based on the definitions provided in Table 5.5-2.

Table 5.5-2. Definitions of Significance Ratings for Effects to Human Health Due to Consumption of Country Foods

Significance	Descriptor of Significance
Significant	Effect is expected to result in an overall decline in country foods quality in comparison to baseline levels of country foods quality, and effects to human health would be expected in consumers of country foods.
Not Significant	Effect may result in an improvement or no change in country foods quality within the Project LSA relative to the baseline country foods quality during the life of the Project, and effects to human health would not be expected in consumers of country foods.

5.5.2 Potential Interactions with Project and Characterization

5.5.2.1 Potential Interactions between Project Components or Activities and Country Foods

Country foods are animals, plants, and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation (Health Canada 2010). People obtaining country foods by hunting, trapping, and collecting berries, mushrooms, and medicinal plants from the country foods LSA, and by fishing inside and downstream of the country foods LSA can be affected by the quality of the country foods they consume.

There are no permanent residents living in the country foods LSA; however, some seasonal and temporary use of the area does occur (see Land Use, Volume 8, Chapter 4; Figure 5.5-1). Inuit people whose main food source is from harvesting country foods are likely the most frequent users of the area (see Land Use, Volume 8, Chapter 4) and, therefore, are the focus of the assessment.

The potential interaction between the quality of country foods and Project components and activities are provided in an interaction matrix summarized in Table 2.4-2 of the Assessment Methodology chapter (Volume 9, Chapter 1). A more detailed assessment of the potential for Project components and activities to interact with and affect the quality of country foods was done as part of the Human Health Risk Assessment (Volume 8, Chapter 6, Section 6.4.2.5.4 and Table 6.4-13), and only a summary is provided in this chapter. Generally, since the quality of country foods is directly related to the quality of environmental media, Project components and activities that can affect air, water, soil, or vegetation quality may also affect the quality of country foods.

There are two main pathways through which COPCs may enter the environment: atmospheric (criteria air contaminants or fugitive dust) or liquid/waterborne emissions. Table 5.5-3 summarizes the potential Project activities that could have effects on the quality of country foods, which could in turn have an effect on the health of human consumers of these foods. The table summarizes the most relevant potential pathways through which COPCs may enter the environment, examples of Project activities and components that may be sources of COPCs, and the phases of the Project in which they occur. Additional detail relating to potential Project interactions with country foods can be found in the Human Health Risk Assessment in Volume 8, Chapter 6, Section 6.4.2.5 (Problem Formulation and Pathway Analysis section).

5.5.2.2 Characterization of Potential Effects to the Quality of Country Foods from Project Interactions

Since the quality of country foods is dependent on the quality of the surrounding environmental media (i.e., air, water, sediment, soil, and vegetation), the potential for Project-related effects to country foods quality was characterized based on the potential for changes in environmental media quality. Potential effects to the health of human consumers due to changes in the quality of country foods were then considered.

Table 5.5-3. Potential Project-related Sources of Contaminants in the Country Foods Local Study Area during Various Phases of the Project

Type of Emission	Pathway for Contaminants to Enter the Environment	Examples of Potential Project-related Activities that may Produce Contaminants	Phase of Project Where Contaminant Release May Occur
Atmospheric Emissions (i.e., air)	Pollutants or inhalable particulate matter	Operation of incinerators, vehicles, aircraft, ships, generators, or other machinery	All phases (except post-closure)
	Fugitive dust	Roads, grading, bulldozing, blasting, and drilling	All phases (except post-closure)
Liquid / Waterborne Emissions	Effluent discharge	Discharge of sewage treatment plant effluent (at camps or from ships), use of mechanical equipment in and around water, discharge of water from the water management structures (TIA, WMF, or Collection Pond), discharge of effluent from ships (sewage or oily bilge water)	All phases (except post-closure)
	Site contact water	Areas where disturbed rock is located (e.g., pits, underground mines, quarries, borrow areas, waste rock storage areas, infrastructure constructed using rock) and site infrastructure	All phases

5.5.2.2.1 Atmospheric Media (Air Quality)

A variety of Project components such as the mill, access roads, quarries, open pits, underground mines, incinerators, waste rock storage areas, ore stockpiles, and a variety of equipment (e.g., generators) and transportation methods (e.g., vehicles, aircraft, ships) can result in emissions of airborne pollutants (e.g., particulate matter, combustion by-products) or fugitive dust. This may occur during all phases of the Project. Atmospheric Project emissions have the potential to enter the air and be transported some distance from the source.

While it is possible that country foods (e.g., caribou and other terrestrial organisms) could take up contaminants from inhalation of contaminants from air, this pathway is considered to be a very minor source of contaminants compared to uptake through dietary sources. Therefore, exposure via the inhalation route been excluded from further consideration as a route of contaminant exposure and uptake in wildlife harvested as country foods (see Volume 8, Chapter 6, Section 6.4.1.5.2).

5.5.2.2.2 Freshwater or Marine Media (Water and Sediment Quality)

There are several potential sources of contaminants to the freshwater environment. Water that has been in contact with Project infrastructure has the potential to contain contaminants such as metals, fuels, and blasting residues (from fuel oils used in explosives), and could affect the quality of country foods if not appropriately managed. Infrastructure built with non-PAG rock is assumed to not contribute poor quality water to the freshwater or marine environments. It is also assumed that any in-water works, such as stream crossings, diversion structures, and marine jetty/barge facilities could potentially be a source of total suspended solids/turbidity and not COPCs.

Metal leaching (ML) can occur from crushed or disturbed rock due to lower pH associated with acid rock drainage (ARD) which could result in acidification and therefore increase metal concentrations and bioavailability in freshwater environments. ML/ARD may occur at the quarries, open pits, underground mines, water rock storage areas, or ore stockpiles.

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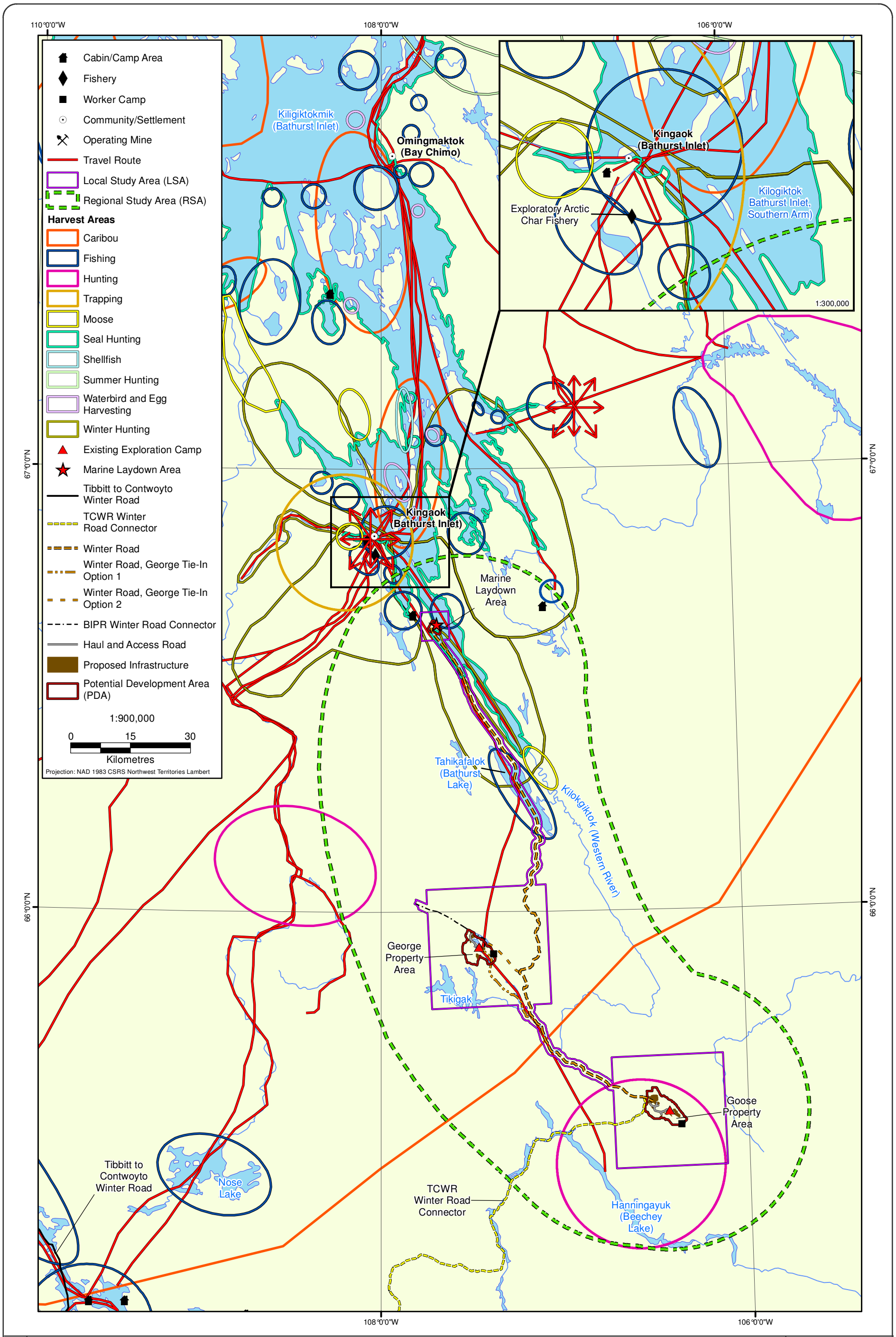


Figure 5.5-1

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Land and Resource Use of Inuit Populations (Bathurst Inlet, Omingmaktok, and Cambridge Bay) in relation to the Country Foods Local and Regional Study Area

Figure 5.5-1

Rescan an ERM company

A number of chemicals will be used in mineral processing and these will be present in effluent and tailings leaving the Mill complex. Effluent from the Mill complex will be stored in the TIA during the Operational phase and no discharge will occur to the environment during this phase. The TIA will be decommissioned in the Closure and Reclamation phase, which is described in Volume 2.

Sewage treatment plants will discharge treated effluent either to the tundra or a water management facility (e.g., the TIA, WMF, or Collection Pond) during all phases of the Project. Sewage effluent will not be discharged directly to the aquatic environment. Discharge locations will be such that CCME guideline will be met in fish-bearing receiving waters. The solid components resulting from sewage treatment (i.e., sludge) will be collected and incinerated in an approved manner and will not directly enter the aquatic environment.

During the Operational phase, activities and components such as drilling, blasting, excavation, grading/bulldozing, air transportation, vehicle/road use, and road maintenance can introduce fugitive dust into water. Metals and other contaminants present in fugitive dust deposited onto surface water can either remain in the water column or be deposited to sediments. Potential by-products of incineration, such as metals, PAHs, dioxins, and furans, could be carried by air and subsequently be deposited on surface waters. These compounds could partition to water and sediment, where they may be available for uptake by aquatic organisms such as fish.

Fuels or other chemicals present in the country foods LSA could enter the aquatic environment through combustion by-products in exhaust or incidental contact between machinery and water or sediments during work conducted in and around waterways. Uptake by fish or other aquatic organisms from water or sediment could introduce these contaminants into the food chain.

Shipping may introduce contaminants into the marine environment through discharge of bilge water, wastewater/sewage, or from exhaust. Bilge water may contain oils, detergents, or other chemicals that have been transported from the ship deck or the engine/machinery compartments to the bilge. Ships that have galleys or bathrooms will also have wastewater containing sewage, grey water, and chemicals that may have been washed down drains. Ship exhaust may contain both particulate matter and combustion by-products such as PAHs. If released to the marine environment, these COPCs have the potential to be taken up by aquatic organisms (e.g., fish consumed as a country food) either directly or through the food chain.

5.5.2.2.3 Terrestrial Media (Soil and Vegetation Quality)

The main sources of COPC release to the terrestrial environment are through deposition of dust containing contaminants, site contact water, or effluent discharge.

Fugitive dust or atmospheric emissions containing metals from a variety of sources such as the mill, access roads, quarries, open pits, underground mines, incinerators, waste rock storage areas, ore stockpiles, and a variety of equipment and transportation methods can result in metal deposition to soils within the country foods LSA. The metals in soil can be taken up by vegetation and, in addition to metals deposited directly on the surface of vegetation, the metals can enter the food chain when consumed by organisms that are collected or harvested as country foods.

Discharge of treated sewage (greywater) effluent to the tundra could introduce low concentrations of chemicals that are used domestically in the camps, such as those found in cleaning products, into soil and vegetation. As noted in Section 5.5.2.2.2 and in the Project description (Volume 2, Chapter 6), treated sewage effluent may be discharged to the terrestrial environment during the Construction phase, prior to the construction of water management facilities.

Site contact water could affect soil or vegetation quality in the vicinity of infrastructure, since it may contain metals, hydrocarbons, or other contaminants. This water will be collected and directed into the TIA, WMF, or Collection Pond. Discharge from these facilities to the tundra may change soil and vegetation quality at the discharge location.

5.5.2.3 Potential Effects to Human Consumers of Country Foods

Potential toxicological effects to humans from contaminants that may be present in country foods depends on variety of factors such as the dose, frequency of exposure, type of the contaminant, and the developmental stage of the human receptor. It is noted that the toxicology of mixtures of contaminants in humans is poorly understood, although it is known that antagonistic, additive, synergistic, or potentiating effects are possible outcomes.

Toxicity can result in variety of health effects depending on the individual contaminant and effects may range from carcinogenic effects to non-carcinogenic effects (e.g., changes in physiological functions or systems). However, toxicity in human consumers of country foods will only occur if sufficiently high concentrations of contaminants are taken in, such that toxicity thresholds are surpassed.

5.5.3 Identification of Mitigation and Management Measures

A number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, soil and vegetation, wildlife, and people (socio-economics). These mitigation and management measures will also serve to protect the quality of country foods. Details of these strategies can also be found in the following chapters:

- Air quality: Volume 4, Chapter 2. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11.
- Vegetation: Volume 5, Chapter 4.
- Wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10; Volume 7, Chapters 6 and 7. The Wildlife Mitigation and Monitoring Plan can be found in Volume 10, Chapter 20.
- Freshwater water, sediment, and fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.
- Marine water and sediment: Volume 7, Chapters 2, 3, 4, and 5. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.

- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21.
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

Key mitigation and management strategies from each of these chapters that would serve to minimize the potential for effects to the quality of country foods are summarized in the following sections.

5.5.3.1 Mitigation and Management Strategies for Air Quality

In order to mitigate or manage potential effects to air quality, a number of strategies have been proposed, which are detailed in the Air Quality Monitoring and Management Plan (Volume 10). Mitigation to preserve air quality includes the following:

- Emissions reduction strategies such as selection of clean, high-efficiency equipment, minimizing idling of vehicles, use of larger haul truck to decrease the number of trips made, speed limits on site roads, emission control systems, and regular servicing of vehicles;
- A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation; and
- An Incineration Management Plan (Volume 10, Chapter 11) including the provision to install an incinerator that complies with applicable standards (Nunavut standards (GN 2002), Canada-wide Standards for Dioxins and Furans (CCME 2000a), and Canada-wide Standards for Mercury Emissions (CCME 2000b)), implementation of waste-segregation and recycling programs to avoid the incineration of unsuitable materials such as chlorinated plastics and minimize waste to be incinerated, and stack testing to ensure guideline compliance.

These air quality mitigation and management strategies will serve to minimize the potential for effects to country foods by minimizing the amount of atmospheric emissions from the Project in the form of airborne contaminants or contaminants associated with fugitive dust. The Incineration Management Plan will ensure that emissions of dioxins, furans, and mercury will meet standards and minimize the potential for these contaminants to enter both the atmospheric and freshwater environments (from atmospheric deposition).

5.5.3.2 Mitigation and Management Strategies for Freshwater Water Quality, Sediment Quality, and Fish

The mitigation or management strategies to minimize potential effects to water quality are extensive and are presented more fully in the fresh and marine water quality and sediment quality chapters

(Volume 6, Chapters 4 to 7) and in the Aquatic Effects Management Plan (Volume 10, Chapter 19). A few of the key strategies are summarized here as follows:

- Infrastructure, waste rock storage areas, and the TIA have all been confined to the local watershed where the deposits are located, minimizing potential for effects to both surface water and the terrestrial environment;
- Only geochemically suitable rock will be quarried and used in construction of infrastructure to minimize the potential for metal mobilization;
- A Site Water Monitoring and Management Plan (Volume 10, Chapter 7) will be implemented at each of the three Project areas (Goose Property, TIA; George Property, WMF; and the MLA, collection pond) to collect and manage water that may have been in contact with Project infrastructure or mine pits/underground workings, waste rock storage areas, or ore stockpiles, which will serve to minimize contaminant entry into the aquatic environment;
- The TIA at the Goose Property, which stores tailings discharged from the mill, site contact water, and sewage effluent, will be a zero-discharge facility during the Operational phase, ensuring that no potentially poor quality water is introduced to the freshwater environment;
- Any effluent to be discharged from the TIA (in Reclamation and Closure phase or Post-Closure phase), WMF, or collection pond will be discharged to a location such that CCME guidelines are met in fish-bearing waters, ensuring the protection of the aquatic environment and the organisms present there (e.g., fish for human consumption);
- Bulk fuel storage areas (Fuel Management Plan, Volume 10, Chapter 4), hazardous materials storage areas (Hazardous Material Management Plan, Volume 10, Chapter 12), and explosives storage facilities (Explosives Management Plan) will be bermed and lined with impermeable barriers to minimize the potential for leaks and spills to reach the aquatic environment, thereby minimizing the potential for these chemicals or fuels to affect the quality of country foods;
- Petroleum product storage tanks will have appropriate secondary containment systems to prevent hydrocarbon/fuel release to the environment (Fuel Management Plan, Volume 10, Chapter 4);
- Refuelling and maintenance activities will be done at least 30 m away from water (except in case of equipment breakdown or approved activities near water) and refuelling will be done only when drainage capture/collection is installed or drip trays are in use (Fuel Management Plan, Volume 10, Chapter 4);
- All machinery that has the potential to have a fluid release or leak will be inspected prior to each shift and repaired as necessary, and oily water treatment plants at equipment maintenance facilities will be used to minimize the introduction of hydrocarbon contaminants into the environment, minimizing their potential for uptake by aquatic organisms; and
- An Aquatic Effects Management Plan (Volume 10, Chapter 19) will be implemented to monitor for changes in the aquatic environment as a result of Project activities.

In addition, an ML/ARD Management Plan (Volume 10, Chapter 22) will be implemented to characterize potential sources of ML/ARD (i.e., potentially acid-generating rock), and control or minimize the potential mobilization of metals from disturbed rock sources (Ore Storage Management Plan, Volume 10, Chapter 8; Mine Waste Rock and Tailings Management Plan, Volume 10, Chapter 9) and subsequent effects on aquatic environment.

The above mitigation and management measures intended to protect water quality will ensure that potential effects to aquatic organisms used for human consumption (e.g., fish) are also protected. The strategies outlined here will minimize the potential for effects to aquatic organisms from metals, chemicals used in explosives or mine processing, fuels, sewage treatment plant effluent, and other potentially poor-quality contact water or effluents by minimizing the potential for these contaminants to enter the aquatic environment.

5.5.3.3 Mitigation and Management Strategies for Marine Water Quality, Fish, and Sediment Quality

The mitigation and management strategies to minimize the potential for effects to marine water quality, sediment quality, and fish due to infrastructure or Project activities in and around the MLA are summarized in Volume 7, Chapter 2 to 5. Some of the key strategies include:

- Design of infrastructure to minimize footprint, which minimizes the potential for influence on water and sediment quality in the MLA;
- Treated sewage effluent will be discharged to either the Collection Pond or to a discharge location such that marine CCME guidelines are met in fish-bearing waters (e.g. Bathurst Inlet);
- Only a winter road will be used to connect the MLA to the Goose and George Properties, minimizing the potential for road dust to enter the marine environment;
- Only geochemically suitable rock quarries or borrow sources will be used to construct infrastructure, to minimize the potential for ML/ARD and subsequent effects on water or sediment quality;
- Contact water at the MLA will be directed to the Collection Pond and this water will only be discharged if the water quality meets future water licence criteria;
- Fuel storage, handling, and dispensing will be done as outlined previously for freshwater quality mitigation and management strategies (Fuel Management Plan, Volume 10, Chapter 4);
- Ships used in the transport of fuel will be conventional double-hulled, compartmentalized petroleum tankers, with Oil Pollution Emergency Plans (Volume 10, Chapter 6) and appropriate response gear;
- The bulk fuel storage facility, pipeline, and all transfer-related equipment will be inspected and maintained in order to minimize the potential for fuel leaks or spills to the environment;
- An Oil Pollution Emergency Plan (Volume 10, Chapter 6) will be implemented, including the measures to be used to contain and clean up a potential spill of oil in the marine environment; and
- Ship and MLA spill response equipment and personnel will be prepared for deployment prior to fuel transfer operations, to ensure a rapid response in the event of a spill to the marine environment, and transfer hoses/pipeline will be monitored hourly for leaks or defects during fuel transfers (Spill Contingency Plans, Volume 10, Chapter 5).

Because spills will be contained and cleaned up according to the Oil Pollution Emergency Plan (Volume 10, Chapter 6), the effects of fuel, lubricants, and other COPCs on marine country foods (shellfish, fish, waterfowl, and marine mammals) will be low. If such spills occur, the Proponent will work with local authorities in monitoring any adverse impacts that may occur to country foods supplies in the affected area and will assist in notification of affected communities through a Community Liaison Officer.

In addition, in the marine environment, shipping will be limited to five to ten ships per year during the Construction phase and three to five ships per year during the Operational phase. Ships will not be permitted to discharge untreated sewage or oil-containing bilge water in the vicinity of the MLA, in accordance with the Vessel Pollution and Dangerous Chemicals Regulation (SOR/2012-69). The use of organotin anti-fouling compounds is prohibited for vessels in Canadian waters and will not be used by vessels servicing the Project. This will minimize the potential for release of contaminants to the marine environment within the country foods LSA and will, therefore, minimize changes in the quality of country foods that may be collected from this area (e.g., mussels, fish, seals).

5.5.3.4 Mitigation and Management Strategies for the Terrestrial Environment (Soil, Vegetation, and Wildlife)

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the country foods LSA.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife from contaminants due to Project infrastructure, activities, or emissions. In addition to measures proposed to minimize effects to air quality and water quality, such mitigation measures include:

- Buildings will be designed and maintained to exclude wildlife, which should minimize exposure to chemicals that may be stored inside;
- Cyanide destruction will occur in the mill, in order to decrease the levels of cyanide that may be found in the TIA;
- The use of wildlife-attracting dust suppressants will be avoided wherever possible;
- Site roads and winter roads will be closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project;
- A policy of no feeding and no intentional attraction of wildlife will be developed and disseminated to all Project and contractor employees;
- A no-littering policy will be developed, which will serve to minimize exposure of wildlife to contaminants that may be found in either the product or packaging;
- Wildlife exclusion measures may be implemented if wildlife (e.g., bears or wolverines) are frequently accessing or attempting to access waste storage areas;
- If water or waste could pose a risk to wildlife, appropriate measures will be taken to exclude wildlife from these areas (e.g., fencing, noise makers).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife that may be hunted or harvested as country foods, thereby decreasing the potential for Project-related changes to health of human country foods consumers.

5.5.3.5 Mitigation and Management Strategies for Land Use

Mitigation measures and management strategies related to land use (Volume 8, Chapter 4) will also be used to minimize the potential for impacts to human consumers of country foods. These strategies are intended to minimize Project interaction or effects to traditional land use or to control access and activities done in areas close to Project infrastructure. Such mitigation measures include:

- Shipping will be done during the open-water season only (no-ice breaking), which minimizes the potential for effects to traditional winter activities such as hunting and travelling;
- Implementation of plans to facilitate ongoing subsistence land use activities through worker rotation schedules, fly-in/fly-out Project operation, and support of land users and the development of knowledge through activities such as:
  - A "no hunting or harvesting" policy for employees while at the Project site;
  - Facilitate harvesting by local Inuit near their home communities by using a two week on, two week off rotation schedule;
  - Promote harvesting and related cultural activities for youth;
  - Provide orientation to employees describing the nature and sensitivity of the Arctic environment to encourage respect and understanding of the local environment; and
- Allow regional land users to access camp facilities while in the area, as long as safety can be ensured.

These mitigation measures to minimize effects to land use will help to ensure that local Inuit consumers of country foods experience minimal disruption to traditional practices of hunting and gathering that may occur in the country foods LSA. It also minimizes the potential that country foods will be collected or obtained in close proximity to the Project footprint since employees of the Project will be subject to the "no hunting or harvesting" policy.

5.5.4 Characterization of Residual Effects

In order for there to be a potential for effects to human health due to contaminants present in country foods within the LSA, three criteria must be met:

- Contaminants must be present in the country foods within the LSA at concentrations high enough that effects in humans may occur;
- Human receptors (consumers) must be present and hunt, harvest, or collect the country foods from within the country foods LSA; and
- The country foods collected from within the LSA must be consumed.

Therefore, in considering the potential for adverse effects to health of consumers of country foods due to changes in the quality of country foods, human receptor locations were also considered. During the various phases of the Project, a no hunting policy for employees while working at the Project sites will be implemented for the areas around Project infrastructure. In addition, use of site roads and winter roads will be controlled and limited to Project-employed personnel to the extent possible.

These two mitigation measures, while primarily intended to ensure safety of employees, will also incidentally decrease the potential for hunting, harvesting, or collection of country foods in the areas closest to Project infrastructure. The areas closest to Project infrastructure are the ones most likely to be affected by Project emissions (e.g., deposition of fugitive dust containing metals), since the potential for changes in the quality of environmental media generally decreases with the distance from

the source. Therefore, the country foods that have the most potential to change in quality are less likely to be harvested or collected and the potential for effects on human health are less likely, particularly in employees of the Project.

The nearest communities to the Project are Kingaok, located approximately 160 km to the north of the Goose Property Area, and Omingmaktok, located approximately 250 km to the northeast of the Goose Property Area. The closest major regional settlements are Kugluktuk and Cambridge Bay, approximately 460 km and 400 km away, respectively. There are no permanent residents living in the country foods LSA, although some seasonal and temporary use of the area does occur (Figure 5.5-1). Inuit people whose main food source is from harvesting country foods are likely the most frequent users of the area (Rescan 2013f) and some activities such as hunting have been reported to occur around the Goose Property Area and the MLA (Figure 5.5-1).

While some of the country foods consumed by Inuit in the region may come from the LSA, considering the distance of these areas from the communities where people reside and the number of other areas identified as potential hunting grounds by local people (Rescan 2013c), it is unlikely that all of the country foods consumed come from the country foods LSA. It is likely that other hunting and gathering areas closer to the communities are also a source of country foods, and use of these hunting or gathering areas outside of the LSA would decrease the potential for Project-related effects to health in consumers of country foods. This is particularly the case for animals that have a small home range (e.g., Arctic ground squirrel), since Project-related effects would be most notable in animals that spend all of their time in close proximity to the Project.

Overall, while the country foods LSA may not be the primary location where country foods are hunted, harvested, or collected, there is still some potential that country foods from the LSA will be consumed by human receptors (i.e., receptors are present at least occasionally and it is assumed that the country foods collected are consumed). Therefore, additional assessment was done to consider the potential for effects to human health due to changes in quality of country foods.

As described previously (Section 5.5.2.1), there are a number of COPCs that may be present in the country foods LSA during the life of the Project including compounds used in mineral processing, chemicals found in treated sewage effluent or blasting residues, and fuels. In addition, by-products of combustion such as PAHs, dioxins, furans may also be present due to the operation of vehicles or incinerators. These potential contaminants were assessed and potential residual effects were characterized in a qualitative manner taking into consideration mitigation and management strategies, and using best professional judgement.

Metals occur naturally in the country foods LSA, sometimes at concentrations exceeding guideline limits (particularly in soil), due to natural physical and geological processes. Because the proposed Project is a metal mine and metal concentrations in the environment are most likely to change as a result of Project development, metals were selected for quantitative evaluation of their potential to affect the quality of country foods.

5.5.4.1 Qualitative Assessment of the Potential for Changes in Quality of Country Foods from Non-metal Contaminants

After mitigation measures and management strategies are considered, the potential for residual effects to the quality of country foods for non-metal contaminants (blasting residues, chemicals used in mineral processing, treated sewage effluent, fuels, oils, PAHs, dioxins, and furans) is considered to be negligible. This conclusion is based on the assumption that mitigation and management strategies,

outlined in Section 5.5.3, are implemented and perform successfully in minimizing the introduction of contaminants into the atmospheric, terrestrial, or aquatic (freshwater and marine) environments.

5.5.4.1.1 Blasting Residues and Chemicals Used in Mineral Processing

Water management strategies are likely to mitigate the potential effects of compounds used in explosives or mineral processing, since site contact water in all areas and water from the Mill facilities at the Goose Property will be collected into water management facilities (TIA at Goose Property, WMF at George Property, and the Collection Pond at the MLA) and will not be discharged to the environment until concentrations of contaminants in the water are below acceptable levels.

In addition, water contained in the TIA will not be discharged at all during the Operational phase, since this facility will be operated with a negative water balance and water from the TIA will be recycled back to the Mill for reuse. Cyanide destruction technology will also be used to decrease the concentration of cyanide in the water of the TIA, and mitigation measures to exclude wildlife from accessing the water in this facility will be used as necessary. The TIA will be closed during the Reclamation and Closure Phase, as described in the Closure Plan (Volume 2, Chapter 8) and the Mine Closure and Reclamation Plan (Volume 10, Chapter 29).

Although a small amount of blasting residue containing fuel oil may be expected to be deposited from atmospheric deposition of particles, this is likely to result in negligible changes in soil or water quality and is very unlikely to result in exceedance of toxicity thresholds in wildlife, birds, fish, or human consumers of country foods. Overall, it is unlikely that blasting residues or chemicals used in the Mill complex will have adverse effects on human health from consuming country foods.

5.5.4.1.2 Treated Sewage Effluent

During the Construction phase, effluent from the sewage treatment plants at the Goose Property, George Property, or MLA will be discharged to land. Discharge to land will only occur until the water management structures in each area are constructed.

The discharge of treated sewage effluent during the Construction phase is likely to occur in close proximity to Project infrastructure (e.g., camps) and most of the larger terrestrial wildlife (e.g., caribou) is unlikely to graze on the vegetation found so close to where human activity is occurring. For organisms with a large home range (e.g., caribou), the area in which treated effluent will be discharged is small in relation to the size of the overall home range, which would decrease the overall potential for changes in contaminant burdens from this source.

In addition, because hunting will be prohibited for employees residing at the camps, it is unlikely that wildlife with small home ranges that may reside in close proximity to Project infrastructure (e.g., Arctic ground squirrels) would be harvested from areas where treated effluent is discharged.

During the Operational phase, treated sewage effluent will be directed to the TIA (Goose Property), the WMF (George Property), or the Collection Pond (MLA), and exposure to country food organisms to the water contained in these facilities would be minimized through the use of exclusion mitigation strategies. Therefore, the potential for changes in the quality of country foods from exposure to treated sewage effluent is considered negligible.

5.5.4.1.3 Fuels, Oils, and PAHs

A number of mitigation measures have been proposed to minimize the potential for environmental contamination from fuels or oil in the terrestrial, aquatic, and marine environments, which will serve

to minimize and prevent effects to the quality of country foods from contaminants found in fuels or oil. This includes the implementation of a Fuel Management Plan (Volume 10, Chapter 4) Spill Contingency Plan (Volume 10, Chapter 5) to mitigate for potential effects due to unintended releases of contaminants, as well as a number of measures intended to minimize the potential for release of fuels or oils from smaller scale, routine activities (e.g., refuelling of vehicles, vehicle maintenance, activities in and around water).

PAHs are one of the classes of chemicals found in fuels and oils, and can also be produced as a by-product of combustion. Some PAHs may enter the environment through operation of the incinerator or from vehicle, aircraft, and ship exhaust. Mitigation measures outlined in the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17), as noted in Section 5.5.3, will minimize the amount of PAHs that may be released to the environment. While some PAHs may be deposited on soil or vegetation, this is likely to occur mostly in a localized area closest to infrastructure or roads, with concentrations decreasing with distance from the source (Dan-Badgo, Rychen, and Ducoulombier 2008).

As described for treated sewage effluent, for large terrestrial wildlife, the potentially affected areas would likely be close to infrastructure and roads, and would be a small area relative to the total home range. Small terrestrial wildlife with smaller home ranges may reside in close proximity to infrastructure or roads and therefore have the potential to be exposed to higher concentrations of PAHs. However, these organisms are less likely to be hunted or consumed due to the access restrictions to site infrastructure and roads and due to the policy prohibiting hunting or collection of country foods by Project employees while at the Project site.

Although it is possible that a small amount of fuel, oil, or PAH (as a combustion by-product) may enter the environment, it is considered unlikely that the contaminants will reach concentrations in the environment that could be taken up by country food organisms to a degree that might cause adverse health effects in human consumers.

5.5.4.1.4 Dioxins and Furans

The use of incinerators that will meet the standards for release of dioxins, furans, and mercury will minimize the potential for effects to the quality of country foods from these contaminants. Since the emissions standards for these compounds will be met, it is unlikely that health effects would occur in human consumers of country foods.

5.5.4.1.5 Summary of Potential Effects to Country Foods from Non-metal Contaminants

While Project activities may lead to the introduction of low levels of non-metal contaminants into the environment, the potential for changes in country food quality translating into adverse effects to human health is unlikely. In order for effects to human health to occur, the concentration of a chemical must be present at high enough concentrations in country foods to exceed threshold levels in consumers.

Based on the information currently available, with the implementation of mitigation and management strategies, it is unlikely that contaminants such as explosive residues, mineral processing chemicals, PAHs, dioxins and furans, and other chemicals found in oil and fuels would be present at high enough concentrations in the environment to affect human health through the consumption of country foods. Therefore, it was determined that there are no Project-related residual effects to the quality of country foods due to non-metal contaminants.

5.5.4.2 Quantitative Assessment of the Potential for Changes in Quality of Country Foods from Metals

Metal toxicity can result in a variety of health effects depending on the individual metals and effects may range from carcinogenic effects to non-carcinogenic effects. Metals that were identified during baseline studies as COPCs include aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc (Rescan 2013f). This was based on their presence at concentrations greater than environmental quality guidelines in at least one environmental media during baseline studies, or due to their potential to bioaccumulate in the food chain. However these metals were present at concentrations in the country foods that are not expected to lead to health effects in human consumers (see Section 5.1 or Rescan 2013f).

Metals occur naturally in environmental media (e.g., water, soil, sediment, and vegetation) and since the proposed Project is a metal mine, it was considered likely that metals were the most likely group of contaminants to experience Project-related changes in concentration. Therefore, metals were assessed quantitatively for changes in concentration in each of the environmental media as a result of Project activities. This was done as part of the Human Health Risk Assessment, presented in Volume 8, Chapter 6, Section 6.4.2. The findings of this assessment are summarized here for convenience, but additional detail may be found in the Human Health Risk Assessment.

As noted previously, the concentration of metals in country foods is dependent on the concentration of the environmental media on which the organisms rely (i.e., water, sediment, soil, and vegetation quality), since metals are taken up by the organisms from each of these environmental media through ingestion. In order to estimate the potential changes in metal concentrations in environmental media, modelling was done for water, soil, and vegetation to predict the metal concentrations in each of these environmental media. The general methods used and the results of the predictive modelling or assumptions are described in the following sections.

5.5.4.2.1 Human Health Risk Assessment Screening of Contaminants (Metals) of Potential Concern

As part of the Human Health Risk Assessment, a screening process for COPCs was developed (Volume 8, Chapter 6, Section 6.4.2.7). The screening process was intended to identify COPCs (in this case metals) that might experience significant changes in concentration in the environmental media (i.e., air, water, soil, or vegetation) due to Project-related activities.

In the first step of the screening process, predicted mean metal concentrations were compared to environmental quality guidelines. For each environmental media, if a metal was found to have a predicted concentration that was higher than the applicable environmental quality guideline, it was retained for the second step of the screening process. If the predicted concentration of a metal was lower than the applicable guideline then the metal was considered to not be a COPC and was eliminated from further consideration. The guidelines used in the first step of the screening process for environmental media included:

- Water Quality Guidelines for the Protection of Aquatic Life for freshwater and marine waters (CCME 2012a), and
- Soil Quality Guidelines for the Protection of Environmental and Human Health for residential/parkland (CCME 2012b).

In the second step of the screening process, predicted mean concentrations of metals were compared to the 95th percentile of their baseline concentrations. This baseline concentration was selected because, considering spatial variability, field sampling variability, variability in laboratory methods,

and conservatism within the modelling, any contaminant concentration that is less than the 95th percentile baseline concentration is unlikely to be sufficiently distinguishable from background levels. This step was done to ensure that all COPCs identified and carried through the risk assessment process were only those COPCs with concentrations that were predicted to increase due to Project-related activities. This second screening step eliminates contaminants which already exceeded guidelines during baseline studies (which is not a Project-related effect).

The second screening step was done for metals that were either greater than their environmental quality guideline, or for media (e.g., vegetation) or metals that do not have environmental quality guidelines. The results of the screening process for country foods are provided in Volume 8, Chapter 6, Section 6.4.2.7.4, and are also summarized here.

5.5.4.2.2 Water Quality

It was assumed that the discharge of liquid/waterborne effluent from the Project would either meet water quality guidelines (for metals that were below guideline limits during baseline studies) or be the same as baseline concentrations (for metals that exceeded guideline limits during baseline studies). This assumption was made due to mitigation measures proposed to minimize the effects to water quality and the commitment to ensure that discharge of effluent meets acceptable criteria prior to discharge (Section 5.5.3). Therefore, no effects to water quality were expected as a result of effluent discharge from the Project.

Wildlife access to the Collection Pond, TIA, and WMF will be minimized through the use of exclusion mitigation measures as needed, and therefore COPCs are not expected to accumulate in wildlife and subsequently affect human health as a result of exposure of wildlife to water in the water management structures. This is because uptake of COPCs cannot occur in wildlife if they are prevented from being exposed to water contained in the water management structures.

Deposition of metal-laden fugitive dust onto lake surfaces was modelled with CALPUFF and details are provided in the Human Health and Environmental Risk Assessment predictive modelling section (Volume 8, Chapter 6, Section 6.4.2.6.3). The model used to predict water concentration of metals in lakes was conservative because it assumed that maximum dust deposition occurred for a period of one year, metals from the dust remained fully mixed and completely suspended in the water column, and there was no loss of metals from dust deposition on lakes (e.g., due to settling to sediment or outflow from the lake).

In determining the predicted metal concentration, the maximum incremental increase in metal concentrations was added to the mean baseline concentration of total metals in the lakes. Results of the modelling indicate that the loading of metals to lakes in the Goose and George Property areas is generally minimal and is well within the range of natural variability, as determined by comparison to the 95th percentile baseline concentration for each metal. The predicted increase in mean concentrations of metals relative to mean baseline concentrations ranged from 0.0006% to 5%, except for aluminum and iron where predicted concentrations were 20% and 17% higher than the mean during baseline studies, respectively (Table 5.5-4). When metal concentrations were below detection limits in either the baseline or predicted concentrations, no value for relative change from the baseline could be calculated; these are shown in the final column of Table 5.5-4 as ‘no value’.

All predicted metal concentrations in the lakes of the country foods LSA were either lower than CCME guidelines for the protection of aquatic life or were lower than the 95th percentile of background concentrations. Therefore, no metals were identified as COPCs in lake water.

Table 5.5-4. Relative Change in Predicted Mean Metal Concentrations Compared to Baseline Mean Metal Concentrations in Lakes within the Country Foods Local Study Area

Metals	Mean Baseline Lake Water Concentration (mg/L)	Mean Predicted Lake Surface Water Concentration (mg/L)	Relative Change from Baseline Concentration (%)
Aluminum	0.0224	0.0269	20.3
Antimony	<0.00010	<0.00010	No value
Arsenic	0.000302	0.000315	4.2
Barium	0.00560	0.00560	0.4
Beryllium	0.0000866	0.0000866	0.006
Bismuth	<0.00050	<0.00050	No value
Boron	0.00730	0.00730	0.02
Cadmium	0.00000862	0.00000863	0.1
Calcium	3.90	3.90	0.04
Chromium	0.000306	0.000320	4.7
Cobalt	0.000431	0.000435	0.8
Copper	0.00196	0.00197	0.5
Iron	0.0685	0.0804	17.2
Lead	0.000289	0.000290	0.3
Lithium	<0.0050	<0.0050	No value
Magnesium	1.829	1.832	0.1
Manganese	0.00840	0.00847	0.9
Mercury	<0.000010	<0.000010	No value
Molybdenum	0.0000538	0.0000540	0.4
Nickel	0.00487	0.00488	0.2
Potassium	0.451	0.452	0.3
Selenium	<0.0002	<0.0002	No value
Silicone	0.409	n/d	No value
Silver	<0.000010	<0.000010	No value
Sodium	0.860	0.860	0.02
Strontium	0.0185	0.0185	0.02
Thallium	<0.00010	<0.00010	No value
Tin	<0.00010	<0.00010	No value
Titanium	<0.010	<0.010	No value
Uranium	0.00000811	0.00000828	2.1
Vanadium	0.000228	0.000237	4.2
Zinc	0.00280	0.00280	0.3

Based on the findings for lakes, it was considered that the metal loading from dust deposition onto streams (i.e., flowing water) would also be negligible. Overall, it was concluded that the predicted mean concentrations of metals in surface waters, even using conservative modelling assumptions, were not substantially different from the metal concentrations measured under baseline conditions. Therefore, no Project-related effects to the quality of country foods were predicted due to changes in water quality.

5.5.4.2.3 Soil Quality

The potential pathways through which metals may enter soil as a result of Project activities are effluent discharge (e.g., treated sewage effluent discharge or effluent discharge from water management structures) or from atmospheric deposition of metals in fugitive dust. It was assumed that the contribution of metals to soils from effluent discharge within the country foods LSA was negligible. This is because mitigation measures to minimize the potential for impacts from effluent discharge, such as implementation of the ML/ARD Management Plan, the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), and the commitment to ensure that any effluent discharged meets acceptable environmental criteria prior to discharge, are expected to protect soil quality. Therefore, effluent discharge was considered to contribute negligible quantities of metals to the soil.

The US EPA has published methods for use in human health risk assessments for calculating contaminant concentrations in soil due to atmospheric dust deposition (US EPA 2005). Calculations of the incremental increase in soil metal concentrations were done based on predicted metal concentrations in dustfall determined using data from the air quality dispersion model and core sample geochemistry (Volume 4, Chapter 1, and Appendix V4-1B; Volume 8, Chapter 6). Air quality dispersion modelling was done for the years when potential air quality effects were at their highest, which were considered to be a one-year period for the Goose (year three of Operational phase) and George (year seven of Operational phase) Property Areas.

For the purposes of soil quality modelling, it was assumed that the dust deposition that occurred during these worst-case scenario years occurred each year throughout the entire ten years of the Operational phase. This would provide a conservative overestimate of the potential for metal deposition to soil from dustfall, since air quality modelling was based on the upper case scenario and not all years would be expected to have similarly high levels of activity or dustfall amounts.

Predicted soil metal concentrations were calculated by adding the baseline soil concentration measured at each site to the incremental increase in soil metal concentration predicted using the US EPA methodology and formulas (US EPA 2005); results are provided in Volume 8, Chapter 6, Section 6.4.2.7.4 (summary of data) or Appendix V8-6L (raw data). For soil sampling sites that were located outside of the air quality modelling domains, it was assumed that the soil metal concentration remained unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

Results of the modelling indicate that the loading of metals to soils in the Goose and George Property areas is minimal and is well within the range of natural variability, as determined by comparison to the 95th percentile baseline concentration for each metal. The predicted increases in mean concentrations of metals relative to baseline mean concentrations were all less than 0.1% (Table 5.5-5), even after assuming a cumulative deposition of metals in dustfall to soil for the full ten years of the Operational phase.

All predicted mean metal concentrations in the soils of the country foods LSA were either lower than CCME guidelines for the Protection of Environmental and Human Health for residential/parkland or were lower than the 95th percentile of background concentrations. Therefore, no metals were identified as COPCs in soils.

Overall, it was concluded that the predicted concentrations of metals in soils, even using conservative modelling assumptions, were not substantially different from the metal concentrations measured under baseline conditions. Therefore, no Project-related effects to the quality of country foods were predicted due to changes in soil quality.

Table 5.5-5. Relative Change in Predicted Mean Metal Concentrations Compared to Baseline Mean Metal Concentrations in Soil within the Country Foods Local Study Area

Metals	Mean Baseline Soil Concentration (mg/kg)	Mean Predicted Soil Concentrations (mg/kg)	Relative Change from Baseline Concentration (%)
Aluminum	5602	5603	0.016
Antimony	<0.1	<0.1	no value
Arsenic	9.06	9.06	0.023
Barium	40.3	40.3	0.0097
Beryllium	0.216	0.216	0.00049
Bismuth	<0.2	<0.2	no value
Cadmium	0.112	0.112	0.0021
Calcium	2182	2182	0.014
Chromium	15.8	15.8	0.017
Cobalt	7.28	7.28	0.0089
Copper	20.7	20.7	0.0093
Iron	10113	10116	0.022
Lead	2.62	2.62	0.0071
Lithium	8.35	8.35	0.0011
Magnesium	2961	2961	0.016
Manganese	93.4	93.4	0.015
Mercury	0.0343	0.0343	0.00031
Molybdenum	<0.5	<0.5	no value
Nickel	20.5	20.5	0.0074
Phosphorus	495	495	0.00000045
Potassium	555	556	0.041
Selenium	<0.2	<0.2	no value
Silver	<0.1	<0.1	no value
Sodium	<100	<100	no value
Strontium	12.8	12.8	0.0067
Thallium	<0.05	<0.05	no value
Tin	<2	<2	no value
Titanium	238	238	0.021
Uranium	0.675	0.675	0.0055
Vanadium	20.1	20.1	0.011
Zinc	19.0	19.0	0.010

5.5.4.2.4 Vegetation Quality

The potential pathways through which metals may enter vegetation as a result of Project activities are effluent discharge (e.g., treated sewage effluent discharge or effluent discharge from water management structures), uptake of metals from soil, or atmospheric deposition of metals in fugitive dust to plant surfaces. It was assumed that the contribution of metals to vegetation from effluent discharge within the country foods LSA was negligible. This is because mitigation measures to minimize the potential for impacts from effluent discharge, such as implementation of the ML/ARD Management Plan, the Water Management

Plan, and the commitment to ensure that any effluent discharged meets acceptable environmental criteria prior to discharge, are expected to protect vegetation quality. Therefore, effluent discharge was considered to contribute negligible quantities of metals to the vegetation.

In order to predict vegetation concentrations of metal due to uptake from soils, a biotransfer factor (BTF) should be used. BTFs are used to represent the relationship between concentrations of metal in soil relative to concentrations of the metal in plant tissues. Since BTF values can be quite variable, site-specific BTF values were calculated wherever possible in order to predict metal uptake in plants from the soil. This was done by determining a BTF for each baseline sampling site where both soil and vegetation were collected at the same time and at the same location. When site-specific BTFs could not be calculated for a particular metal (e.g., either soil or vegetation baseline metal concentrations were below detection limits), published BTF values in Baes et al. (1984) or Staven et al. (2003) were used instead.

The BTFs were then used to predict the uptake of metal to vegetation based on predicted soil quality (Section 5.5.4.2.3). This was done as part of the Human Health Risk Assessment and additional details on the prediction of vegetation uptake of metals from soil can be found in Volume 8, Chapter 6, Section 6.4.2.6.5. Results of this modelling can be found in Volume 8, Chapter 6, Section 6.4.2.7.4 (summary of data) and Appendices V8-6M (lichens and sedge) and V8-6N (berries; raw data).

The US EPA has published methods for use in human health risk assessments for calculating contaminant concentrations in vegetation due to atmospheric dust deposition onto plant surfaces (US EPA 2005). Calculations of the incremental increase in vegetation metal concentrations were done based on predicted metal concentrations in dustfall determined using data from the air quality dispersion model and core sample geochemistry (Section 6.4.2.6.4 or Volume 4, Appendix V4-1B). Air quality dispersion modelling was done for the years when potential air quality effects were at their highest, which were considered to be a one-year period for the Goose (year three of Operational phase) and George (year seven of Operational phase) Property Areas.

As in the soil quality modelling, for the purposes of vegetation quality modelling, it was assumed that the dust deposition that occurred during these worst-case scenario years occurred each year throughout the entire ten years of the Operational phase. This would provide a conservative overestimate of the potential for metal deposition to vegetation from dustfall, since air quality modelling was based on the years with the highest potential for air quality effects and not all years would be expected to have similarly high levels of activity or dustfall amounts. Predicted vegetation metal concentrations were calculated by adding the baseline vegetation metal concentration measured at each site to the incremental increase in vegetation metal concentration predicted using the US EPA methodology and formulas for deposition to plant surfaces (US EPA 2005); results are provided in Volume 8, Chapter 6, Section 6.4.2.7.4 (summary of data) or Appendices V8-6M (lichens and sedge) and V8-6N (berries; raw data).

The total predicted vegetation metal concentration at each site was calculated as the concentration predicted in the plant due to root uptake plus the concentration on the plant surface due to dust deposition. Results are provided in the Human Health Risk Assessment (Volume 8, Chapter 6) in Appendix V8-6O for lichens and sedge and Appendix V8-6P for berries, alongside a comparison to the measured baseline concentration. A summary of the data is also provided in Volume 8, Chapter 6, Section 6.4.2.7.4.

For vegetation sampling sites that were located outside of the air quality modelling domains, it was assumed that the vegetation metal concentration remained unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

Results of the modelling indicate that the loading of metals to vegetation in the Goose and George Property areas is generally minimal and is well within the range of natural variability, as determined by comparison to the 95th percentile baseline vegetation concentration for each metal. The predicted increases in mean concentrations of metals in vegetation relative to baseline mean concentrations were variable, with some concentrations predicted to increase and others expected to decrease (Table 5.5-6).

Table 5.5-6. Relative Change in Predicted Mean Metal Concentrations Compared to Baseline Mean Metal Concentrations in Vegetation within the Country Foods Local Study Area

	Lichen and Sedge			Berries		
Metals	Mean Baseline Concentration (mg/kg)	Mean Predicted Concentrations (mg/kg)	Relative Change from Baseline Concentration (%)	Mean Baseline Concentration (mg/kg)	Mean Predicted Concentrations (mg/kg)	Relative Change from Baseline Concentration (%)
Aluminum	337	337	-0.020	3.21*	6.30	1*
Antimony	<0.05	<0.05	no value	<0.01	<0.01	no value
Arsenic	0.286	0.285	-0.29	<0.01	<0.01	no value
Barium	14.4	14.5	0.92	3.42	3.42	-0.056
Beryllium	<0.5	<0.5	no value	<0.1	<0.1	no value
Bismuth	<0.15	<0.15	no value	<0.03	<0.03	no value
Cadmium	0.0467	0.0254	-46	0.0181	0.0165	-8.6
Calcium	1133	1117	-1.4	284	284	-0.014
Chromium	<0.5	<0.5	no value	<0.1	<0.1	no value
Cobalt	1.54	1.72	11	<0.02	<0.02	no value
Copper	2.48	2.51	0.99	1.05	1.05	0.0019
Iron	325	324	-0.27	2.98*	3.73	3*
Lead	0.729	0.730	0.13	<0.02	<0.02	no value
Lithium	<0.5	<0.5	no value	<0.1	<0.1	no value
Magnesium	384	384	-0.032	129	129	0.027
Manganese	54.6	54.4	-0.32	28.6	28.6	0.14
Mercury	0.0570	0.0498	-13	<0.001	<0.001	no value
Molybdenum	<0.05	<0.05	no value	<0.01	<0.01	no value
Nickel	4.47	4.94	11	0.424	0.424	0.082
Phosphorus	331	325	-1.7	250	250	-0.034
Potassium	905	914	0.93	1376	1377	0.027
Selenium	<1	<1	no value	<0.2	<0.2	no value
Silver	<0.05	<0.05	no value	<0.01	<0.01	no value
Sodium	<100	<100	no value	<200	<200	no value
Strontium	4.58	4.54	-0.84	0.74	0.742	0.011
Thallium	<0.05	<0.05	no value	<0.01	<0.01	no value
Tin	<0.25	<0.25	no value	0.172	<0.05	no value
Titanium	9.65	9.66	0.059	<1	<1	no value
Uranium	0.0319	0.0321	0.60	<0.002	<0.002	no value
Vanadium	<0.5	0.837	no value	<0.1	<0.1	no value
Zinc	15.1	15.1	-0.061	5.4	5.41	-0.130

** Values represent adjusted relative change from baseline concentration once metal concentrations below method detection limits were excluded (see text for additional explanation).*

Some of the mean baseline concentrations were skewed due to the presence of a large proportion of samples with metal concentrations below detection limits, which can result in a mean baseline concentration that is artificially low relative to the predicted concentrations. This is an artefact of the manner in which non-detects are handled through the replacement of the value with a concentration of half of the method detection limit. It can occur when there is a mix of non-detected and detected concentrations that make up the overall mean, where the overall mean is greater than the detection limit.

Baseline aluminum berry concentration is a good example of where this skewing and overestimation of the difference between baseline and predicted metal concentrations occurred. Aluminum was below detection limits in 5 of 11 berry samples included in the calculation of mean baseline aluminum concentration. When these 5 samples are excluded from the calculation of mean baseline (5.05 mg/kg) and mean predicted (5.10 mg/kg) aluminum concentrations, the overall percent change is approximately 1%. A similar overestimation of change relative to baseline occurred with iron, where iron was below detection limits in 3 of the 11 berry samples. When these 3 samples are excluded from the calculation of mean baseline (3.73 mg/kg) and mean predicted (3.84 mg/kg) iron concentrations, the overall percent change is approximately 3%.

All predicted metal concentrations in the vegetation of the country foods LSA were lower than the 95th percentile of background concentrations. Therefore, no metals were identified as COPCs in vegetation.

Overall, it was concluded that the predicted concentrations of metals in vegetation, even using conservative modelling assumptions, were not substantially different from the metal concentrations measured under baseline conditions. Therefore, no Project-related effects to the quality of country foods were predicted due to changes in vegetation quality.

5.5.4.2.5 Summary of the Potential Effects to Country Foods from Metal Contaminants

All of the predicted freshwater, soil and vegetation metal concentrations were less than guideline limits or within the range of natural variability (i.e., less than the 95th percentile of baseline metal concentrations) within the country foods LSA. As a result, no COPCs were identified in freshwater, soil of vegetation. Therefore, it was concluded that there is no potential for residual effects to the quality of country foods since the concentrations of metals in environmental media are not predicted to change substantially relative to baseline conditions. Consequently, the potential for residual effects to human health from the incidental consumption of metals in country foods due to Project-related activities is the same as under baseline conditions.

5.5.4.3 Summary of the Potential for Residual Effects to Human Health Due to the Consumption of Country Foods

In order for human health to be affected by Project-related changes in contaminants that may be present in country foods, several conditions must be met. First, human consumers must be present and consume country foods from the potentially affected area. While some hunting, harvesting, or collection of country foods may occur in the country foods LSA, given the substantial distance of this area from regional settlements or communities it is unlikely that consumers will obtain all of their country foods from the LSA. In addition, mitigation measures proposed for the Project include restrictions on hunting or harvesting in the vicinity of Project infrastructure by employees while residing at the Project camps.

Second, the contaminants that may be present in country foods must be increased by Project activities to a level that could cause health effects in human consumers. Under baseline conditions, no potential risks to human health from the consumption of country foods were identified (Section 5.1). Qualitative

assessment of non-metal COPCs (Section 5.5.4.1) found that there was negligible potential for change in the quality of country foods and therefore, effects to human health through consumption of country foods are very unlikely. This conclusion is based on the assumption that the proposed mitigation measures to minimize environmental contamination are implemented and effective. Quantitative assessment of metal COPCs found that the predicted concentrations of metals in freshwater, soil, and vegetation were not substantially different than the concentrations measured during baseline studies, and predicted concentrations of metals are within the range of natural variability in the area (Section 5.5.4.2; Human Health Risk Assessment in Volume 8, Chapter 6, Section 6.4.2). Therefore, the quality of country foods as a result of Project activities is not expected to change substantially, and concentrations of COPCs are not expected to reach levels where the health of consumers would be affected.

Therefore, based on the available information, Project-related effects to the quality of country foods are not expected to lead to changes in human health. It is concluded that there are no residual effects to human health due to the consumption of country foods.

5.5.5 Significance of Residual Effects

Since no potential residual effects to human health due to the consumption of country foods were identified, a significance assessment is not required (Section 5.5.1; Volume 9, Chapter 1).

5.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

No Project-related residual effects for human health due to the consumption of country foods were identified. Therefore, there is also no potential for cumulative effects to occur and no cumulative effects assessment is required (Volume 9, Chapter 1).

5.7 TRANSBOUNDARY EFFECTS

Transboundary effects may be expected to occur if residual effects from the Project are identified and extend beyond the country foods LSA. However, no Project-related residual effects or cumulative residual effects for human health due to the consumption of country foods were identified, so there is no potential for residual effects to extend beyond the country foods LSA. Therefore, there is no potential for transboundary effects to occur.

5.8 MITIGATION AND ADAPTIVE MANAGEMENT

Extensive mitigation or management measures will be in place to minimize or eliminate potential effects on environmental media (air, water, sediment, soil, and vegetation) and country foods themselves (fish and wildlife). Summaries of these mitigation measures can be found in tables in the following chapters:

- Air quality: Volume 4, Chapter 2;
- Vegetation: Volume 5, Chapter 4;
- Terrestrial Wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10;
- Marine Wildlife: Volume 7, Chapters 6 and 7;
- Freshwater water, sediment, and fish: Volume 6, Chapters 4, 5, 6, and 7;
- Marine water and sediment: Volume 7, Chapters 2, 3, 4, and 5.

In addition, management plans can be found in Volume 10 of the DEIS.

5.9 IMPACT STATEMENT

Based on the country foods baseline screening level assessment results (Rescan 2013f), consumption of country foods from the country foods LSA were shown to not present any health risks from the selected COPCs to local human consumers under baseline conditions.

Based on the qualitative and quantitative results of the effects assessment, the quality of country foods is not expected to change substantially from baseline conditions. Therefore, human health due to the consumption of country foods from within the country foods LSA is not expected to change in comparison to the baseline levels. No residual effects were identified and no health effects to human consumers of country foods are expected as a result of the Project activities or infrastructure during any phase of the Project. Potential effects of the Project on the VSEC of country foods are not significant.

5.10 SUPPORTING AND SUPPLEMENTAL INFORMATION

Additional information to support the quantitative effects assessment of the potential for metals to affect the quality of country foods, beyond the summary of information provided in this chapter, can be found in the Human Health Risk Assessment in Volume 8, Chapter 6, Section 6.4.2.

6. Human Health and Environmental Risk Assessment

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6. Human Health and Environmental Risk Assessment

The Back River Project (the Project) is a proposed development by Sabina Gold & Silver Corp. (Sabina) of a mixed open-pit and underground gold mine in the West Kitikmeot region of Nunavut. The Project is broken down into three primary areas: the George Property Area (located approximately 50 km south southwest of Bathurst Inlet), and the Goose Property Area (located approximately 100 km south southeast of Bathurst Inlet), and the Marine Laydown Area (MLA) in southern Bathurst Inlet. The George Property Area is located approximately 70 km to the northwest of the Goose Property Area. The (MLA) may include storage areas for supplies and fuel. The closest unincorporated communities to the proposed mine site properties are Kingaok (approximately 160 km north of the Goose Property Area) and Omingmaktok (250 km northeast of the Goose Property Area). The communities of Kugluktuk (approximately 460 km away) and Cambridge Bay (approximately 400 km away) are the closest major regional settlements. Other communities within the Kitikmeot Region are Gjoa Haven (approximately 575 km away), Kugaaruk (approximately 795 km away), and Taloyoak (approximately 705 km away). Yellowknife, NWT (approximately 485 km away) is also an important community, as it will likely serve as a hub for transportation and goods and services supply.

Section 8.3 of the *Guidelines for the Preparation of an Environmental Impact Statement for Sabina Gold & Silver Corp.'s Back River Project* (the EIS Guidelines) requires that a Human Health (HHRA) and Environmental Risk Assessment (ERA) be completed as part of the EIS submission to the Nunavut Impact Review Board (NIRB 2013). In this context, HHRAs and ERAs involve comprehensive and systematic processes designed to identify, analyze, and evaluate the effects of a project on environmental and human health (Health Canada 1999a; Stantec 2009). A risk assessment defines existing (baseline) environmental conditions and uses this baseline information to evaluate potential changes to environmental quality resulting from Project-related effects that could impact environmental or human health. As part of this assessment, types and sources of contaminants or noise emissions were identified, and pathways of exposure were identified for the various receptors (e.g., humans and wildlife). The assessment included consideration of Project-related changes to noise levels and the quality of environmental media (i.e., air, water, sediment, soil, vegetation, and country foods), and the subsequent potential for health effects to fish, birds, wildlife, and humans due to Project-generated contaminants or noise.

All contaminants from anthropogenic or natural sources have the potential to cause toxicological effects to biota or human health. However, three criteria must be present for a contaminant of potential concern (COPC) to pose a potential risk to environmental or human health (Health Canada 2010e):

- there must be potential for emissions or release of COPCs at sufficiently high concentrations to cause toxicological effects;
- receptor(s) must be present; and
- there must be existing pathway(s) for COPC exposure by receptor(s), and the receptor must be able to take up the COPC.

Risk assessment of contaminants characterizes the nature and estimated magnitude of potential risks associated with the exposure of receptors (e.g., wildlife and humans) to contaminants that may be present at concentrations that exceed applicable guidelines/standards or site-specific background levels as a result of Project activities. Consideration of baseline conditions is important to ensure that only changes in contaminant concentrations relative to background levels are identified and assessed as

potential Project-related effects. This is particularly true for contaminants where their concentrations exceed guideline limits under baseline conditions, prior to Project development.

Information about background conditions prior to development were collected during baseline studies, including:

- Air quality (Volume 4, Section 1.1);
- Water quality (Volume 6, Section 4.1 and Volume 7, Section 2.1);
- Sediment quality (Volume 6, Section 5.1 and Volume 7, Section 3.1);
- Freshwater aquatic resources and fish (Volume 6, Sections 6.1 and 7.1);
- Marine aquatic resources and fish (Volume 7, Sections 4.1 and 5.1);
- Soil and vegetation (Volume 5, Sections 3.1 and 4.1);
- Wildlife (Volume 5, Sections 5.1, 6.1, 7.1, 8.1, 9.1, and 10.1; Volume 7, Sections 6.1 and 7.1);
- Country foods (Volume 8, Section 5.1); and
- Noise (Volume 4, Section 2.1).

Baseline conditions are also described briefly in Section 6.1 of this chapter for each of the valued ecosystem components (VECs) or valued socio-economic components (VSECs) that are relevant for the ERA and HHRA. In addition, modelling was conducted to predict the concentrations of contaminants in environmental media (i.e., air, water, sediment, soil, vegetation, and country foods) and noise levels during Project activities and operations; this information is summarized in Sections 6.4.1.6, 6.4.2.6, and 6.4.3.1.

The HHRA and ERA adhered to the basic principles of risk assessment frameworks in guidance provided by Health Canada (e.g., Health Canada 2010a, 2010b, 2010c, 2010d, 2010e), the Canadian Council of Ministers of the Environment (CCME 1996), and the United States Environmental Protection Agency (US EPA 1989, 1995, 1999, 2005b, 2005a, 2012). The general approach used for this risk assessment was divided into five stages: Problem formulation, exposure assessment, effects assessment, risk characterization, and uncertainty analysis (Section 6.4-1).

6.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

Baseline studies were conducted to:

- understand existing conditions in the local and regional study areas of the Project;
- provide a benchmark (i.e., before-after-control-effect approach) for evaluating the potential future effects of the Project and to characterize pre-disturbance conditions for the purpose of reclamation activities; and
- support predictive modelling for effect analysis.

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 MLA in 2012 and 2013. Table 2.2-1 in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) provides a summary of field-collected baseline information for the proposed Back River Project.

6.1.1 Air Quality

Air quality was assessed in the Draft Environmental Impact Statement (DEIS) Volume 4, Chapter 1 as part of the atmospheric environment assessment. Details of the baseline sampling program can be found in Volume 4, Section 1.1 and in Rescan (2012a), Appendix V4-1A.

The air quality in the West Kitikmeot of Nunavut can generally be classified as pristine. Local emissions are limited to stationary (power generation and heating) and mobile sources (trucks, snowmobiles, all-terrain vehicles, etc.) operated by local residents in the few communities within the West Kitikmeot region, well away from the Project. Mines operating in Nunavut and the NWT outside of the West Kitikmeot region represent the only major industrial emission source. Because of the limited local emission sources, long-range transport of air contaminants is the main influence on ambient air quality. The atmospheric boundary layer in the Arctic is generally very stable and surface inversions occur frequently. As a result, dispersion of air contaminants can be less effective in the Arctic than in other regions.

An air quality baseline program was initiated at the Goose Property Area in 2011 and in 2012 the program was expanded to include the George Property Area as well as the southern part of Bathurst Inlet. Dustfall stations and passive air sampling stations (PASS) for nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and ozone (O_3) concentrations were deployed on site during the summer months in order to assess the ambient air quality of the area.

The total dustfall recorded was low (Volume 4, Chapter 1, or Rescan 2012a) as expected for a non-industrial area, and values were well below criteria set in other provinces (currently no applicable dustfall criteria exist for Nunavut or the Northwest Territories). Of the 33 metals analysed in dustfall samples, 14 were below the detection limits, and overall metal deposition rates for the 19 metals that were detected were very low. The highest median acid deposition rate observed was less than any of the CCME published calculated critical loads of acid deposition for forest soils for provinces in Canada (Aherne 2008). The maximum 30-day O_3 level fell within the expected background range (Health Canada 1999b). Since there are no 30-day standards for NO_2 or SO_2 in Nunavut, 30-day averages were conservatively compared with Nunavut annual standards, and were found to be much lower than annual standards (Volume 4, Chapter 1, or Rescan 2012a). No total suspended particulates (TSP), PM_{10} (particulate matter up to and including 10 µm in size), $PM_{2.5}$ (fine particulate matter up to and including 2.5 µm in size), or carbon monoxide (CO) monitoring stations were available near the Project area, therefore background concentrations from ambient air quality monitoring stations at other remote locations in Nunavut and the Northwest Territories were used to represent Project background.

6.1.2 Freshwater and Sediment Quality

Freshwater and sediment quality was assessed in the DEIS Volume 6, Chapter 4 and Chapter 5, respectively, as part of the freshwater environment assessment. Details of the baseline sampling program can be found in Volume 6, Sections 4.1 and 5.1 and in Appendices V6-3A or Rescan (2011b), V6-3B or Rescan (2012c), V6-3C or Rescan (2012e) and (Rescan 2013h).

All proposed infrastructure at the Goose Property lies within the Ellis River Watershed. The Ellis River Watershed flows to the northwest and enters the ocean on the west side of Bathurst Inlet (see Federal Watershed map in Volume 6, Chapter 1). The Back River Watershed lies south of the proposed infrastructure, in the Goose Property Area, and flows to the east, eventually entering the Arctic Ocean south of Gjoa Haven. Lakes and streams in the George Property Area drain into the Western River Watershed that flows north and enters Bathurst Inlet at its southernmost point.

Historical and baseline sampling for water quality data is available from the Goose Property Area since 1993 and the George Property Area since 2006. In the George Property Area, Bob, Dragon, Fold, George, Komatik, Long, Lytle, Occurrence, Slave, Arrow, and Sleigh lakes and Esker and Low Cow ponds were all sampled at least once in the baseline and historical sampling programs. Similarly, samples have been collected from Big, Chair, Echo, Fox, Del, Giraffe, Goose, Llama, Mam, Moby, Rabbit, Wasp, Leaf, and Umwelt lakes and Pond 19 in the Goose Property Area. The major inflows (IF) and outflows (OF) of Goose and George lakes, as well as streams near Project activities, including the Pond 19 IF, Moby OF, Gander IF, and Dragon Watershed OF, were also sampled for water quality in the baseline and historical sampling programs.

The water quality of streams and lakes in the Project region was generally good, with low concentrations of anions, suspended material, nutrients, and most metals. Surface water was generally soft, with low alkalinity and buffering capacity, slightly-acidic to slightly-alkaline pHs, and had generally high dissolved oxygen concentrations. Waterbodies in close contact with metal-bearing geological features often had naturally elevated concentrations of arsenic, chromium, copper, and zinc (e.g., Goose Lake, Llama Lake, Umwelt Lake, Chair Lake, Mam Lake, Giraffe Lake, Wasp Lake, Echo Lake, Pond 19, Arrow Lake, Leaf Lake, Propeller Lake, Big Lake, Del Lake, Moby Lake, Rascal Lake, Fox Lake, Rabbit Lake, Lytle Lake, Occurrence Lake, Sleigh Lake, Komatic Lake, Low Cow Pond, George Lake, Fold Lake, Esker Lake, Slave Lake, Long Lake, McCoy Lake, Dragon Lake, Llama OF, Echo OF, Goose Lake inflows and outflows, Giraffe Lake inflow and outflow, Pond 19 OF, Moby OF, Chair OF, Propeller OF, Del IF, Sleigh OF, Lytle OF, Dragon Watershed OF, and the inflow and outflow of McCoy Lake).

The baseline sampling program found sediments in lakes and streams in the Project region to be characteristic of freshwater systems in the Arctic. Sediments tended to be comprised of larger particles in streams than in lakes, likely due to the flow regime, and were moderately to slightly acidic. The organic content of the sediments in both lakes and streams tended to be low but was correlated with the abundance of fine particles in the sediment, which is consistent with the accumulation of organic matter through adsorption onto particles and local water flow conditions promoting the accumulation of both fine particles and organic material. The sediments in some streams and lakes (e.g., Goose Lake, Wasp Lake, Leaf Lake, Giraffe Lake, Llama Lake, Umwelt Lake, Rabbit Lake, Fox Lake, Echo Lake, Rascal Lake, Propeller Lake, Chair Lake, Mam Lake, Big Lake, Del Lake, Fold Lake, George Lake, Bob Lake, Lytle Lake, Occurrence Lake, Sleigh Lake, Dragon Lake, Esker Lake, Komatic Lake, McCoy Lake, Long Lake, Wasp OF, Giraffe OF, Goose OF, Wolf OF, Propeller OF, Chair OF, Del inflow, George OF, Lytle OF, Sleigh OF, Dragon OF, Dragon Watershed OF, and McCoy OF) in the Project region had naturally elevated concentrations of some metals, including arsenic, cadmium, chromium, copper, and zinc that exceeded CCME Interim Sediment Quality Guidelines (CCME 2013a). These elevated metal concentrations did not result in water concentrations above Health Canada's Drinking Water Guidelines (Health Canada 2012b). Proximity to common geological features with naturally elevated metal concentrations is the probable source of these metals for the streams and lakes with elevated concentrations of these metals.

6.1.3 Marine Water and Sediment Quality

Marine water and sediment quality were assessed in the DEIS Volume 7, Chapter 2 and Chapter 3, respectively, as part of the marine environment assessment. Details of the baseline sampling program can be found in Volume 7, Sections 2.1 and 3.1 and in Appendix V7-2A, Rescan (2013c), (Rescan 2002), (Rescan 2008a), (Rescan 2008b), and (Rescan 2012i).

Baseline marine water quality data have been collected in the southern Bathurst Inlet during 2001, 2002, 2007, 2008, 2010, 2012, and 2013. The LSA that contains the MLA Potential Development Area (PDA) was sampled in 2012 and 2013.

The water quality of Bathurst Inlet was low in nutrients, suspended solids, and metals; typical of an Arctic environment. In the baseline sampling, the deep waters in the inner basin of Bathurst Inlet had decreased oxygen levels, as expected in a deep fjord with limited deep water exchange, but there was no evidence of sub- or anoxia. Nutrient concentrations varied seasonally and throughout the water column. The deep waters of Bathurst Inlet had generally similar nutrient concentrations irrespective of season, which indicate the processes of mixing and deep primary production were roughly balanced with re-mineralization. Under the ice-cover in winter, nutrient concentrations were generally higher, which likely was the result of decreased phytoplankton nutrient demands. In summer samples from near-shore sites in the LSA, nutrient concentrations in the surface waters were substantially lower, due to the nutrient demands of phytoplankton and the stable pycnocline serving as a barrier to mixing and nutrient replenishment except in the shallowest of sites. Nitrogen was the putative limiting nutrient in Bathurst Inlet in summer since nitrate concentrations were generally near or below detection limits at all LSA sites and phosphorus was generally still measurable in surface waters.

Overall, Bathurst Inlet in the LSA and throughout the RSA is naturally low in metals during both the open-water and ice-covered seasons. Many metal samples were near or below their analytical detection limits, particularly measurements of arsenic, chromium, copper, iron, lead, mercury, and zinc. Only a few samples had metal concentrations that were greater than the CCME marine water quality guidelines. A single sample in the LSA had a cadmium concentration that was greater than its CCME guideline level (BACK2013N12). A small subset of samples from the RSA in Bathurst Inlet had metal concentrations greater than the CCME water quality guidelines for cadmium, chromium, and mercury (HACK20071, HACK20085, BIPR20104, BACK2012O414, BACK2012O440, BACK2012O624, BACK2012O644, and BACK2012O654).

The sediment quality in the LSA was sampled in 2013 and sampled in the RSA in 2001, 2002, 2007, 2010, and 2012. The sediments of Bathurst Inlet were heterogeneous, likely as a result of local physical processes, and some of this variation was reflected in the measures of natural sediment quality during the baseline program. Sediments in the LSA were sandy (50 to 90% sand particles). More variation in sediment particle composition was observed over the larger scale in the RSA, and sediments ranged from sandy (>90% sand particles) through loose clay-silt sediments (70% clay with the remainder silt). Sand tended to predominate in the shallower sites (< 5 m), with silts and clays become more frequent in the deeper near-shore sites; wind-driven mixing and currents likely were the causes of these depth-related sediment distributions.

Cadmium, mercury, lead, and zinc sediment concentrations were low in the LSA, and often near or below the analytical detection limits, and less than the CCME sediment quality guidelines.

Near-shore sites in the RSA with high silt/clay content often had elevated concentrations of arsenic (in 2010 at BIPR2010R, BIPR20101, BIPR20102, BIPR20103b, BIPR20104, BIPR20105, BIPR20106b, BIPR20107; in 2012 at BACK2012O622 and BACK2012O632), chromium (in 2001 at BIPR20011, BIPR20012, BIPR20013, BIPR20014, BIPR20015; in 2010 at BIPR20103b), and copper (in 2010 at BIPR2010R, BIPR20101, BIPR20102, BIPR20103b, BIPR20104, BIPR20105, BIPR20106, BIRP20107; in 2012 at BACK2012O622 and BACK2012O632). However, no sediment samples from the baseline program had sediment metal concentrations in excess of the CCME Probable Effect Level Guidelines (CCME 2013a).

6.1.4 Freshwater Aquatic Resources and Fish

Freshwater aquatic resources and fish were assessed in the DEIS Volume 6, Chapters 6 and 7, respectively, as part of the freshwater environment assessment. Details of the baseline sampling program can be found in Volume 6, Sections 6.1 and 7.1 and in Appendices V6-6A or Rescan (2010), V6-6B or Rescan (2012b), V6-6C or Rescan (2012d), and Rescan (2013g).

The baseline sampling program collected data on aquatic biota in the Project region in 2011 and 2012, with some historical data from the George Property Area in 2007. The sampling program collected data on the phytoplankton and periphyton communities, which are key primary producers in lakes and streams respectively, and zooplankton and benthos, which are important consumers and crucial parts of aquatic food webs. Baseline studies on fish habitat occurred in 2010, 2011, 2012, and 2013.

The aquatic biota in the streams and lakes in the Project region reflect the pristine nature of this Arctic environment. The long cold winters, large spring freshet, and short summer all contribute to low overall primary production and low primary producer biomass in lakes and streams. Lake zooplankton and lake and stream benthic invertebrate communities all showed considerable variation in composition and abundance between sites and years. This is not unusual and is consistent with the close coupling between trophic levels and the strong local effects due to patchiness in distribution, local environmental variation and life-history strategies. The benthic environment of lakes and streams is crucial to aquatic productivity, and the baseline sampling program showed healthy and robust communities of benthic invertebrates affected by natural variation and ecological processes.

Fish were captured in all of the sampled lakes in the Goose Property Area (Goose Lake, Umwelt Lake, Llama Lake, Reference B Lake, Big Lake, Fox Lake, Del Lake, Rabbit Lake, Moby Lake, Rascal Lake, Swan Lake, Pond 1, and Ponds D, I and L); however, most of the shallow ponds were not fish-bearing due to their shallow depth and ephemeral connectivity to other waterbodies. Lakes in the Goose Property Area contained: Lake Trout (*Salvelinus namaycush*), Round Whitefish (*Prosopium cylindraceum*), lake cisco (*Coregonus artedi*), Longnose Sucker (*Catostomus catostomus*), Ninespine Stickleback (*Pungitius pungitius*), and lake whitefish (*C. clupeaformis*). Streams were inhabited by: Arctic Grayling (*Thymallus arcticus*), Slimy Sculpin (*Cottus cognatus*), and Burbot (*Lota lota*). The concentration of mercury in Lake Trout and Round Whitefish tissue did not exceed Health Canada Guidelines (0.5 mg/kg; Health Canada 2012a) in any of the lakes (Llama, Goose, Umwelt, Gander, and Reference B) sampled. Fish from all sampled lakes had similar metal concentrations in their tissues.

Fish were found in many lakes on the George Property Area (George Lake, Fold Lake, Occurrence Lake, Esker Pond, Sleigh Lake, Komatic Lake, Dragon Lake, Upper Long Lake, Bob Lake, and Reference Q Lake). Five species of fish were captured at the George Property Area: Lake Trout, Arctic Grayling, Round Whitefish, Burbot, and Slimy Sculpin. Lake Trout was the dominant species in lakes. Streams were dominated by Slimy Sculpin and Burbot, with some Arctic Grayling. While no fish have been captured in several of the lakes in the Kanosak Creek (George Outflow) drainage, fish may use these waterbodies seasonally as they migrate up and down the watershed. Mercury concentrations in Lake Trout tissues did not exceed Health Canada Guidelines (0.5 mg/kg; Health Canada 2012a) in any lake sampled (including George Lake and Reference C Lake). Concentrations of most other metals in fish tissue were similar among lakes.

6.1.5 Marine Aquatic Resources, Fish, and Wildlife

Marine aquatic resources, fish, and wildlife (seabirds/seaducks and ringed seals) were assessed in the DEIS Volume 7, Chapters 4, 5, 6, and 7, respectively, as part of the marine environment assessment. Details of the baseline sampling program can be found in Volume 7, Sections 4.1, 5.1, 6.1, and 7.1 and in Appendices V7-4A or Rescan (2012f), V5-5C or Rescan (2013n), and V5-5D or Rescan (2012h).

The baseline sampling program collected data on the natural aquatic biota in Bathurst Inlet since 2001. The areas near Project activities in the LSA were sampled in 2001, 2002, 2007, 2010, 2012, and 2013, whereas sampling in the marine RSA began in 2008 and continued in 2012 and 2013. Fish habitat and fish community information is available for southern Bathurst Inlet from studies conducted in 2001, 2010, 2012, and 2013. None of the captured fish species are currently considered endangered,

threatened, or are listed under Canada's *Species at Risk Act* (2002). Wildlife baseline sampling programs collected data on marine mammals in 2004, 2007, 2012, and 2013, and incidental observations were recorded in 2011. Baseline sampling programs for seabirds/ducks occurred in 2011, 2012, and 2013.

Shoreline habitat in southern Bathurst Inlet was dominated by a shallow water shelf that extended at a slope of 8% to a depth of approximately 10 m and a distance of 120 m offshore. Beyond this distance, the shoreline drops off steeply at a gradient of 30% to depths greater than 40 m. These general physical habitat characteristics were applicable to surveyed sites with moderate to high wave exposure throughout southern Bathurst Inlet. Ice scour and wave action removed sediments from near-shore exposed areas, but in areas more sheltered from those forces, clays and fine marine sediment remained in near-shore and intertidal zones. The shoreline in these areas has a lower gradient and the bays were generally shallow (< 15 m). Mud (silt, clay, and fine sediments) was the most common substrate type found in southern Bathurst Inlet, and was more common in areas sheltered from waves and in deep water. Cobble, sand, gravel, and rock were mainly observed in very shallow depths at areas with greater exposure to waves and ice scour, and in the intertidal zone. The intertidal zone was assessed as low quality habitat due to the lack of cover and evidence of substantial ice scour. The subtidal and near-shore habitat provides good quality habitat for pelagic species and benthic species that prefer fine substrates, but poor habitat for species requiring rock or gravel substrate.

The marine ecosystem in Bathurst Inlet is strongly affected by the physical environment. Winter time productivity in the Inlet is low due to low phytoplankton biomass and light limitation. The under-ice phytoplankton community was a mix of dinoflagellates (*Dinophysis* and *Gymnodinium* sp.) and diatoms (*Achnanthes*, *Nitzschia*, and *Chaetoceros* sp.), which are common components of Arctic phytoplankton communities, and diatoms are thought to be particularly important in ice algae and spring bloom communities. In the spring, abundant nutrients in the surface waters combined with increased light levels likely causes a spring bloom. This spring bloom serves as an important food source for zooplankton and the pelagic food web. The zooplankton community in Bathurst Inlet was dominated by the calanoid copepods *Pseudocalanus* and *Acartia*, organisms that are known to be dependent on robust spring blooms of phytoplankton. The strong pycnocline and stable water column present in Bathurst Inlet in summer inhibits nutrient replenishment from the deep waters and creates nitrogen-limited conditions in the surface waters. Although total phytoplankton biomass was higher in summer, these values are low for a coastal ecosystem and would be classified as oligotrophic. The phytoplankton community in the LSA was dominated in the summer by flagellated taxa, including chlorophytes, cryptophytes, and dinoflagellates. Many of these taxa are capable of vertical migration to seek sources of nutrients as well as mixotrophy, which is further evidence for the nutrient-limited nature of Bathurst Inlet in summer.

Benthic production is important in Arctic marine ecosystems, and the benthos baseline sampling program found a diverse and robust community of benthic organisms. Near-shore sites with sandy sediments tended to be dominated by the small bivalves *Macoma* and *Astarte*, which serve as important food sources for fish. Sediments with finer grains, often found in deeper waters, had more diverse benthos communities comprised of a mix of polychaetes worms, cumaceans, and amphipods. The diversity of sediment environments, including sandy, silty, and rocky substrates is important in promoting overall ecosystem production and biodiversity. The baseline data showed the LSA to be host to a healthy benthic environment.

Twelve fish species were captured during the Bathurst Inlet fish community surveys. Fourhorn sculpin (*Myoxocephalus quadricorni*) was the most abundant species in 2001 and 2010. In 2012, Capelin (*Mallotus villosus*) was the most abundant, likely because sampling coincided with the Capelin spawning period. Other common species were: Pacific Herring (*Clupea pallasii*), Starry Flounder

(*Platichthys stellatus*), Arctic Cisco (*Coregonus autumnalis*), and Saffron Cod (*Eleginus gracilis*). The remaining six captured species during baseline studies included: Arctic Flounder, Broad Whitefish, Lake Trout, Ninespine Stickleback, Rainbow Smelt, and Slender Eelblenny. Bathurst Inlet does support aboriginal subsistence fisheries and cod and Arctic Char are the preferred targets for subsistence hunters; however, Arctic char was not caught at any marine site throughout the baseline sampling program. Other species consumed are: Wolfish, Herring, Flounder species, Whitefish species, Lake Trout, Cisco species, Sculpin species, seaweed, clams, mussels, sea urchin, crabs, and sea stars.

Marine birds include seabirds, seaducks, shorebirds, and some waterbird species that are reliant on marine environments during various life history stages, such as foraging or staging (Gill et al. 1996). A total of 15 species and 1,808 individuals were observed and identified to the species level. The most commonly observed species were: red-breasted merganser (*Mergus serrator*), Canada goose (*Branta Canadensis*), greater scaup (*Aythya marila*), and herring gull (*Larus argentatus*). The glaucous gull (*L. hyperboreus*), black scoter (*Melanitta americana*), surf scoter (*M. perspicillata*), white-winged scoter (*M. fusca*), common eider (*Somateria mollissima*), Arctic tern (*Sterna paradisaea*), long-tailed duck (*Clangula hyemalis*), and Brant (*Branta bernicla*) are considered Sensitive by the Nunavut ranking system (CESCC 2010). The majority of waterbirds observed during the summer marine surveys consisted of gulls.

There are two marine mammals that are resident in Bathurst Inlet: the ringed seal (*Phoca hispida*) and the bearded seal (*Erignathus barbatus*). Canadian populations of ringed seals were designated as Not at Risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2002b) but are considered a high priority candidate on the Species Specialist Subcommittees' (SSC) candidate list and the COSEWIC candidate list for reassessment in fall of 2013 (COSEWIC 2012). Canadian populations of bearded seals are designated as Data Deficient (COSEWIC 2002a) and are listed as mid-priority candidates on the SSC candidate list, but have not yet been scheduled for reassessment (COSEWIC 2012). The corrected density of ringed seals in the marine RSA using seal count data from 2012 was estimated to be 2.05 seals/km^2. The density of seals in the southern portion of the RSA near the proposed port site was lower than that in the northern section of the RSA. However, densities of ringed seals were correlated to ice conditions with highest densities associated with cracked ice and solid ice and the lowest density in areas of high ice deformation and extensive melt water. The occurrence of bearded seals in Bathurst Inlet was much lower, with only 42, 9, and 31 bearded seals observed in 2007, 2009, and 2013 respectively. Bearded seals were associated with cracked ice and ice with melt water in areas that were fairly shallow (< 150 m). Of the ringed seals observed during the survey, 17 and 31 were identified as pups in 2012 and 2013 respectively, indicating that there may be potential for ringed seals to build lairs and raise pups within the RSA. Additionally, 32 potential lairs were observed in 2013.

6.1.6 Soil and Vegetation

Soils and vegetation were assessed in the DEIS Volume 5, Chapters 3 and 4, respectively, as part of the terrestrial environment assessment. Details of the baseline sampling program can be found in Volume 5, Sections 3.1 and 4.1, Appendix V5-3A or Rescan (2013e), and Appendix V5-4A or Rescan (2013b).

The Ecosystems and Vegetation baseline sampling program collected data on soil, plants, and lichens in the vicinity of the proposed Project in 2012. The vast majority of the Project area is located in Takijuq Lake Upland Ecoregion of the Southern Arctic Ecozone, which extends across central Nunavut and is bordered by the tree line to the south and by the Northern Arctic ecosystem to the north. The southern tip of the study area is situated in Garry Lake lowland Ecoregion, while the northern extreme of the winter road extends to the Bathurst Hills Ecoregion.

The vast majority of the study area is covered by morainal veneers (NRCan 2012) deposited by glaciers. Local morainal material (till) has a sand matrix with variable amounts of silt and relatively low coarse

fragment content (Rescan 1997). Granitic bedrock is usually poor in nutrient elements and gives rise to more acidic soils than basic sedimentary rocks. Other soil parent materials in the Project area include glaciofluvial sands that are nutrient poor and glaciolacustrine or marine clays that are nutrient rich (Acton 1989). Soils that developed on marine sediments have textures ranging from clay to silty clay with traces of sand and shells (EBA Engineering Consultants Ltd. 1996). In general, due to harsh climatic conditions, the rates of soil development in the study area are very slow (SENES 2008).

There are a few species endemic to Takijuq Lake Upland Ecoregion (NRCan 2012). Heath Shrub/Lichen Tundra is the most predominant tundra plant community (Ecological Framework for Canada 2012), and the nutrient regime is poor. Dwarf birch (*Betula nana*), northern labrador tea (*Ledum palustre*), a number of ericaceous shrubs (*Vaccinium* sp.), and several species of Saxifrage (*Saxifraga* sp.) form the dominant shrub cover. Forbs, grasses, and mosses are not abundant. *Carex*/Rock Lichen community is typically associated with rock outcrops where the dominant vegetation consists of rock sedge (*Carex rupestris*), white mountain avens (*Dryas integrifolia*), and dwarf ericaceous shrubs (e.g., *Cassiope* sp., *Empetrum* sp.). Several species of lichens are also associated with this ecosystem.

Eskers harbour a diverse vegetation community, although plant composition is largely dependent on specific site conditions (e.g., slope position). Lingonberry (*Vaccinium vitis-idaea*), bearberry (*Arctostaphylos uva-ursi*), and prickly saxifrage (*Saxifraga tricuspidata*) are usually found on esker crests, ericaceous species (e.g., *Empetrum* sp., *Vaccinium* sp., *Cassiope* sp.) on windward slopes, dwarf birch on sheltered leeward slopes, and sedges on slope toes. The Riparian (Seep) Birch community is often found on upper slopes and terraces along streams or seepage areas. Ericaceous shrubs, cottongrass, and sedge species are also abundant, and tufted moss (*Aulacomnium palustre*) is characteristic of this community.

Wetlands are dominated by two plant communities: Tussock Meadow and Wet Meadow. The Eriophorum Tussock Meadow community is typified by the abundance of cotton grasses (*Eriophorum* sp.) that grow in clumps or tussocks, and birch and willow species are common, along with ericaceous species and mosses. The Wet Carex Meadow is defined by a high abundance of sedges, and mosses are common, but there are no lichens. The southern border of the Southern Arctic Ecozone is defined by a lack of full-size trees along its southern edge. Stunted forms of certain tree species, such as dwarf birch (*Betula nana*), green alder (*Alnus viridis* spp. *crispa*), willow species (*Salix* spp.), and less commonly, white and black spruce (*Picea glauca* and *P. mariana*) grow throughout the Ecozone.

In the 2012 baseline study, the Goose Property Area and the MLA sampling locations did not have any soil metal concentrations above the CCME Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural (CCME 2013b). At the George Property Area and Reference locations, arsenic was the only metal found to be above the CCME Guideline limit for some samples. In the George Property Area, three (75%) samples at 0 to 5 cm depth were found to exceed the CCME Guideline for arsenic, whereas eight (31%) Reference sites at 0 to 5 cm depth and two (67%) Reference sites at 50 to 60 cm soil depth were found to exceed the CCME Guideline for arsenic.

During baseline studies, samples of lichen (*Cladina stygia* and *Stereocaulon paschale*), sedge (*Carex aquatilis*), and berries (bog blueberry [*Vaccinium uliginosum*] and bog cranberry [*V. vitis-idaea*]) were collected for tissue metal analysis. Some of these samples were co-collected with soil samples that were also analysed for metal concentrations. Results of these metal analyses can be found in Volume 5, Chapters 3.1 and 4.1. Co-collected samples were used to calculate site- and species-specific soil-to-plant metal biotransfer factors (BTFs).

6.1.7 Terrestrial Wildlife

Terrestrial wildlife was assessed in the DEIS Volume 5, Chapters 5 (caribou, *Rangifer tarandus*), 6 (grizzly bear, *Ursus arctos horribilis*), 7 (muskox, *Ovibos moschatus*), 8 (wolverine, *Gulo gulo,* and furbearers), 9 (migratory birds), and 10 (raptors) as part of the terrestrial environment assessment. Details of the baseline programs can be found in Volume 5, Sections 5.1, 6.1, 7.1, 8.1, 9.1, and 10.1, and in Appendices V5-5A or Rescan (2013a), V5-5B or Rescan (2013l), V5-5C or Rescan (2013n), V5-5D or Rescan (2012h), V5-5E or Rescan (2011a), and V5-6A or Rescan (2013k).

The wildlife baseline sampling program characterized the avian and mammalian communities within various study areas around the Goose and George Property Areas as well as the MLA in 2011, 2012, and 2013. In addition, there was a baseline study for caribou and muskox conducted in 2010. In 2012 a total of 52 bird species, two marine mammals, and eight terrestrial mammals were confirmed to occur within the Project study areas. Of these species, 18 birds and two terrestrial mammals were identified as species of conservation concern at the territorial or federal level.

The Project location is within the range of two barren-ground caribou herds: the Bathurst and Beverly herds. The Bathurst herd is consistently present in the western edge of the RSA during the post-calving period (June 16 to July 20) and the spring migration (May) while on their way to their calving grounds located north-west of the RSA. The Beverly herd overlaps with the RSA primarily during the summer, and fall seasons with the core habitat summer range overlapping the Goose Property Area during the summer (July 16 to August 31). Some Beverley caribou may overwinter above treeline and occur in the southern extent of the RSA during some years at this time, but the density of Beverley caribou in the RSA during winter is very low. Beverly caribou may also pass through the eastern edge of the RSA on their way to the calving grounds located north-east of the RSA during spring migration (May). Overall, collar data suggests that Beverly caribou are most commonly present around the Goose Property Area in the summer (mid-July to the end of August) and Bathurst caribou are most commonly present during the post-calving period (mid-June to mid-July) around the George Property Area. Detection of caribou by remote cameras at Project infrastructure sites was lower relative to other sites within the RSA.

Muskoxen that occur within the RSA are referred to as the central mainland population and are found throughout the Project area at relatively low densities (Gunn 1990; Dumond 2007). In 2007, five aerial surveys were conducted in May, June, early July, late July, and September and a total of 50 muskox were observed on transects with an additional 82 observed off transects. In 2008, two adults were observed in May and two during the July surveys. An additional 98 muskox were observed incidentally; 84 adults and 14 calves/juveniles. In 2010, aerial transect surveys were conducted in May, June, and July and a total of 53 muskox were observed with an additional 34 muskox recorded beyond the 500 m transects. Each aerial survey typically observed two to three groups of muskox. A group was consistently observed each year on the low hills to the west of Bathurst inlet, while the other one to two herds were observed at various locations in the southern study area.

Grizzly bears in the Project area are part of the Bathurst Inlet population cluster and there is no official estimate on grizzly bear population size for the West Kitikmeot region of Nunavut. However, a crude estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which includes the Project area (Ross 2002). During the 2012 Rescan baseline survey, 111 bears were identified in the RSA with the highest numbers of bears on the lower reaches of the Western River (> 10 bears), along the Back River, and on the large eskers 10 to 15 km west and south-west of George Camp. Grizzly cubs were observed in the RSA in 2011 and 2012, and in 2012 two grizzly bear dens were located in the RSA.

Other Arctic furbearers in the region include red and Arctic foxes (*Vulpes vulpes and V. lagopus*, respectively), wolves (*Canis lupus*), Arctic ground squirrels (*Spermophilus parryii*), and wolverines (*Gulo gulo*). Wolverine populations in the central Arctic appear to be stable, though recent estimates are lacking (COSEWIC 2003). The total population size of wolverines in Nunavut is estimated as 2,000 to 2,500 individuals (COSEWIC 2003; Slough 2007). Results from the Rescan 2012 baseline survey indicate a relatively low number of wolverine in the area; however, two wolverine dens were found during this survey. Grey wolf populations are stable or increasing within their Canadian range, except in northern Alberta and some parts of the Northwest Territories (Hayes and Gunson 1995). Wolf reproductive success and population size are largely regulated by the availability of caribou and baseline field data indicated moderate densities of wolves in the RSA. Wolf dens and pups have been detected in the RSA during baseline surveys, with one den located less than 3 km from the George Lake Camp.

Nine raptor species have been detected in the RSA. Six of these species nest on steep cliff ledges (golden eagle [*Aquila chrysaetos*], bald eagle [*Haliaeetus leucocephalus*], gyrfalcon [*Falco rusticolus*], peregrine falcon [*F. peregrinus*], rough-legged hawk [*Buteo lagopus*], and the common raven [*Corvus corax*]), while three species nest on the ground (northern harrier [*Circus cyaneus*], snowy owl [*Bubo scandiacus*], and short-eared owl [*Asio flammeus*]). All five raptor species of conservation concern expected to occur in the study region (golden eagle, gyrfalcon, rough-legged hawk, peregrine falcon, and short-eared owl) were detected breeding in the RSA.

Upland breeding birds are ground-nesting species that include migratory songbirds and shorebirds, and resident ptarmigan. A total of 21 bird species (10 songbirds, nine shorebirds, and two ptarmigan) were detected either during these surveys or observed incidentally. Ten of the upland breeding birds observed are listed as Sensitive in Nunavut by the Canadian Endangered Species Conservation Council (CESCC 2010) due to concern for long-term population declines or require special attention or protection to prevent them from becoming at risk. Overall, species richness and relative abundance was higher in lowland habitat relative to upland habitat. The Focused Marine Survey Area at Bathurst Inlet supported a richer and more abundant community of upland breeding birds, particularly of species of conservation concern, compared to the other study areas, while lowland habitat in the George Lake reference bird survey area had lower species richness, and supported fewer territories of upland breeding birds compared to the other study areas.

Arctic waterbirds observed during the 2011 and 2012 Rescan surveys included migrating ducks (dabbling and diving), geese, swans, loons, terns, gulls, cranes, jaegers, and grebes. The Nunavut ranking system (CESCC 2010) lists these species of concern, the Arctic tern (*Sterna paradisaea*), glaucous gull (*Larus hyperboreus*), and long-tailed duck (*Clangula hyemalis*) as Sensitive. Overall, 19 waterbird species were observed during these surveys and four additional species were observed incidentally during other baseline studies. Canada goose (*Branta canadensis*) was the most common observed species representing 91% of all counts in 2011. Overall abundance of waterbirds was lowest during the spring staging survey and increased during each subsequent survey with the highest abundance of waterbirds occurring during the fall staging survey.

6.1.8 Country Foods

Country foods quality was assessed in the DEIS Volume 8, Chapter 5 as part of the human environment assessment. A baseline country foods risk assessment was conducted in 2013 to determine the level of risk to human consumers associated with intake of COPCs present in country foods. Details of the baseline assessment are provided in Rescan (2013j) or Appendix V8-5A and in Volume 8, Chapter 5, Section 5.1.

In total, the quality of seven representative country foods from seven different groups was estimated prior to development of the potential Project, and thus was reflective of baseline levels of metals. The country foods evaluated included: a large terrestrial mammal (caribou), a small terrestrial mammal (Arctic ground squirrel), a bird species (Canada goose), fish (Lake Trout), a shellfish species (bay mussel, *Mytilus trossulus*), a marine mammal (ringed seal), and berries (bog cranberry and bog blueberry, combined). This study also evaluated potential health risks associated with the ingestion of baseline metal concentrations in the country foods. Several other marine species (Wolfish, Herring, Flounder species, Whitefish species, Lake Trout, Cisco species, Sculpin species, clams, seaweed, mussels, sea urchin, crabs, and sea stars) are also locally harvested and consumed but were not included in the model. Non-aboriginal recreational fish harvest in Bathurst Inlet is expected to be low, and there are currently no commercial fisheries harvests reported in Bathurst Inlet.

Metals, including aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc were selected as the COPCs. The country foods baseline risk assessment integrated the results of the environmental media baseline data, human receptor characteristics, and regulatory-based toxicity reference values (TRVs). Of the COPCs identified, arsenic is considered to have carcinogenic potential; therefore, the incremental lifetime cancer risk (ILCR) was calculated for consumption of arsenic in country foods. For all the COPCs, the recommended maximum weekly intake (RMWI) and recommended number of weekly serving were calculated for each country food.

Based on the calculated ILCRs, RMWIs, and recommended number of weekly servings of COPCs, this assessment predicted no unacceptable health risks to people from consuming caribou, Arctic ground squirrel, Canada goose, Lake Trout, bay mussel, ringed seal, or berries under the existing pre-Project conditions. This means that consumption of these country foods at the quantities and frequencies used in the assessment would be considered safe and would not affect human health.

6.1.9 Noise

Noise was assessed in the DEIS Volume 4, Chapter 2 as part of the atmospheric environment assessment. Details of the noise baseline program can be found in Volume 4, Section 2.1 and in Rescan (2012g), Appendix V4-2A.

Aside from mine exploration activities, the noise environment in the Project area is pristine. There are no additional industrial sites or human settlements close enough to the Project to be audible; consequently, only natural sources such as wind, precipitation, and wildlife contribute to background noise levels.

Noise monitoring was conducted in March and June 2012 using sound level meters that were deployed at 10 sites at varying distances from the Goose camp, George exploration camp, and the MLA. The locations were selected to characterize the range of baseline conditions in the noise RSA, based on their proximity to known deposits and sensitive wildlife receptors. The time periods were chosen to encompass winter and summer conditions, and to include the critical bird nesting period and a portion of the caribou migration in June. Monitoring was undertaken for 24-hours at each location. Natural background noise sources recorded included birds, animals, insects, precipitation, and winds. Anthropogenic sources recorded included heavy machinery and aircraft (Volume 4, Chapter 2, Rescan 2012g).

In general, the June monitoring period had higher noise levels than the March monitoring period due to more non-anthropogenic noise sources in June, such as birds and insects. The highest noise levels were measured at Goose and George Camps, which is to be expected due to the noise generated by anthropogenic sources during exploration. The levels measured are comparable to estimated baseline levels for quiet, rural areas as provided in the Health Canada guidance, which considers a quiet rural

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 initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB ftp site. The use of TK/TU information in VEC or VSEC selection is discussed in the individual chapters, as follows:

- Air quality: Volume 4, Chapter 1, Section 1.2.2;
- Freshwater and sediment quality: Volume 6, Chapters 4 and 5, Sections 4.2.2 and 5.2.2;
- Marine water and sediment quality: Volume 7, Chapters 2 and 3, Sections 2.2.2 and 3.2.2;
- Freshwater aquatic resources and fish: Volume 6, Chapters 6 and 7, Sections 6.2.2 and 7.2.2;
- Marine aquatic resources, fish, and wildlife: Volume 7, Chapters 4, 5, 6, and 7, Sections 4.2.2, 5.2.2, 6.2.2, and 7.2.2;
- Soil and vegetation: Volume 5, Chapters 3 and 4, Sections 3.2.2 and 4.2.2;
- Terrestrial wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10, Sections 5.2.2, 6.2.2, 7.2.2, 8.2.2, 9.2.2, and 10.2.2; and
- Country foods: Volume 8, Chapter 5, Section 5.2.2.

In addition, TK/TU was used to guide the selection of VECs or VSECs for inclusion in the ERA and HHRA, particularly in regards to the types of animals (VECs) that might have been historically valued (e.g., as sources of food or fur) by local people.

Several animals were traditionally hunted by Inuit (described in detail below) and this information was used to help determine VECs and VSECs for inclusion in the ERA and HHRA. Inuit from the West Kitikmeot belong to one of three regional groups: Ocean Inuit - people of the sea; Nunamiut - Inlanders or people of the land; and Kiligiktokmiut - people of Bathurst Inlet, Perry River, and Ellice River. The major distinction between these groups is the primary food consumed: Ocean Inuit depend mainly on seals; Nunamiut depend mainly on caribou; while Kiligiktokmiut depend on both caribou and seals. The proposed Project area mainly overlaps with the area that was inhabited and used by the Kilikgiktokmiut people and the discussion below will focus on them; however, the other groups would also hunt and travel through the area.

When caribou and seals were unavailable other animals were hunted for food, such as grizzly bear (in spring and fall), muskox (in spring, fall, and winter), Arctic hare (in winter) and ground squirrels (in summer and fall). Migrating waterfowl were hunted by coastal Inuit in spring and summer, and ptarmigan were eaten by Inuit everywhere. Other harvested waterfowl included Sandhill cranes, eider ducks, and loons. Bird eggs were also consumed when available. Fishing occurred mainly in the spring and fall, timed with spawning runs. Wolves, foxes, and wolverines were only hunted for their fur but would be eaten by Inuit if there was no other food available. Moose were very rarely seen north of the tree line. Smaller mammals (i.e., brown lemmings, Arctic or collared lemmings, and tundra voles) were not consumed by Inuit but their importance in the diet of Arctic fox and snowy owl was recognized. Walrus and other marine mammals were neither common nor important food items. The most important lake and river fish consumed were Arctic Char (land-locked and over-wintering), Lake Trout, and white fish (Broad Whitefish and Arctic Cisco), while other consumed species were Arctic Grayling, Longnose Sucker, Burbot, Northern Pike, and eels.

area with day-night sound levels due to human-made sounds to be below 45 dBA (Health Canada 2011). Only a single monitoring location (S01 situated at the Goose Camp) experienced noise levels greater than 45 dBA during both monitoring periods. Overall, noise data collected in 2012 was reflective of pristine background noise conditions as well as exploration camp noise conditions. These baseline levels are considered representative of the noise environment across the modelled area.

6.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The Kitikmeot Inuit Association produced a report (KIA 2012) that presents regional-level Traditional Knowledge (TK) for the proposed Back River Project, which was the TK information source used in this HHRA and ERA (unless indicated otherwise). The report includes Inuit oral knowledge collected by the Naonaiyaotit Traditional Knowledge Project (NTKP). The NTKP comprises a 750,000 km^2 study area (the Slave Geological Province) and includes information on Inuit land use and fish and wildlife ecological data. The NTKP is used as a repository of Kitikmeot Inuit TK, used as a land-use planning tool, and informs and improves the quality of environmental assessments for developments proposed in the Kitikmeot region. The NTKP oral data comes from interviews conducted with 68 elders and land-users (in addition to input from other community members) in 1995 and 1996 and between 1997 and 2000. The NTKP data is relevant as of the mid-1990s. The regional-level TK report prepared for the Project divides the region into a LSA and RSA. The LSA is the area of land and water that encompasses the Project and is consistent with the largest boundary of the wildlife, regional marine, and terrestrial study areas (defined in Rescan baseline studies). The RSA encompasses broad regional-scale information in the NTKP database relevant to the Project (e.g., wildlife migration routes, Inuit land use activities, and travel routes) and includes hamlet communities closest to the Project (Kugluktuk, Ekaluktutiak or Cambridge Bay, Omingmaktok, and Kingaok).

6.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available Traditional Knowledge (TK) from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) was reviewed for the HHRA and ERA existing environment and baseline information. The use of traditional knowledge/traditional use (TK/TU) information in the existing environment and baseline information section for each VEC or VSEC is discussed in the individual chapters, as follows:

- Air quality: Volume 4, Chapter 1, Section 1.2.1;
- Freshwater and sediment quality: Volume 6, Chapters 4 and 5, Sections 4.2.1 and 5.2.1;
- Marine water and sediment quality: Volume 7, Chapters 2 and 3, Sections 2.2.1 and 3.2.1;
- Freshwater aquatic resources and fish: Volume 6, Chapters 6 and 7, Sections 6.2.1 and 7.2.1;
- Marine aquatic resources, fish, and wildlife: Volume 7, Chapters 4, 5, 6, and 7, Sections 4.2.1, 5.2.1, 6.2.1, and 7.2.1;
- Soil and vegetation: Volume 5, Chapters 3 and 4, Sections 3.2.1 and 4.2.1;
- Terrestrial wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10, Sections 5.2.1, 6.2.1, 7.2.1, 8.2.1, 9.2.1, and 10.2.1; and
- Country foods: Volume 8, Chapter 5, Section 5.2.1.

6.2.2 Incorporation of TK for VEC and VSEC Selection

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 (see Volume 9, Chapter 1). The TK report presents clear maps

6.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The use of TK/TU information in determination of spatial and temporal boundaries for the VEC/VSEC effects assessment is discussed in the individual chapters, as follows:

- Air quality: Volume 4, Chapter 1, Section 1.2.2;
- Freshwater and sediment quality: Volume 6, Chapters 4 and 5, Sections 4.2.3 and 5.2.2;
- Marine water and sediment quality: Volume 7, Chapters 2 and 3, Sections 2.2.2 and 3.2.2;
- Freshwater aquatic resources and fish: Volume 6, Chapters 6 and 7, Sections 6.2.3 and 7.2.3;
- Marine aquatic resources, fish, and wildlife: Volume 7, Chapters 4, 5, 6, and 7, Sections 4.2.3, 5.2.3, 6.2.3, and 7.2.3;
- Vegetation: Volume 5, Chapter 4, Section 4.2.3;
- Terrestrial wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10, Sections 5.2.3, 6.2.3, 7.2.3, 8.2.3, 9.2.3, and 10.2.3; and
- Country foods: Volume 8, Chapter 5, Section 5.2.3.

Inuit in the Kitikmeot region had traditional camps, travel routes, hunting and fishing areas, and water collection areas that they used year after year. These locations and timing of use were considered when determining spatial and temporal boundaries for the HHRA, and in the ERA to a lesser extent, since it provides information on the historical locations of potential receptors and potential exposure pathways.

6.2.3.1 Inuit Camps near the Back River Project

Nunamiut lived primarily near Contwoyto Lake, Rockinghorse Lake, and Napaktolik. During winter, spring, and fall they lived together in large camps and hunted caribou during spring and fall migrations. In the winter they trapped, and in spring and fall they travelled to trading post stores to sell and trade furs, obtain provisions, and visit with others. While traveling the land they fished and hunted. One of the most important gathering (and continuous living) places was Contwoyto Lake due to the migration of Bathurst caribou twice a year at this location. Unlike other areas, caribou were present at Contwoyto Lake in winter and often in large numbers. Major wintering areas also included Napaktolik, Rockinghorse Lake, Nose Lake, Itchen Lake, Hanigakhik, and James River. In the Contwoyto Lake area, Inuit usually traded at Kingaok/Bathurst Inlet trading posts, while Inuit in the Napaktolik area usually traded at Kugluktuk and Read Island posts, and this is reflected in their travel routes.

Kiligiktokmiut lived adjacent to Bathurst Inlet and in the Perry River and Ellice River drainages. Kilogiktok was used on a continual basis for thousands of years, and Inuit not only lived at Kingaok but also along many bays of the Inlet near the many narrows. After trading posts were erected at Kingaok and Omingmaktok (in the 1920s and 1964, respectively), permanent settlements became established. Major camps were located on Kent Peninsula, Kingaok, several locations along both shores of Bathurst Inlet, at the junction of Mara River and Burnside River, at the junction of James River and Hood River, and several locations on Huikkittak and Western River. Important camping areas were located at Beechey Lake, which is also the Bathurst caribou calving ground. A traditional community is located at Tudlak, which is at the outflow into Hanningayuk. Major Inuit gathering areas are further to the east at the mouths of Perry River and Ellice River.

6.2.3.2 Inuit Travel Routes near the Back River Project

Inuit lived where wildlife was abundant, and gathering places and harvesting areas were linked by major travel routes. Travel routes linked Inuit to fur-trading posts after European contact. Travel routes also served as harvesting and camping routes.

Nunamiut and Kiligiktokmiut usually undertook two major trips to fur-trading posts from where they had wintered. The first trip occurred in the fall before trapping season to obtain supplies on credit, the second was in the spring to sell furs and pay back the advance. Trips to trading posts also occurred on special occasions (e.g., Christmas), and in the winter if supplies or food ran short.

Contwoyto Lake is at the heart of Nunamiut land-use, and in the east there is a major travel route to Bathurst Inlet, and in the west a major travel route following the tree line to the coast at Kugluktuk. Gathering places were located along these routes and the largest and most important ones were at large lakes and major rivers. Nunamiut from the east and west coasts would travel inland to Contwoyto Lake, Rockinghorse Lake, and Napaktolik to visit, hunt, and get to the trading posts. Their routes covered a large area that included Kathawachaga Lake, Concession Lake, Itchen Lake, Pellatt Lake, Yamba Land, and Lac de Gras.

Kiligiktokmiut travel and harvest routes encompassed the length and breadth of Bathurst Inlet. Overland routes began at the ocean river mouths (e.g., Hiukkittak, Angimayak, Kolgayok, and Kunayok) and moved inland. Towards the south, travel routes went to Beechey Lake and Back River.

6.2.3.3 Inuit Hunting and Fishing Areas

Movements, behaviour, and availability of wildlife dictated Inuit harvesting activities, and hunting and trapping occurred all over the region. In the west Kitikmeot, Contwoyto Lake and Bathurst Inlet were so rich in wildlife resources that Inuit were able to live there year-round. Caribou, other large mammals, furbearing animals, and fish were abundant in Bathurst Inlet and its coastal river system.

The principal caribou herds hunted in the Kitikmeot region were Island caribou (that summer on Victoria Island) and mainland caribou (Beverly and Bathurst herds). Migratory caribou use all of Bathurst Inlet (including the Project area) due to its proximity to the calving grounds. Bathurst caribou calving areas are present throughout the Project study area, while calving areas of Beverly and Island caribou are east of Bathurst Inlet and on Victoria Island, respectively. Prime caribou hunting areas occurred at ice-free lakes, inlets, and river narrows, which would funnel caribou on the landscape. Important narrows for Nunamiut included much of Contwoyto Lake, Nalokvik at Fry Inlet, Napaktolik, Rockinghorse Lake, Concession Lake, and Lac de Gras. Ocean narrows were also important for Kiligiktokmiut and included Rideout Island, all the major narrows in Bathurst Inlet, and narrows in river systems such as Hiukkittak, Western River, and Burnside River.

Coastal Inuit predominantly harvested ringed seals rather than caribou, and the bearded seal was occasionally hunted. Seals were hunted in the spring while hauled out on the sea ice and in summer by boat. Important spring hunting areas include the Kent Peninsula isthmus, the ocean coast from Perry River to Cambridge Bay, Bathurst Inlet and islands within, Coronation Gulf, and Prince Albert Sound. Hunting areas were widespread in the summer, and were on the sea ice adjacent to the coast and ocean islands in the winter. Ringed seals were found predominantly in Bathurst Inlet, while bearded seals were hunted in Kent Peninsula, Bathurst Inlet, Elu Inlet, and Burnside River.

Marine fishing areas were located in the ocean adjacent to the mainland and island coastlines, and at the mouth of major rivers. Important freshwater fishing areas were all lakes and rivers feeding into

Bathurst Inlet, especially Hiukkittak, lakes near Kingaok (especially Tagionuak), Fishing Lake, Bathurst Lake, Kenyon Lake, and Beechey Lake. Weirs were built at river mouths to catch fish.

In the summer and fall the Inuit prepared for trapping by stashing meat, while the trapping itself mostly took place in winter. Trapping wolves, foxes and wolverine usually occurred along ocean shorelines and riverbanks, while trapping Arctic fox occurred in wetlands and along the coast. Traps were also set in the boreal forest by Inuit who lived near the tree line.

6.2.3.4 Inuit Drinking Water Collection Areas

Inuit preferred obtaining drinking water from large rather than small shallow lakes. Due to tidal action near river mouths, coastal Inuit traveled inland to obtain drinking water. If clean water was unavailable, water could be treated by filtration or boiling. Water and ice were obtained from: lakes; flowing rivers and creeks; pools under cliffs; pools among deep rock crevasses (from rain or melting snow); underground streams and cold water springs; wetlands; snow; inland in winter from lakes and rivers through an ice hole; on the ocean in winter from snow and icebergs; and on the ocean in spring from ice and pools of water on the ice surface. While at camp there were traditional places Inuit obtained water and while travelling they obtained water wherever they found it. Inuit felt they could obtain water everywhere and specific locations for obtaining drinking water were not mapped in the KIA (2012) report.

6.2.4 Incorporation of TK for Effects Assessment

The use of TK/TU information in the VEC/VSEC effects assessments is discussed in the individual chapters, as follows:

- Air quality: Volume 4, Chapter 1, Section 1.2.2;
- Freshwater and sediment quality: Volume 6, Chapters 4 and 5, Sections 4.2.4 and 5.2.2;
- Marine water and sediment quality: Volume 7, Chapters 2 and 3, Sections 2.2.2 and 3.2.2;
- Freshwater aquatic resources and fish: Volume 6, Chapters 6 and 7, Sections 6.2.2 and 7.2.4;
- Marine aquatic resources, fish, and wildlife: Volume 7, Chapters 4, 5, 6, and 7, Sections 4.2.4, 5.2.4, 6.2.4, and 7.2.4;
- Vegetation: Volume 5, Chapter 4, Section 4.2.3;
- Terrestrial wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10, Sections 5.2.4, 6.2.4, 7.2.4, 8.2.4, 9.2.4, and 10.2.4; and
- Country foods: Volume 8, Chapter 5, Section 5.2.4.

6.2.5 Incorporation of TK for Mitigation and Adaptive Management

The use of TK/TU information in the development of mitigation and adaptive management strategies is discussed in the individual chapters, as follows:

- Freshwater and sediment quality: Volume 6, Chapter 4, Section 4.2.5;
- Freshwater aquatic resources and fish: Volume 6, Chapters 6 and 7, Sections 6.2.4 and 7.2.4;
- Marine aquatic resources, fish, and wildlife: Volume 7, Chapters 6 and 7, Sections 6.2.5 and 7.2.5;

- Vegetation: Volume 5, Chapter 4, Section 4.2.4;
- Terrestrial wildlife: Volume 5, Chapters 5, 6, 7, 8, 9, and 10, Sections 5.2.5, 6.2.5, 7.2.5, 8.2.5, 9.2.5, and 10.2.5; and
- Country foods: Volume 8, Chapter 5, Section 5.2.5.

6.3 VALUED COMPONENTS

The TK information (Section 6.2.2), along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB ftp site. As part of this process, the human and environmental risk assessments were identified as a Subject of Note. However, many of the VECs and VSECs are used as receptors of the human and environmental risk assessments.

6.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

Section 8.3 of the EIS Guidelines for the Project indicates that an ERA and HHRA is required, separate from the effects assessment chapters for the individual VECs or VSECs. The following sections present the ERA and the HHRA that were completed for this Project.

6.4.1 Environmental Risk Assessment (ERA) for Contaminants

Risk assessment is a tool used to characterize potentially adverse environmental health effects from Project-related contaminant emissions. The following five steps are generally included in the risk assessment:

1. Problem Formulation: identifies a representative set of receptors that may be present, COPCs that may be present at levels potentially harmful to receptors, and pathways by which receptors may be exposed to COPCs. A conceptual model, which is a pictorial representation of the exposure pathways and routes of COPCs associated with this specific assessment, is one of the major outcomes of the Problem Formulation.
2. Exposure Assessment: the extent to which receptors might be exposed to the COPCs. Calculates the estimated daily intake (EDI) of COPCs by receptors for each relevant exposure pathway identified in the Problem Formulation. The calculations use site-specific COPC concentrations in environmental media (e.g., air, water, sediment, soil, vegetation, and country foods) and receptor-specific characteristics (e.g., body weight, ingestion rate, and consumption frequency).
3. Effects Assessment: identifies tolerable daily intakes (TDIs), or levels of daily exposure that can be taken into the body without appreciable health risk. These are referred to as toxicity reference values (TRVs) by some regulatory agencies. For COPCs with guidelines, these values were used instead of TRVs.
4. Risk characterization: determines the potential occurrence of adverse health effects by comparing the EDI with the TRV or the predicted concentration of a COPC with the guideline limit for that COPC.
5. Uncertainty Analysis and Data Gaps: evaluation of the assumptions, uncertainties and conservatism made throughout the assessment and their effects on the conclusions.

An ERA was performed to assess the potential for adverse effects from the Project on key ecological species. The ERA does not consider all potentially affected ecological species, but instead focuses on selected VECs (see Section 6.3.2.1). In addition, several environmental media VECs (i.e., air, water, sediment, soil, and vegetation) and the noise VEC were also included in the ERA as pathways through which contaminant or noise exposure may occur in the key VEC species.

6.4.1.1 Potential Valued Components and Scoping

ERAs estimate effects from contaminants on populations, communities, and multispecies ecosystems (CCME 1996). ERAs predict the probability of adverse effects and include exposure-response relationships, thus the risk calculated is a function of hazard and exposure to receptors (CCME 1996).

There are many VECs and ecological subjects of note that were included in the DEIS, such as:

- Atmospheric environment:
  - air quality;
  - noise and vibration;
  - meteorology and climate;
- Freshwater environment:
  - Hydrology;
  - ground water (subject of note);
  - limnology and bathymetry (subject of note);
  - water quality;
  - sediment quality;
  - fish/aquatic habitat;
  - fish community (Lake Trout and Arctic Grayling);
- Marine environment:
  - physical processes (subject of note);
  - water quality;
  - sediment quality;
  - fish/aquatic habitat;
  - fish community (Arctic Char);
  - seabirds/seaducks;
  - ringed seals;
- Terrestrial environment:
  - geology (subject of note);
  - geochemistry (subject of note);
  - permafrost (subject of note);
  - landforms and soil (subject of note, VEC = special landscape features);
  - vegetation;
  - caribou;
  - grizzly bear;
  - muskox;
  - wolverine and furbearers;

- migratory birds (upland birds and waterfowl); and
- raptors.

However, not all of these VECs or subjects of note are relevant for the ERA since they would not be considered susceptible to effects from contaminants or noise, or would not be pathways for contaminant exposure of ecological receptors. Further scoping of the VECs for inclusion in the ERA is detailed in Section 6.3.2.1.

6.4.1.2 Valued Components Included in the Assessment

Among the list of all potential ecological VECs, a subset was selected for inclusion in the ERA. Applicable legislation, concerns expressed during consultation with communities or regulatory agencies, and the potential for a VEC to interact with the Project and be affected by contaminants or noise were the main factors considered in determining which VECS to include in the ERA. Selection of VECs included both those that could be potential receptors and the VECs representing potential exposure pathways (i.e., environmental media including air, water, sediment, soil, and vegetation). TK/TU was also considered in making VEC selections for the ERA, aiding in the selection of VECs that may have ecological or cultural importance to people in the region (Section 6.2.2).

Wildlife and wildlife habitat are protected under several federal and territorial acts, including the:

- *Canadian Fisheries Act* (1985a);
- *Canadian Marine Mammal Regulations* (1993a);
- *Canadian Migratory Birds Convention Act* (1994);
- *Canadian Species at Risk Act* (2002);
- *Canadian Wildlife Act* (1985b);
- *Nunavut Wildlife Act* (2003); and
- *Nunavut Land Claims Agreement* (1993b).

Consultation with communities and regulators has been ongoing and comments received up to February 2013 were considered in scoping of the VECs for the ERA. The potential for a VEC to interact with the project was determined based on the VEC scoping exercise for the DEIS (Volume 8, Section 2.3.1).

The VECs from the DEIS (listed in Section 6.3.1.1) were sorted based on whether or not they were potential pathways or receptors in the ERA. The following VECS were considered to be potential pathways for exposure and were included in the ERA as pathway VECs:

- air quality;
- marine and freshwater quality;
- marine and freshwater sediment quality;
- soil (subject of note);
- vegetation; and
- noise.

Table 6.4-1 summarizes the VECs that were considered in the ERA to be potential receptors for either contaminant or noise exposure. The VECs that were not included as receptors or pathways in the ERA are summarized in Table 6.4-2.

Table 6.4-1. Valued Ecosystem Components Included as Receptors in the Environmental Risk Assessment

Subject Area	Valued Ecosystem Component	Consultation with Communities[1] and TK Information[2]	Consultations with Regulatory Agencies[3] and Regulatory Considerations[4]	Potential Impacts
Freshwater Environment	Fish/aquatic habitat (benthic invertebrates)	Moderate to significant comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of water or sediment quality, noise.
	Fish community: Arctic grayling	Moderate to significant comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of water quality, noise.
	Fish community: Lake trout	Moderate to significant comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of water quality, noise.
Marine Environment	Fish/aquatic habitat (benthic invertebrates)	Few or no comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of water or sediment quality, noise.
	Fish community: Arctic char	Few or no comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of water quality, noise.
	Seabirds/seaducks	Few or no comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Lethal or sublethal effects due to degradation of environmental media quality, noise.
	Ringed seals	Few or no comments expressed.	Moderate to significant comments expressed. Moderate regulatory considerations.	Lethal or sublethal effects due to degradation of environmental media quality, noise.
Terrestrial Environment	Caribou	Moderate to significant comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.
	Muskox	Moderate to significant comments expressed.	Moderate to significant comments expressed. Moderate regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.
	Wolverine/Furbearers	Moderate to significant comments expressed.	Moderate to significant comments expressed. Moderate regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.
	Grizzly bears	Moderate to significant comments expressed.	Few or no comments expressed by regulatory agencies. Moderate regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.
	Migratory Birds	Few or no comments expressed.	Moderate to significant comments expressed. Significant regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.
	Raptors	Few or no comments expressed.	Moderate to significant comments expressed. Moderate regulatory considerations.	Direct mortality, sublethal effects due to degradation of environmental media quality, noise.

Notes:

[1] *Community consultation information reflects information from Back River Project consultations up to February 2013.*

[2] *TK Information refers to the contents of KIA (2012).*

[3] *Regulatory agency comments reflect 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.*

Table 6.4-2. Valued Ecosystem Components Excluded as Receptors in the Environmental Risk Assessment

Subject Area	Valued Ecosystem Component	Rationale for Exclusion
Atmospheric Environment	Meteorology and climate (subject of note)	Few or no comments expressed in consultation with communities and regulatory agencies. Low regulatory considerations and TK information. Unlikely to be affected by contaminants or noise.
Freshwater Environment	Hydrology	Few or no comments expressed in consultation with communities. Low TK information, significant regulatory considerations. Unlikely to be affected by contaminants or noise.
	Groundwater (subject of note)	Few or no comments expressed by regulatory agencies and low regulatory considerations. Unlikely to be affected by contaminants or noise.
	Limnology and bathymetry (subject of note)	Few or no comments expressed by regulatory agencies and low regulatory considerations. Unlikely to be affected by contaminants or noise.
Marine Environment	Physical processes (subject of note)	Few or no comments expressed in consultation with communities and TK information. Unlikely to be affected by contaminants or noise.
Terrestrial Environment	Geology (subject of note)	Few or no comments expressed in consultation with communities and TK information. Regulatory agencies expressed few or no comments and low regulatory considerations. Not likely to be affected by contaminants or noise.
	Landforms (subject of note)	Few or no comments expressed in consultation with communities and TK information. Unlikely to be affected by contaminants or noise.
	Permafrost (subject of note)	Few or no comments expressed in consultation with communities and TK information. Unlikely to be affected by contaminants or noise.

Humans were considered to be the only receptors for the HHRA. Therefore, the VECs or VSECs included in the HHRA as potential pathways to affect human health were:

- air quality;
- water quality (in the context of drinking water);
- country foods consumption (which included consideration of water, soil, and vegetation quality); and
- noise.

6.4.1.3 Spatial Boundaries

Spatial boundaries were defined for each assessment VEC and are described in chapters for individual VECs in Volumes 4 to 7, along with a rationale describing how the boundaries were delineated. The following general criteria were used to determine the spatial boundaries:

- the physical or socio-economic extent of Project activities and potential Project effects;
- the location and distribution of VECs, including the spatial extent of ecosystems and protected areas potentially affected by the Project; and

- the spatial extent of the known current use of lands and resources for traditional purposes.

Four general spatial boundaries were used in the risk assessment:

1. Project Footprint — includes all physical structures and activities that comprise the Project as specified in the Project Description (Volume 1, Chapter 3).
2. Potential Development Area (PDA) — includes the Project Footprint, plus a buffer area.
3. LSA — the area where there is a reasonable expectation of immediate impacts from the Project activities on valued environmental and socio-economic components. The LSA includes the PDA plus a buffer.
4. RSA — a broader area where there is a potential for direct, indirect, or cumulative environmental or socio-economic impacts and includes lands, waters, and potentially affected communities in the Nunavut Settlement Area (NSA).

The LSA for each VEC was selected as the initial spatial boundary for assessment in the ERA. After conducting the ERA, if it was determined that potential effects extended beyond the LSA then the assessment of potential risks would be extended to the RSA.

6.4.1.3.1 Atmospheric Environment

The air quality VEC was included in the ERA as an environmental exposure pathway and the atmospheric LSA/RSA map for this VEC is shown in Figure 6.4-1 and in Volume 4, Figure 1.4-1.

6.4.1.3.2 Freshwater Environment

Freshwater quality and sediment quality VECs were included in the ERA as environmental pathways and their LSA and RSA are shown in Volume 6, Figure 4.4-1. Other VECs in the freshwater ERA included fish/aquatic habitat (benthic invertebrates) and fish community (Arctic Grayling and Lake Trout). Maps showing the LSA and RSA for each VEC are found in Volume 6, Figures 6.4-1 (fish/aquatic habitat) and 7.4-1 (fish species).

Figure 6.4-2 illustrates the freshwater environment LSA and RSA that was used by all VECs within this environment.

6.4.1.3.3 Marine Environment

Marine water quality and sediment quality VECs were included in the ERA as environmental pathways and their LSA/RSA maps are shown in Volume 7, Figures 2.4-1 and 3.4-1, respectively. Other VECs in the marine environment ERA included fish/aquatic habitat, fish community (Arctic Char), seabirds/seaducks, and ringed seals. Maps showing the LSA and RSA for each VEC are found in Volume 7, Figures 4.4-1 (fish/aquatic habitat), 5.4-1 (Arctic Char), 6.4-1 (seabirds/ducks), and 7.4-1 (ringed seals).

Figure 6.4-3 provides the marine environment LSA and RSA that was used by all VECs within this environment.

6.4.1.3.4 Terrestrial Environment

Soil quality (subject of note) was included in the ERA as environmental pathway. Other VECs in the terrestrial environment ERA include caribou, grizzly bears, muskox, wolverine and furbearers, migratory birds, and raptors. Maps showing the LSA and RSA for each VEC are found in Volume 5, Figures 5.4-1 (caribou), 6.4-1 (grizzly bear), 7.4-1 (muskox), 8.4-1 (wolverine and furbearers), 9.4-1 (migratory birds), and 10.4-1 (raptors).

Figure 6.4-4 provides the terrestrial environment LSA and RSA that was used by all VECs within this environment.

6.4.1.4 Temporal Boundaries

Temporal boundaries were defined based on the duration of each Project phase. Temporal boundaries were defined in relation to planned activities over the lifetime of the Project within which a reasonable expectation of interaction with environmental receptors can be predicted. These temporal boundaries were used unless otherwise noted; any adjustments would have been made, as appropriate, to reflect seasonal variations or life-cycle requirements of biological receptors. Temporal boundaries were with the Project phases as follows:

- Site Preparation — 2 years;
- Construction phase — 2 years;
- Operational phase — 10 years;
- Reclamation and Closure phase — 10 years;
- Post-closure phase — 5 years;
- Other potential phases:
  - Temporary Closure — less than 2 years; and
  - Care and Maintenance phase — 2 to 10 years.

There are two main pathways for contaminants to enter the environment: airborne emissions (e.g., dust, particulates, and gases) and liquid emissions (e.g., effluent discharge). For the purposes of the ERA and based on the information available at the time of writing, the phase or phases in which the greatest potential for effects to environmental receptors was selected for assessment, with consideration of the potential for both air and water emissions during those phases. This was done to represent the upper bound of expected Project-related changes and therefore represents the phase or phases associated with the greatest level of risk; risk during other phases would be expected to be lower. Selection of Project phases for assessment and the rational for their selection is described in the following sections.

6.4.1.4.1 Freshwater Environment

For the VECs in the freshwater environment (water, sediment, fish/aquatic habitat, and fish), the Operational phase was selected for assessment. Although there will be no discharge of effluent to the aquatic environment from the TIA during this phase, the potential for fugitive dust emissions are highest during the Operational phase. Contaminants can be carried from sources to receptors by fugitive dust, which can be then deposited on surface waters as dustfall. Therefore, the Operational phase represents the upper bound or worst-case for potential water quality effects due to dust deposition (i.e., air emissions).

6.4.1.4.2 Marine Environment

For the VECs in the marine environment, the Site Preparation and Construction phases were assessed in the ERA. This is because activity at the MLA is expected to be highest during these phases, with the potential for fuel storage and a camp of up to 100 people present in the MLA during these phases. Shipping levels would also be at their highest during this phase with approximately five to ten ships per year (or equivalent barges). During the Operational phase, continued fuel storage and shipping (to a lesser extent with approximately three to five ships per year) may occur, but fewer people would be present at the MLA.

PROJECT # 0194096-0040 GIS # BAC-04-023 December 17 2013

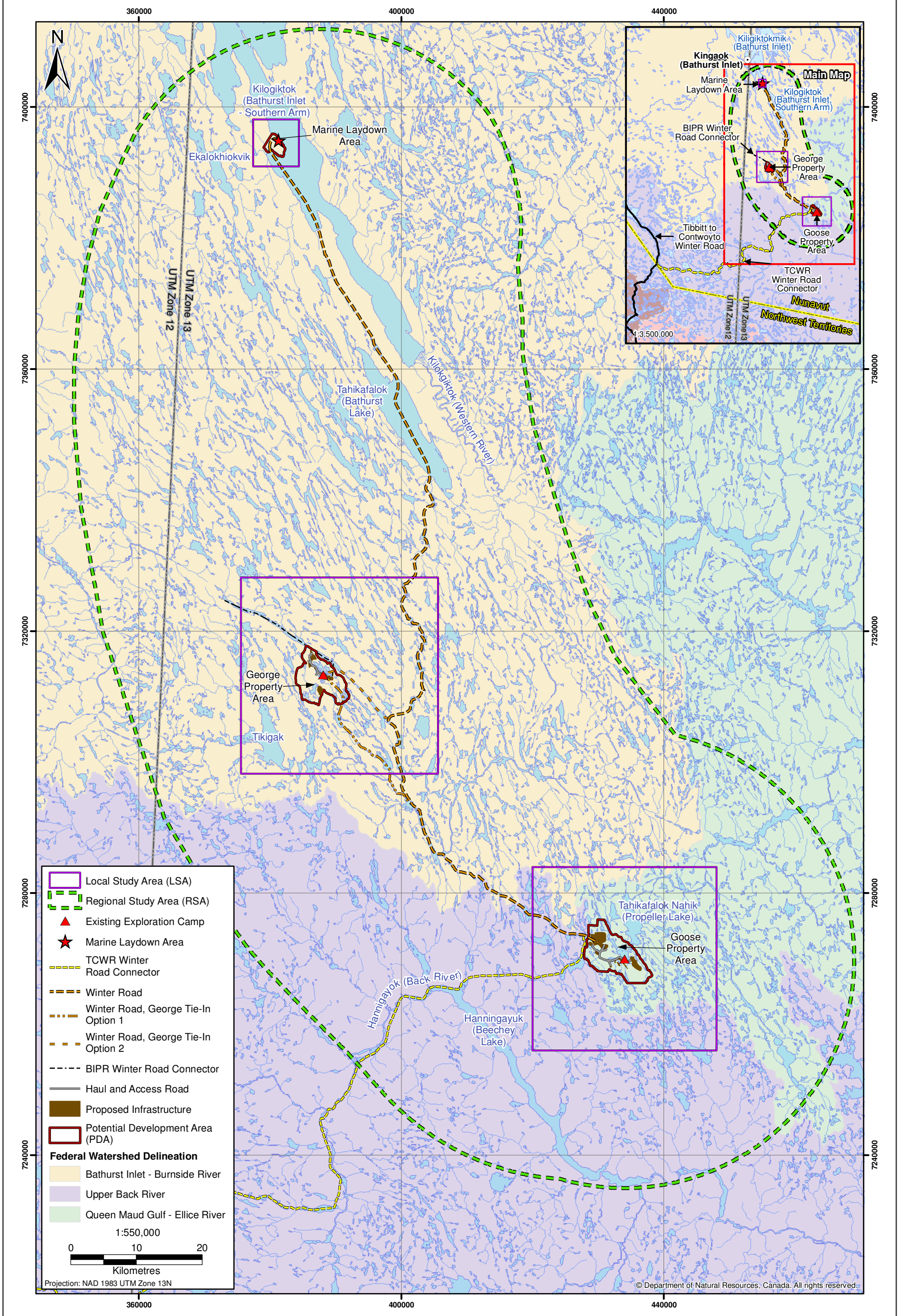


Figure 6.4-1

Sabina GOLD & SILVER CORP.

Atmospheric Environment Local and Regional Study Areas

Figure 6.4-1

Rescan an ERM company

PROJECT #0194096-0040 GIS # BAC-04-024 December 17 2013

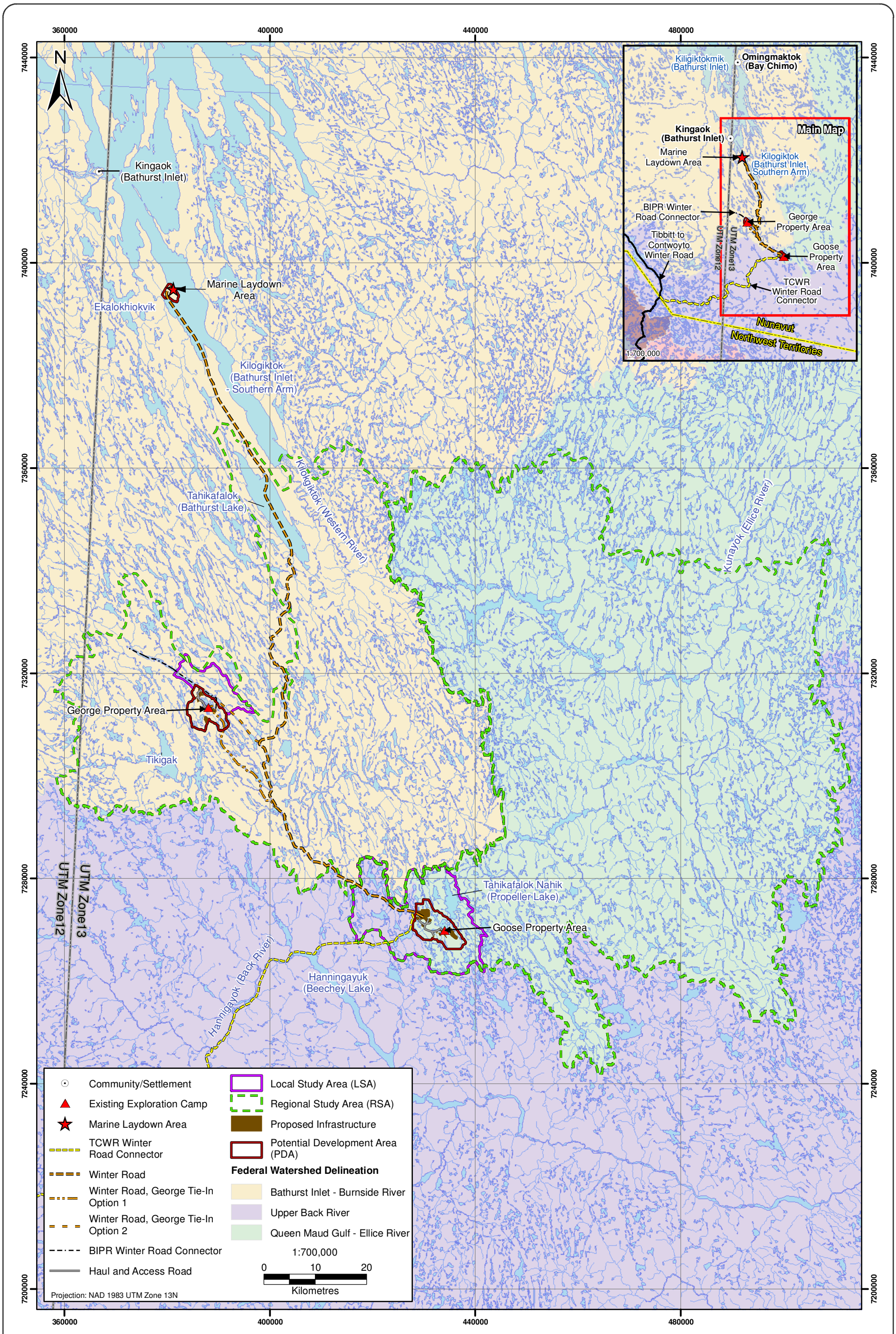


Figure 6.4-2

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Freshwater Environment Local and Regional Study Areas

Figure 6.4-2

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-04-025 September 17 2013

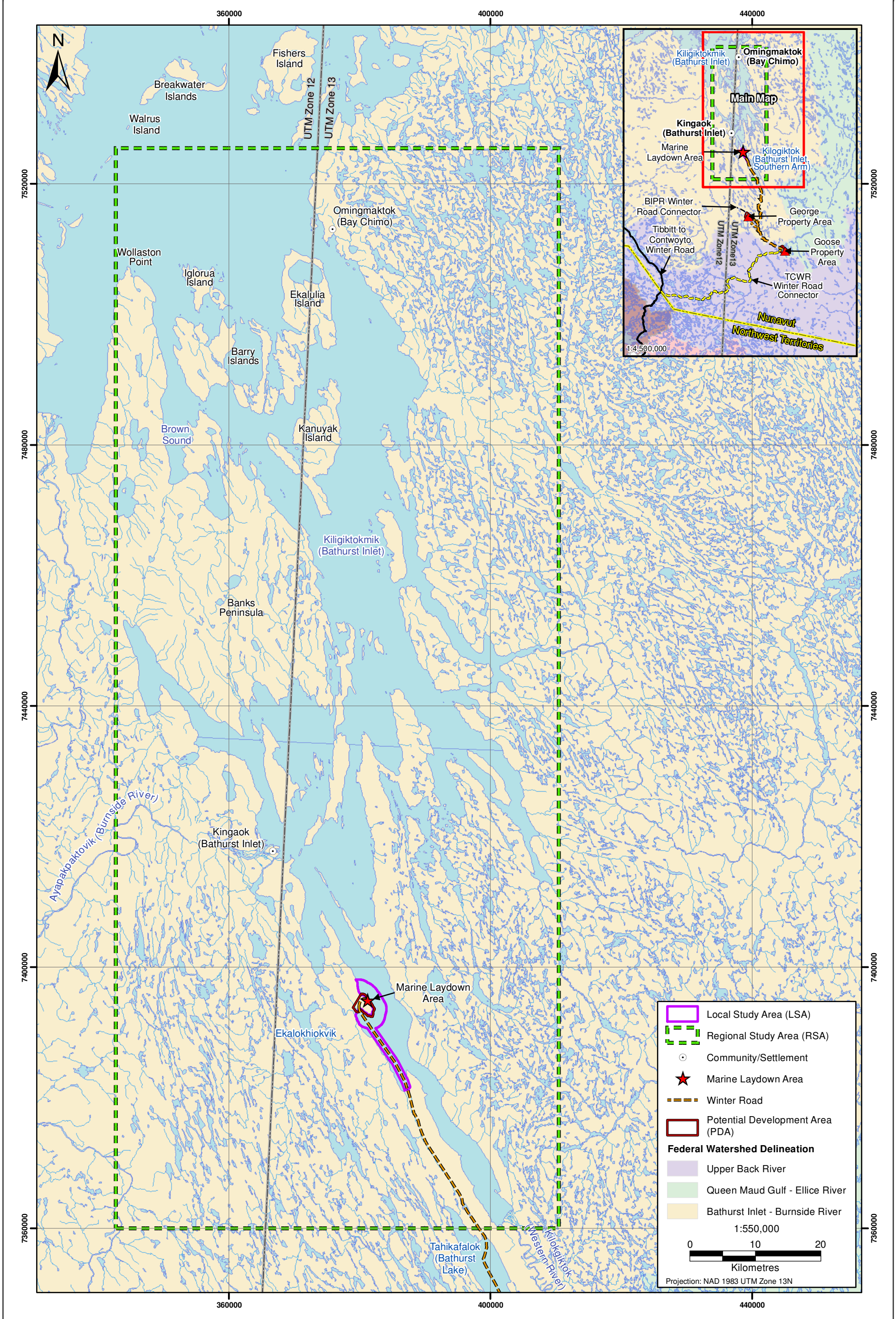


Figure 6.4-3

Sabina GOLD & SILVER CORP.

Marine Environment Local and Regional Study Areas

Figure 6.4-3

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-04-026 December 17 2013

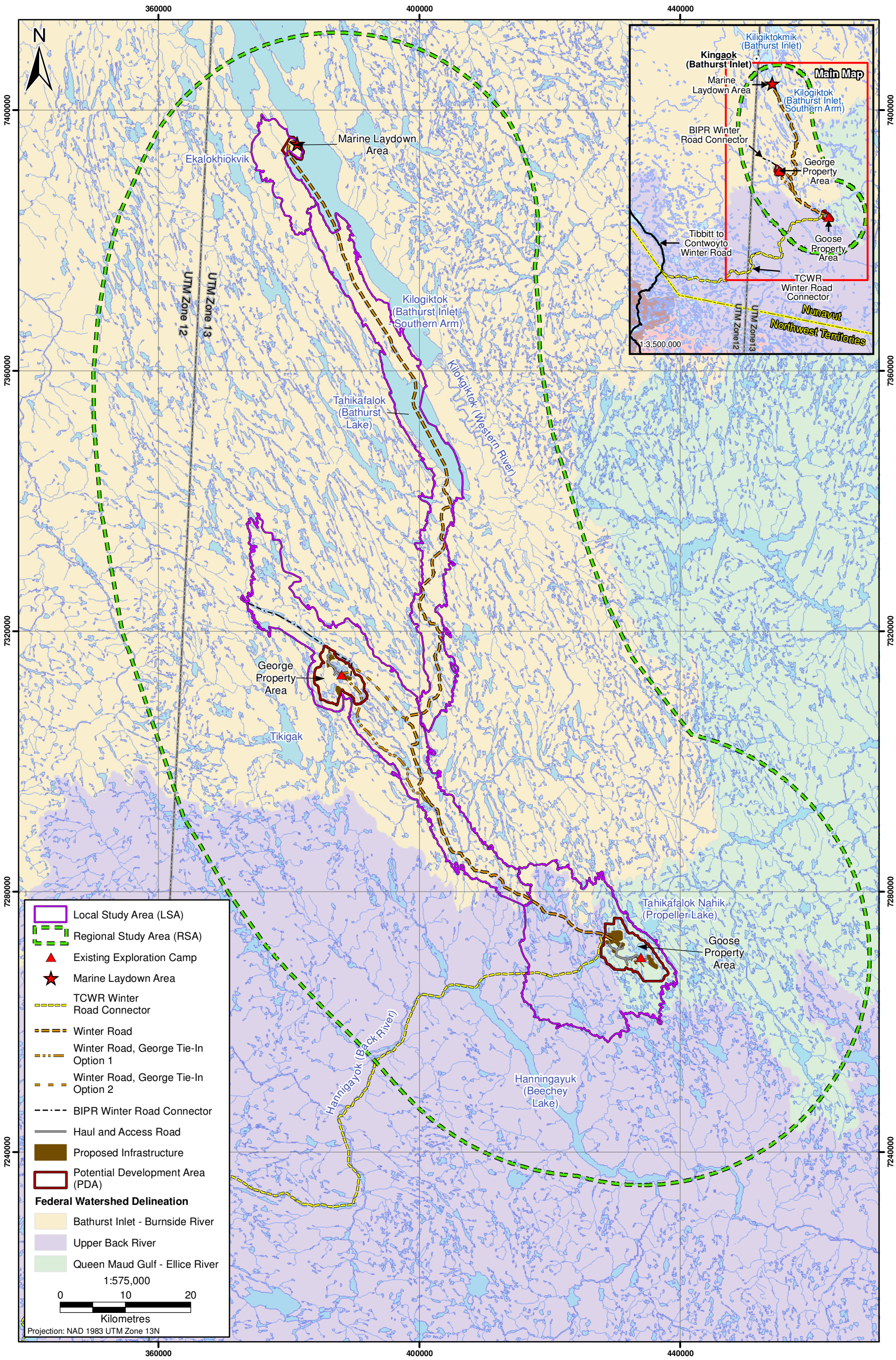


Figure 6.4-4

Sabina GOLD & SILVER CORP.

Terrestrial Environment Local and Regional Study Areas

Figure 6.4-4

Rescan an ERM company

6.4.1.4.3 Terrestrial Environment

For VECs in the terrestrial environment, the Operational phase was selected for assessment in the ERA. This is because the Operational phase is expected to be of the longest duration in which a relatively high level of activity is planned to occur. The greatest number of potential pathways and contaminant sources to the terrestrial environment is likely to occur during this phase (see Section 6.4.1.5 for further discussion of pathways and contaminant sources). The Operational phase is when there is the most potential for impact from fugitive dust emissions and dust deposition, which is likely to be the most significant pathway for COPC exposure from Project-related activities for terrestrial VECs.

6.4.1.5 Mitigation Measures

No additional mitigation measures were considered in the assessment beyond what was outlined in previous volumes and chapters. For the purposes of the ERA, mitigation measures and management strategies outlined in the individual chapters and management plans were considered to have been implemented and performing successfully in minimizing/eliminating potential effects.

Mitigation measures for noise and air quality were described in Volume 4. The Air Quality Monitoring and Management Plan and the Noise Abatement Plan can be found in Volume 10, Chapters 17 and 18, respectively.

Mitigation measures for the terrestrial environment were described in Volume 5. The Wildlife Mitigation and Monitoring Plan can be found in Volume 10, Chapters 20.

Mitigation measures for freshwater were covered in Volume 6. Mitigation measures for the marine environment were covered in Volume 7. The Aquatic Effects Management Plan, which addresses both freshwater and marine environments, can be found in Volume 10, Chapters 19.

6.4.1.5.1 Mitigation Measures for Non-metal Contaminants of Potential Concern

Certain atmospheric emissions from the Project were excluded from consideration as COPCs. These include volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins, and furans. Although dioxins and furans may be deposited on the surrounding landscape and enter the local food web from soil, water, and vegetation, use of controlled incineration technology is predicted to substantially reduce the potential contamination exposures (Webster and Mackay 2007). An Incineration Management Plan (Volume 10, Chapter 11) will be in place during all phases of the Project in order to minimize emissions from incineration activities. This plan will include the installation of an incinerator that complies with Nunavut standards (Government of Nunavut 2002) and the Canada-Wide Standards for Dioxins and Furans (CCME 2000a) and Canada-Wide Standards for Mercury emissions (CCME 2000b). An Air Quality Monitoring and Management Plan (Chapter 17, Volume 10) will also be implemented. Due to mitigation, such as installing modern incineration equipment, and regular maintaining vehicle, generator, and incinerator emission controls, Project-related PAH releases to the environment are unlikely to be at high enough concentrations to affect human health (Volume 6, Chapter 4). VOCs were not included in the assessment because standards or objectives for ambient VOC concentrations have yet to be established for Nunavut and Canada and emission levels from the Project are expected to be minimal.

Fuels, other petroleum products (e.g., oils), and hazardous substances stored and used during Project development inside the LSA will require mitigation and management measures to ensure that they do not enter the freshwater, marine, and terrestrial environments. The Fuel Management Plan (Chapter 4), Spill Contingency Plan (Chapter 5), Oil Pollution Emergency Plan (Chapter 6), Mine Waste Rock and Tailings Management Plan (Chapter 9), Landfill and Waste Management Plan (Chapter 10),

Hazardous Materials Management Plan (Chapter 12), Explosives Management Plan (Chapter 13), and Shipping Management Plan (Chapter 15) can be found in Volume 10. Proper storage, handling, and clean-up of any spills of fuels/petroleum products and potentially hazardous substances will reduce the potential for these products to affect ecological receptors. Details of a few of the key mitigation strategies are listed here as follows:

- bulk fuel storage areas, hazardous materials storage areas, and explosives storage facilities will be bermed and lined with impermeable barriers to minimize the potential for leaks and spills to reach the aquatic environment, thereby minimizing the potential for these chemicals or fuels to affect the ecological receptors;
- cyanide destruction will occur in the mill, in order to decrease the levels of cyanide that may be found in the TIA;
- petroleum product storage tanks will have appropriate secondary containment systems to prevent hydrocarbon/fuel release to the environment;
- refuelling and maintenance activities will be done at least 30 m away from water (except in case of equipment breakdown or approved activities near water) and refuelling will be done only when drainage capture/collection is installed or drip trays are in use;
- all machinery that has the potential to have a fluid release or leak will be inspected prior to each shift and repaired as necessary, and oily water treatment plants at equipment maintenance facilities will be used to minimize the introduction of hydrocarbon contaminants into the environment, minimizing their potential for uptake by aquatic organisms;
- an Aquatic Effects Management Plan (Volume 10, Chapter 19) will be implemented to monitor for changes in the aquatic environment as a result of Project activities; and
- if water or waste could pose a risk to wildlife, appropriate measures will be taken to exclude wildlife from these areas (e.g., fencing and noise makers; Wildlife Management Plan, Volume 10, Chapter 20).

In addition, other hazardous substances such as hydraulic fluid, explosives, laboratory chemicals and solvents, lead acid batteries, and oil filters may be present during various Project phases. Safe handling and storage of hazardous materials is governed by the Hazardous Materials Management Plan (Volume 10, Chapter 12) and therefore these materials are not expected to pose a risk to the health of wildlife, fish and aquatic habitat, or fish community VECs.

Accidental releases of fuels, other petroleum products, and hazardous substances will be responded to efficiently and safely as described in the Spill Contingency Plans (Volume 10, Chapter 5). In particular, the following key spill mitigation measures will minimize and prevent exposure of ecological receptors:

- ships used in the transport of fuel will be conventional double-hulled, compartmentalized petroleum tankers, with Shipboard Oil Pollution Emergency Plans and appropriate response gear;
- the bulk fuel storage facility, pipeline, and all transfer-related equipment will be inspected and maintained in order to minimize the potential for fuel leaks or spills to the aquatic and terrestrial environments;
- an Oil Pollution Emergency Plan (Volume 10, Chapter 6) will be implemented, including the measures to be used to contain and clean up a potential spill of oil in the marine and freshwater environments; and

- ship and MLA spill response equipment and personnel will be prepared for deployment prior to fuel transfer operations, to ensure a rapid response in the event of a spill to the marine environment, and transfer hoses/pipeline will be monitored hourly for leaks or defects during fuel transfers.

Because spills will be contained and cleaned up according to the Oil Pollution Emergency Plan (Volume 10, Chapter 6), the effects of fuel, lubricants, and other COPCs on marine and freshwater aquatic VECs (fish, seabirds, and marine mammals) will be low.

In addition, in the marine environment, shipping will be limited to five to ten ships per year during the Construction phase and three to five ships per year during the Operational phase. Ships will not be permitted to discharge untreated sewage or oil-containing bilge water in the vicinity of the MLA, in accordance with the Vessel Pollution and Dangerous Chemicals Regulation (2001). The use of organotin anti-fouling compounds is prohibited for vessels in Canadian waters and will not be used by vessels servicing the Project. This will minimize the potential for release of contaminants to the marine environment within the LSA and will, therefore, minimize effects to marine water and sediments. Therefore, the sources of oils, fuels, and other hazardous chemicals and potential effects to ecological health from the exposure to these chemicals are considered negligible and will not be considered further in the ERA.

6.4.1.6 Identification of Disease Vectors

A zoonotic disease is an infectious disease that has the ability to be transmitted between species (sometimes by a vector) from non-human animals to humans, or from humans to other animals. A disease vector is a biological agent (e.g., person, animal, or microorganism) that has the ability to carry and transmit infectious diseases to other living hosts. Vectors such as arthropods (e.g., mites, ticks, lice, fleas, mosquitoes, and flies) and wildlife (e.g., bats, raccoons, and rodents) can transmit harmful diseases to humans.

Zoonotic diseases can be considered contaminants if (Leighton 2003):

- they are introduced into an ecosystem for the first time by humans;
- human activity causes them to concentrate in specific areas;
- human activities alter the ecosystem in a way that changes the occurrence of diseases due to changes in relationships between pathogens and their hosts; or
- genetic engineering technology results in the creation of new man-made pathogen strains.

Several zoonotic diseases occur in Arctic host species, such as trichinella in walrus and polar bear and cryptosporidium in marine and terrestrial mammals (NRCan 2009). However, information is lacking on the specific hosts and modes of transmission in the Arctic environment and the situation is changing rapidly due to climate change as there is a link between zoonotic diseases and temperature (NRCan 2009). Environmental temperatures greatly affect vectors with developmental stages that occur outside a warm blooded host, for example the developmental rate of insects and nematodes are limited by cooler northern climates (Bradley et al. 2005). Two important diseases in Canada (Lyme disease spread by ticks, and West Nile virus spread by mosquitoes and wild birds) have not been detected in the Arctic due to cold temperatures (Leighton 2011). However, this distribution range may change as temperatures in the north increase. For people residing in Nunavut, zoonotic disease transmission via wildlife is likely the predominant method of exposure.

Zoonotic diseases present in the Arctic include: *Trichinella*, *Anisakis*, *Diphyllobothrium*, *Echinococcus*, and *Toxoplasma*, and potentially *Cryptosporidium* and *Giardia* (Polley, Hoberg, and Kutz 2010).

Additionally, the Artic fox is a carrier for some strains of rabies, while Brucellosis is caused by the bacterial genus *Brucella* and can be transmitted from animals (e.g., bison, caribou, fox, bears, ringed seals, and beluga whales) to people upon contact or consumption (Leighton 2011). However, the ecology of *Brucella* in caribou and marine mammals is too poorly understood to enable identification of current trends or predict future trends (Leighton 2011). Each one of these zoonotic diseases can result in obvious clinical disease in humans; however, infected people do not always display clinical symptoms. A list of potential zoonotic diseases in Nunavut and their wildlife vectors is presented in Table 6.4-3.

Table 6.4-3. Potential Zoonotic Diseases in Nunavut and Their Vectors

Disease	Disease Type	Vector
Anthrax (*Bacillus anthracis*)	Bacteria	Bison, cervids
Broad fish tapeworm (*Diphyllobothriasis*)	Parasite	Fish
Brucellosis (*Brucella* spp.)	Bacteria	Mammals
Cryptosporidosis (*Cryptosporidium* spp.)	Parasite	Mammals, mosquitos
Filarial worms (*Dirofilaria* spp.)	Parasite	Black flies
Giardia (*Giardia* spp.)	Parasite	Mammals, birds
Hantavirus (*Bunyaviridae*)	Virus	Rodents (e.g., mice)
Herring roundworm (*Anisakiasis simplex*)	Parasite	Fish
Hydatid Disease (*Echinococcus granulosus* and *Echinococcus multilocularis*)	Parasite	Canine (dog, wolf, coyote, fox)
Leptospirosis (*Leptospira* spp.)	Bacteria	Beaver, deer, rodents, raccoon
Plague (*Yersinia pestis*)	Bacteria	Rodents, squirrels, mink, marten, bobcat, lynx, flea
Rabies (*Rhabdoviridae*)	Virus	Bat, any mammal
Raccoon Roundworm (*Baylisascaris* spp.)	Parasite	Raccoon
Ringworm (*Microsporum canis and Trichophyton verrucosum*)	Parasite	Mammals
Sarcoptic mange (*Sarcoptes scabiei*)	Parasite	Canine (dog, wolf, coyote, fox)
Toxoplasmosis (*Toxoplasma gondii*)	Parasite	Mammals
Trichinellosis (*Trichinella spiralis*)	Parasite	Bear
Tuberculosis (*Mycobacterium bovis and Mycobacterium avium*)	Bacteria	Birds, bison, cervids
Tularemia (*Francisella tularensis*)	Bacteria	Beaver, hare, rabbit, muskrat

6.4.1.7 Problem Formulation and Pathway Analysis

The purpose of this section is to establish whether there is a reasonable possibility that there is a linkage between a Project-related source of contaminants and ecological receptors (VECs screened into the ERA in Section 6.3.2). There are two main potential sources of Project-related contaminants: atmospheric emissions of criteria air contaminants (CACs) and fugitive dust; and liquid effluent (e.g., effluent, site runoff).

Atmospheric emissions and contaminants associated with fugitive dust have the potential to enter the atmosphere, travel some distance, and settle where they can reside in different media such as marine and freshwaterbodies, marine and freshwater sediment, soil and vegetation, and prey (food chain) items. Liquid effluent has the potential to enter the terrestrial environment due to direct discharges, or enter the marine and freshwater environments (water and sediment) through runoff from the terrestrial environment.

6.4.1.7.1 Sources and Types of Potential Project-Related Contaminants

Potential Sources of Project-Related Contaminants Specific to the Atmospheric Environment

A detailed inventory of Project-related emissions sources, points of release and quantities of air contaminants released can be found in the Air Quality Modelling Report (Volume 4, Chapter 1, Appendix V4-1B or Rescan 2013i).

CACs are primarily produced by combustion of diesel and other fuels, and includes nitrogen oxides (NO_x), sulphur oxides (SO_x), ozone (O_3), and particulate matter that is less than 2.5 microns or 10 microns in size ($PM_{2.5}$, and PM_{10}, respectively). Fugitive dust is typically generated by blasting or equipment use. To summarize, sources of Project-related atmospheric contaminants considered in the air quality model included:

- stacks;
- the processing plant (including generators inside);
- the underground mines;
- generators in the pits and at camps;
- incinerators;
- equipment (such as mining and personnel trucks, drill rigs, and bulldozers in mines and on access roads);
- aircraft;
- shipping vessels; and
- dust emissions from grading and bulldozing, and explosives from drilling and blasting.

Potential Sources of Project-related Contaminants Specific to the Freshwater Environment

During the various Project phases, activities and components such as drilling, blasting, and excavation, air transportation, road use, and road maintenance can introduce fugitive dust into the air. Fugitive dust could then be deposited on surface waters, where contaminants associated with the fugitive dust (e.g., metals and blasting residues) could enter either the water or sediment.

Potential sources of effluent include the water management structures (TIA, WMF, and Collection Pond), treated effluent from sewage treatment plants at the camps, and water that has been in contact with Project infrastructure (e.g., site infrastructure, pits, underground mines, roads, etc.).

The water management facilities will collect and store effluents or run-off that may contain contaminants. Compounds used in explosives may be present in run-off from waste rock storage areas or in effluent or tailings from the mill; effluent from these areas will be collected and directed to the appropriate water management facility. Contaminants may be present in treated sewage effluent which will be discharged to the land during the Construction phase, until water management facilities are built and effluent will then be directed to these structures. Site contact water, which may contain metals or other chemicals, will be collected and directed towards the water management structures in each of the Project areas (Goose Property Area, George Property Area, and the MLA).

Water quality modelling was conducted for effluent contained within the TIA. The Water Quality Prediction Report (Volume 11) provides details on the sources, points of release, and quantities (loadings) of potential contaminants (e.g., metals and blasting residues) to the TIA.

Discharge of effluent from water management structures during the Operational phase (i.e., WMF and Collection Pond only) could introduce contaminants to the terrestrial or aquatic environments, depending on the discharge location. The intended discharge location for these facilities is to land (> 500 m from water), but it is possible that run-off from the discharge locations may make its way to surface waters over time, carrying contaminants to the aquatic environment. However, any water discharged to the environment will meet applicable water quality criteria.

Some quarries' and road runoff will go to the environment but the quantities of contaminants associated with these potential sources were considered to be negligible relative to other sources (e.g., fugitive dust from blasting and road use). Any in-water works, such as stream crossings and diversion structures will only be a source of TSS/turbidity and not COPCs.

Potential Sources of Project-related Contaminants Specific to the Marine Environment

Marine shipping during Construction and Operational phases can generate air pollutants through the combustion of diesel fuel. These air pollutants include CO, NO_x, SO_2, $PM_{2.5}$, and PM_{10}. Fugitive dust will arise from rock blasting, vehicle movement, handling of fine materials, and incineration of garbage. Generally dust will occur sporadically and be suspended for a relatively short time prior to deposition. The COPCs could then be taken up by benthic invertebrates, fish, and marine wildlife and could accumulate in the food chain.

Compounds used in explosives during construction of the MLA may be present in run-off to the marine environment. Metals occur naturally in environmental media (e.g., water, soil, sediment, and vegetation) due to local physical and geological processes, and their concentrations could potentially change due to Project activities depositing dust containing metals or due to metal leaching/acid rock drainage/metal leaching (ML/ARD).

Direct discharge of brine from the desalinization plant at the MLA into Bathurst Inlet is proposed; however, all other effluents or contact water in the MLA will be directed to the Collection Pond, and may be discharged to the tundra (> 500 m away from water). Although potential discharges may occur at some distance from the marine environment, run-off containing contaminants from the discharge location may reach the marine environment over time. Any in-water works, such as marine jetty/barge facilities may be a source of TSS/turbidity but not of COPCs.

Potential Sources of Project-related Contaminants Specific to the Terrestrial Environment

Fugitive dust will arise from rock blasting, vehicle movement, and handling of fine materials. Generally dust will occur sporadically and be suspended for a relatively short time prior to deposition. Dust particles can be a carrier of metals naturally occurring in rocks and can deposit onto soils and vegetation. The COPCs could then be taken up by terrestrial wildlife and could accumulate in the food chain.

Discharge of effluent from water management structures during the Operational phase (WMF and Collection Pond only) could introduce contaminants to the terrestrial environment (> 500 m from water), where soil and vegetation may take up COPCs. The COPCs could then be taken up by terrestrial wildlife and could accumulate in the food chain.

6.4.1.7.2 Potential Receptor Exposure Routes

Receptor exposure routes are pathways through which a receptor could be exposed to a COPC. The exposure routes that may exist between contaminants and ecological receptors will depend upon many factors and may be direct, indirect, or both.

Ingestion

Aquatic and terrestrial receptors could be exposed to COPCs directly by ingesting water and sediment. In addition, COPCs could be taken up indirectly through the food chain by ingesting prey items, as discussed in the following paragraphs.

In the aquatic environment, if the concentration of COPCs in either water or sediment changes as a result of Project activities, there is potential for those COPCs to enter the food chain and affect the health of organisms at progressively higher trophic levels. The aquatic VECs of fish/aquatic habitat (i.e., benthic invertebrates) could take up COPCs by consuming primary producers containing COPCs or incidental consumption of sediment particles. Any COPCs incorporated into the biomass of primary producers and benthic invertebrates would be available for ingestion by fish community VECs (Arctic Grayling and Lake Trout). Similarly, marine mammals (e.g., ringed seals) or piscivorous seabirds may be exposed to COPCs through the food chain by consuming fish containing COPCs.

Terrestrial VECs (wildlife, migratory birds, and raptors) ingest freshwater, food, and (in some cases) soil. Some soil may be ingested either incidentally (soil attached to plant roots) or because some birds' gizzards require small pebbles for digestion. Herbivorous and omnivorous VECs (e.g., caribou, muskox, wolverine and furbearers, grizzly bears, and migratory birds) could be exposed to COPCs when feeding on above-ground vegetation. This is because COPCs from deposition of fugitive dust could be found either on the plant surface or could have been taken up by plants from soil.

Omnivores and carnivores (wolverine and furbearers, grizzly bears, and raptors) derive their energy and nutritional requirements from a diet consisting mainly or exclusively of animal tissue through either predation or scavenging. Therefore, they can be exposed to COPCs via the food chain (i.e., transfer of COPCs taken up by lower trophic level organisms to higher trophic level organisms).

Gill Uptake

Gill uptake refers to the uptake of COPCs by fish and some benthic invertebrates (i.e., molluscs) through the epithelium of the gills or other respiratory surfaces. Gills are not solely involved in dissolved oxygen and carbon dioxide exchange, but are also important organs for ion- and osmoregulation. In some invertebrate organisms, gills are solely used for feeding, while in other organisms they can be used for both feeding and oxygen uptake. Subsequently, COPCs may accumulate in fish and invertebrate VECs, making them bio-available to other animals in the food chain. Because gill uptake of COPCs can contribute significantly to the overall exposure to COPCs in fish and benthic invertebrate VECs, gill uptake was included in the ERA as a potential exposure route.

Dermal Contact

Dermal contact is defined as the uptake of COPCs through the skin when an organism is in direct contact with the exposure medium (e.g., water, soil, or sediment). The dermal contact exposure route was included for aquatic VECs, where benthic invertebrates have a large surface area to volume ratio and are embedded in sediments and water. Therefore, the dermal exposure route may be a significant portion of benthic invertebrates' COPC exposures and was included in the assessment for the aquatic (freshwater or marine) environment.

Receptor Exposure Routes Considered Negligible

Wildlife exposure to contaminants via inhalation and dermal contact are not pathways usually assessed in ERAs. Wildlife toxicity reference values for inhalation and dermal pathways are unavailable, plus the ingestion pathway is expected to be a much larger contributor to exposure, while inhalation and dermal exposures are expected to be very small contributors (Sample et al. 1997; BC MOE 2013b). Thus

terrestrial wildlife exposure to contaminants via the inhalation and dermal contact pathways were not considered in the ERA.

6.4.1.7.3 Environmental Receptor Locations

Baseline studies provided information about where potential ecological receptors were located within the freshwater, marine, or terrestrial environment LSAs. More detailed information can be found in Section 6.1 (Existing Environment and Baseline Information) or in the chapters for each VEC.

Freshwater Environment Receptors

Lakes and ponds where fish have been confirmed to be present during baseline studies (Volume 6, Chapter 7) in the Goose and George Property Areas are shown in Figures 6.4-5 and 6.4-6, respectively. In the Goose Property Area, fish were captured in all of the sampled lakes; however, most of the shallow ponds were not fish-bearing due to their shallow depth and ephemeral connectivity to other waterbodies. Lakes in the Goose Property Area contained Lake Trout, Round Whitefish, Lake Cisco, Longnose Sucker, Ninespine Stickleback, and Lake Whitefish. Streams were inhabited by Arctic Grayling, Slimy Sculpin, and Burbot.

In the George Property Area, fair to good fish habitat was present in larger waterbodies which contain deeper water; smaller, shallow lakes and ponds had poor quality habitat for fish rearing and overwintering because they provide little cover and freeze to the bottom during winter. Five species were captured in the George Property Area: Lake Trout, Arctic Grayling, Round Whitefish, Burbot, and Slimy Sculpin. Lake Trout was the dominant species in lakes. Streams were dominated by Slimy Sculpin and Burbot, with some Arctic Grayling.

Aquatic resources, such as primary (e.g., periphyton and phytoplankton) and secondary producers (e.g., benthic invertebrates) were found in waterbodies throughout the freshwater environment LSA and were also present in waterbodies where fish were not found.

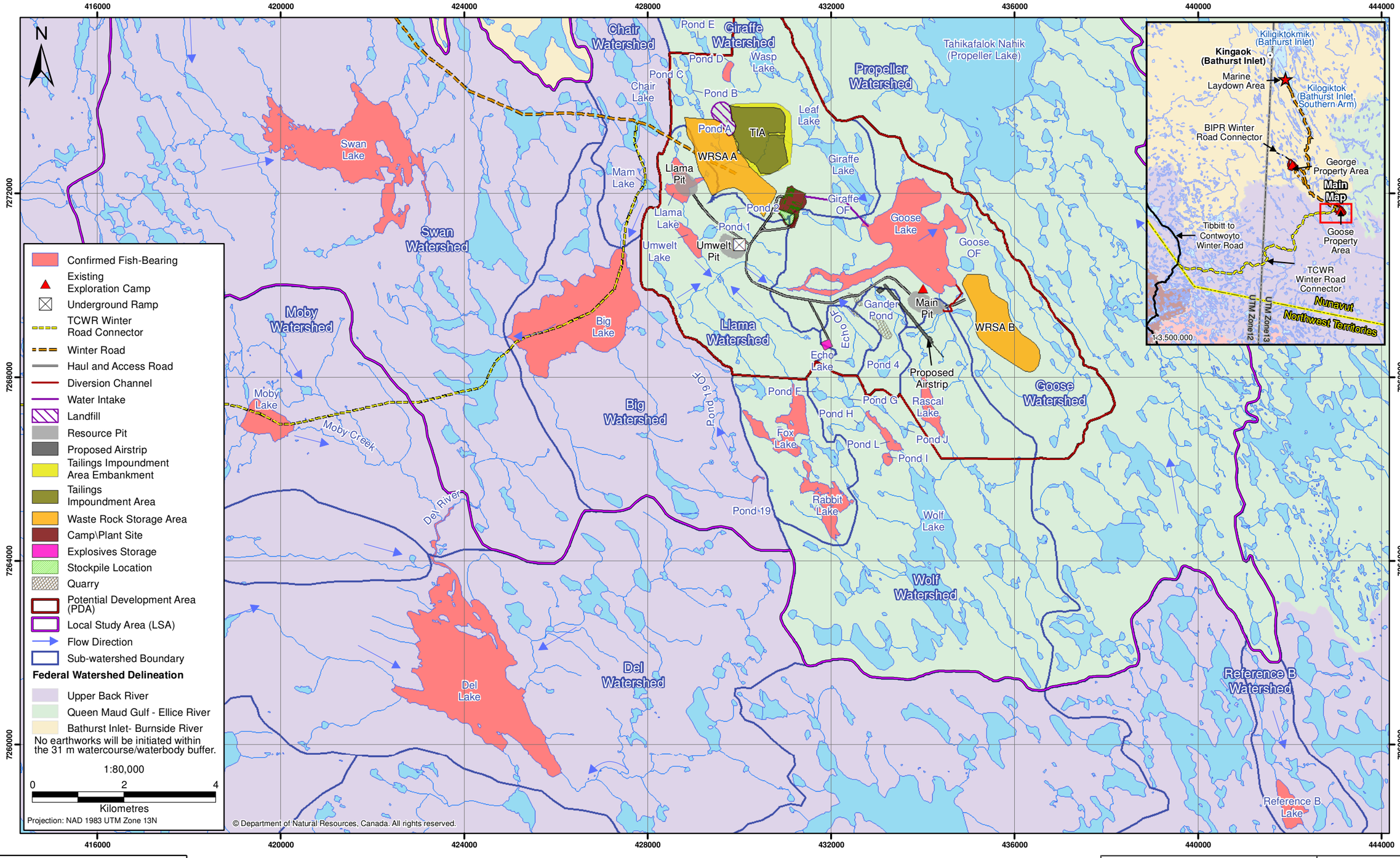
Marine Environment Receptors

Twelve fish species were captured during the baseline Bathurst Inlet fish community surveys (Volume 7, Chapter 5). The most abundant species were Fourhorn Sculpin and Capelin. Pacific Herring, Starry Flounder, Arctic Cisco, and Saffron Cod were other common species. Arctic Char migrate through the marine LSA in late summer as there is an Arctic Char bearing river at the south end of Bathurst Inlet; however, Arctic Char have never been captured in baseline studies. Capelin is only expected to be present in the marine LSA during the spawning season that runs from mid-July to mid-August. Lake Trout may stray into brackish water within the marine LSA but they are mainly a freshwater species. All the other marine fish species captured during baseline studies would be expected to be present in the marine LSA on a fairly regular basis.

Seabirds/seaducks occur in staging areas in the marine LSA for approximately one month in the spring and again for the month of August. A section of Bathurst Inlet, directly south of the proposed MLA within the marine environment LSA, is an important staging area for seabird/seaducks (reviewed in Volume 7, Chapter 6, Section 6.1; see Figure 6.1-2). The staging areas are more prevalent in the fall relative to the spring. Large flocks of geese migrate through the terrestrial RSA, especially around the Goose Property Area, which contains several large wetlands.

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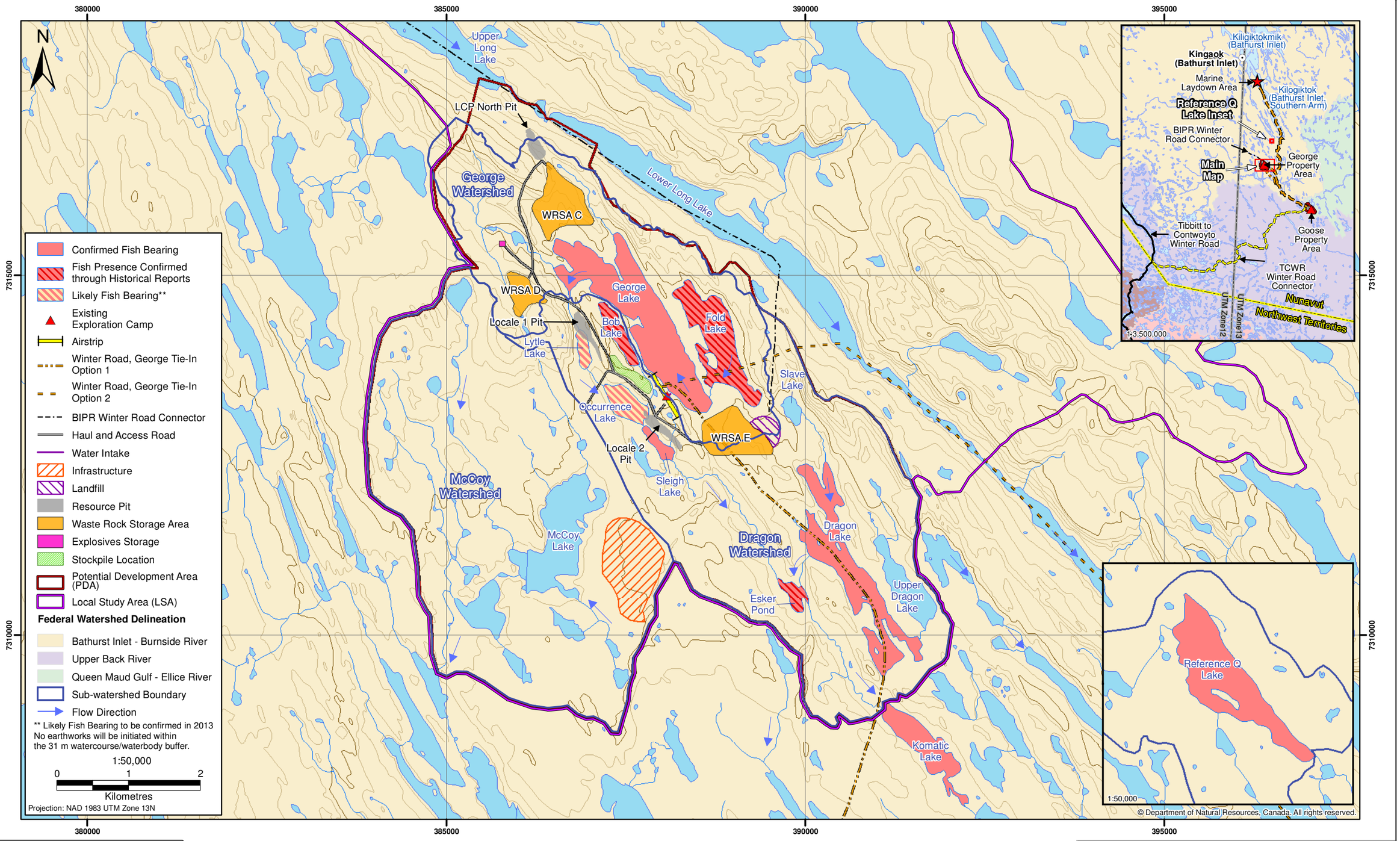


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Figure 6.4-5

Confirmed Fish-Bearing Lakes and Ponds, Goose Property Area



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Figure 6.4-6

Confirmed Fish-Bearing Lakes and Ponds, George Property Area

Ringed seals are the only marine mammals that occur in the marine LSA. They may be present year-round, although densities of ringed seals are greater from mid-March until early July during pupping and moulting periods during the ice-covered season. Ringed seals tend to disperse to other areas during the open-water season, although a few ringed seals have been observed in the marine LSA during the summer (reviewed in Volume 7, Chapter 7, Section 7.1). There is potential for the Project to alter, or disturb high quality habitat for ringed seals in the marine LSA (see Figure 7.5-1 in Volume 7, Chapter 7).

Terrestrial (Wildlife) Receptors

The wildlife VECs that could be affected by contaminants within the terrestrial environment are: caribou (Bathurst herd, Dolphin and Union herd, Beverly herd); grizzly bears; muskox; wolverine and furbearers; migratory birds; and raptors. The information below provides a summary of where these species can be found in the terrestrial LSA and RSA. Additional details of where these wildlife VECs can be found in the terrestrial LSA and RSA can be found in the existing environment section (Section 6.1.7 of this chapter), or in the individual chapters for the various wildlife species in Volume 5, Chapters 5 to 10.

CARIBOU

Three barren-ground caribou herds have been identified, whose ranges overlap the terrestrial or marine wildlife RSAs for the Project. The Bathurst herd is found in the wildlife RSA and LSA primarily during spring migration and post-calving periods, and the Beverly herd is found in the RSA and LSA, primarily during late summer and fall. The Dolphin and Union caribou herd, which overwinters on the coastal mainland of Nunavut, may overlap with portions of the marine RSA to a very small extent during the winter but are typically not found within the marine LSA and do not occur in the terrestrial wildlife LSA or RSA.

Bathurst caribou overwinter in the boreal forest and move relatively quickly to calving grounds to the northwest of the RSA. Post-calving, some of the females and calves will cross into the western portion of the RSA and may be found in the terrestrial LSA from mid-June to mid-July (Volume 5, Chapter 5, Section 5.1.2.2 and 5.1.2.5). Throughout the rest of the summer and during fall, Bathurst caribou likely do not occur within the terrestrial LSA as they move to areas west and south of the Project area.

Beverly caribou overwinter in the boreal forest and move relatively quickly to calving grounds to the northeast of the RSA. The Beverly herd may travel through the LSA in a northerly direction during spring migration, although collaring data indicate this herd generally travels east of the RSA during the spring migration to the calving grounds (Chapter 5, Volume 5, Section 5.1.3.2 and 5.1.3.5). The Beverly caribou may also overlap with the marine LSA during this period. During post-calving, females and calves remain in the Queen Maud Gulf Migratory Bird Sanctuary east of the RSA. During the summer and into the fall (mid-July to end of October), Beverly caribou occur in the terrestrial LSA and RSA particularly around the southern half of the RSA before migrating south towards the treeline.

The Dolphin and Union herd can occur in the marine RSA during the winter but are generally not found within the marine LSA or the terrestrial wildlife LSA or RSA. Thus, their range does not overlap with the Goose and George Property Areas (Volume 5, Chapter 5, Section 5.1.4.2).

MUSKOX

Muskox travel in herds and have relatively small seasonal home ranges, but sometimes can migrate distances of up to 140 km between summer and winter ranges (Reynolds 1998; Gunn and Fournier 2000). Muskox have been observed within 2 km of George Camp, and near Project infrastructure sites at Goose Property in 2013 (Volume 5, Chapter 7, Section 7.1.5.1). In addition, since 18% of the terrestrial LSA (and 13% of the RSA) contains high-quality summer habitat, muskox may be found in the

terrestrial LSA during this period (Volume 5, Chapter 7, Figure 7.1-2). During the winter months, only 4% of the terrestrial LSA (and 6% of the RSA) contains high-quality winter habitat (Volume 5, Chapter 7, Figure 7.1-3); however, muskox are relatively sedentary in winter, moving on average 1 to 1.5 km/day, therefore may occur in the terrestrial LSA.

Grizzly Bear

Grizzly bears have been observed in the terrestrial LSA and RSA between late-April and end of August but they can occur in the LSA/RSA between late-April to October; during the rest of the year they are hibernating in dens (Volume 5, Chapter 6, Section 6.1.4). There have been no bear observations inside the George or Goose PDAs during baseline studies conducted in the RSA, and only one grizzly bear has been observed in the MLA PDA. The results of the grizzly bear habitat suitability mapping are similar between the LSA and RSA for all seasons and suitability ranks. Within the terrestrial LSA, less than 1% of the habitat was rated as high-quality denning habitat for grizzly bear (Volume 5, Chapter 6, Figure 6.1-8). Although the area of high-quality spring habitat (2%), summer habitat (9%), and fall habitat (5%) are low within the terrestrial LSA, grizzly bear home ranges are very large. Thus, they may occur in the terrestrial LSA during these seasons (Volume 5, Chapter 6, Section 6.1.5.2, and Figures 6.1-1 to 6.4-1).

Wolverine and Furbearers

Wolverines can be found in the terrestrial LSA during the entire year (Volume 5, Chapter 8). Two active wolverine den sites were located in the terrestrial LSA during baseline studies conducted in the RSA (Volume 5, Chapter 8, Section 8.1.5.2, Figure 8.1-5). One of these dens was located near the Goose Property Area in 2012 within 1 km of proposed site infrastructure; the other was located approximately 2 km away from the Goose Camp. Both dens were found in rocky boulder areas. The results of the wolverine habitat suitability mapping for the denning period are similar between the LSA and RSA, with approximately 46% of the habitat classified as suitable denning habitat (Volume 5, Chapter 8, Figure 8.1-6).

Grey wolves may also occur in the terrestrial LSA. Grey wolves overwinter alongside caribou below the treeline and in the spring follow the migration of barren-ground caribou northwards towards their calving grounds (Rescan 2013a). Wolves begin to follow caribou herds southward back towards their winter grounds as soon as the young are able to travel with the pack, generally in September (Rescan 2013a). Thus, wolves can occur in the terrestrial LSA when caribou are available (mid-May through end-September), although wolves have occasionally been observed outside of these periods in the terrestrial LSA. Observations of wolves and their dens were recorded within the terrestrial LSA (Volume 5, Chapter 8, Figure 8.1-7). One wolf den observed in 2007 was located near (north of) the George Property Area. Wolf denning occurs from late-April to September, and very little suitable denning habitat (< 1%) occurs within the terrestrial wildlife LSA and RSA (Volume 5, Chapter 8, Figure 8.1-8).

Raptors

Five cliff-nesting raptor species have been observed in the terrestrial LSA including golden eagle, bald eagle, gyrfalcon, peregrine falcon, and rough-legged hawk (Volume 5, Chapter 10, Figure 10.1-1). Raptors generally occur in the LSA and RSA during the breeding and rearing season (April through September), and migrate south during the winter. Nesting occurs from April through August and nests are usually located on steep ledges or cliffs. Two raptor nest sites have been observed within 1.5 km of project infrastructure in the terrestrial wildlife LSA and a total of 147 raptors nest sites were observed in the terrestrial wildlife RSA during baseline studies (Volume 5, Chapter 10, Figure 10.1-1). Area of suitable cliff-nesting habitat is equivalent to 4% of the terrestrial LSA (see Section 10.1.5.2 in Volume 5 and Rescan 2013a). The remainder of the terrestrial LSA (92.2%) was considered not to be suitable for nesting habitat as it lacks cliffs. These areas of suitable habitat were similar to those occurring in the RSA.

Three ground-nesting species may also occur in the terrestrial RSA including the short-eared owl, northern harrier, and snowy owl. The short-eared owl is a ground-nesting species of raptor that has been observed in the terrestrial LSA (Volume 5, Chapter 10, Figure 10.1-1), and is a species of conservation concern that breeds in the Arctic during the summer (April through September) and overwinters in southern regions (Clark 1975; Ims and Fuglei 2005). Approximately half (51.9%) of the terrestrial LSA was considered to be suitable habitat for nesting for short-eared owl (see Section 10.1.5 in Volume 5 and Rescan 2013a) and this proportion was similar to that in the RSA.

MIGRATORY BIRDS

Migratory birds consist of upland breeding birds and waterbirds. The majority of migratory bird species that breed in the Arctic migrate long distances between their summer range on the tundra and their winter ranges at southern latitudes. Migratory birds arrive on the tundra from early- to late-May, to breed, and depart again in the fall, usually starting in late-August and throughout September. Upland breeding birds consists of landbirds, shorebirds, and ptarmigan and they occur throughout the terrestrial LSA (Volume 5, Chapter 9, Section 9.1.5.2 and Figure 9.1-4) during the breeding season. Waterbirds also occur within the terrestrial wildlife LSA (Volume 5, Chapter 9, Section 9.1.5.1 and Figures 9.1-1a and 9.1-1b) and marine wildlife LSA (Volume 7, Chapter 6, Figure 6.1-2) between spring staging, summer breeding and fall migration periods. Concentrations of waterbirds occur on lakes and/or marine areas for longer periods of time during staging periods, with staging events lasting up to one month in early spring and in autumn during or prior to migration events. During breeding periods, which can last up to a few months, density of waterbirds is typically lower as pairs disperse to nesting areas (Volume 5, Chapter 9, Sections 9.1.3 and 9.1.5) in the summer.

6.4.1.7.4 Receptor-Project Interactions

An interaction matrix outlining the links between VECs included in the ERA and Project components and activities is shown in Table 6.4-4. Linkages between Project emissions and potential effects to the health of wildlife, fish and aquatic habitat, and fish communities were considered and screened via a pathway analysis. Project components are expected to interact with health of wildlife, fish and aquatic habitat, and fish community VECs through four interaction pathways: air, freshwater and sediment, marine water and sediment, and soil/vegetation pathways.

At the outset, all of the Project components or activities during the Construction and Operational phases were screened for potential linkages to health effects for each VEC. The Reclamation and Closure or Post-Closure phases were not included because potential effects to VEC health were considered negligible compared to the Construction and Operational phases.

In the second step, Project components or activities were screened out by considering timing and magnitude of potential emissions, environmental design features (e.g., Project design elements), and mitigation (e.g., environmental best practices, management policies and procedures). Pathways with no linkage are not included in the ERA. By screening for those pathways and Project-related emissions that are most likely to have effects on wildlife receptors, receptor-Project interaction pathways are short-listed for a comprehensive assessment for potential health effects on VECs in the ERA.

The potential interactions between Project emissions and receptors are shown in Figure 6.4-7 and described in the following sections.

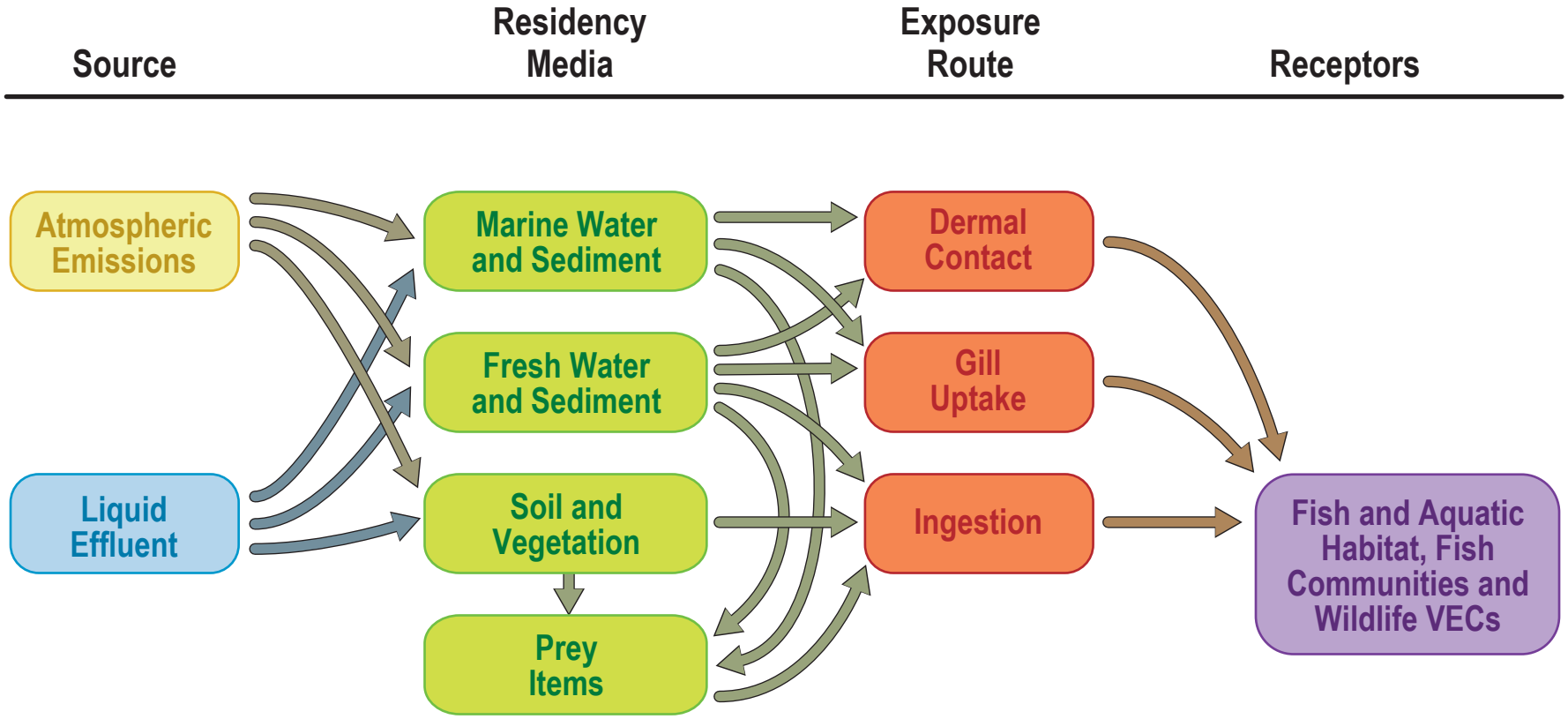


Figure 6.4-7

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Potential Environmental Receptor Exposure Pathways,
Back River Project

Figure 6.4-7

Rescan Engineers & Scientists

Table 6.4-4. Receptor-Project Interactions and their Rationale for Inclusion in the Environmental Risk Assessment

VEC	Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC	Pathway Analysis (Included/ Not Included?)	Rationale for Inclusion or Exclusion from the Risk Assessment
Freshwater Environment VECs (fish/aquatic habitat, fish communities: lake trout and Arctic char)	Construction	Freshwater and sediment	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Impact Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Refuelling/Fuel Storage and Handling Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Marine Laydown Area: on-land laydown areas/fuel storage Chemical and Hazardous Material Storage and Management Explosives Storage and Handling	Construction activities may increase dust deposition (with bound metals), which may result in changes to freshwater and sediment quality. Construction activities may release liquid wastes to the aquatic environment. This could affect the quality of freshwater fish/aquatic habitat and the health of freshwater fish communities.	Not included	Not included because construction activities are expected to be less than operation activities and the only phase assessed was that with highest potential for effects (Operational Phase).
			Water Use Air Transport of Personnel and Goods Diesel Power Generation Marine Transport of Goods Marine Laydown Area: in-water infrastructure Incinerator Machinery and Vehicle Emmissions Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to VECs are expected to result from these project activities.	Not included	n/a
	Operations	Freshwater and sediment	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Storage Area Tailings Storage In-Pit and Surface Water Management Road and Airstrip Use & Maintenance Water Use Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Marine Transport of Goods Marine Laydown Area: Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling	Operation activities may increase dust deposition (with bound metals), which may result in changes to freshwater and sediment quality. Operation activities may also create liquid wastes that enter the aquatic environment via the terrestrial environment. This could affect freshwater fish/aquatic habitat quality and the health of freshwater fish communities.	Included	Potential effects to freshwater and sediment quality from dust deposition or effluent discharge could affect freshwater fish/aquatic habitat quality and the health of freshwater fish communities and these were included in the environmental risk assessment.
			Diesel Power Generation Incinerator Air Transport of Personnel and Goods Machine and Vehicle Emissions Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts toVECs are expected to result from these project activities.	Not included	n/a

(continued)

Table 6.4-4. Receptor-Project Interactions and their Rationale for Inclusion in the Environmental Risk Assessment (continued)

VEC	Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC	Pathway Analysis (Included/ Not Included?)	Rationale for Inclusion or Exclusion from the Risk Assessment
Marine Environment VECs (fish/aquatic habitat, fish communities: Arctic char, seabirds/seaducks, ringed seals)	Construction	Marine water and sediment	Water Use Marine Laydown Area: on-land laydown areas/fuel storage Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Sewage Treatment Plant and discharge Machinery and Vehicle Refuelling/Fuel Storage and Handling Marine Laydown Area: in-water infrastructure Marine Transport of Goods	Construction activities may increase dust deposition (with bound metals), which may result in changes to marine water and sediment quality. Construction activities may also create liquid wastes that enter the aquatic environment. Changes to marine water and sediment quality could affect marine fish/aquatic habitat, marine fish communities, seabirds/seaducks, and ringed seals.	Not included	Not included because construction activities are expected to be less than operation activities and the only phase assessed was that with highest potential for effects (Operational Phase).
			Quarry Development Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Incinerator Landfill Construction/Solid Waste Management Machinery and Vehicle Emmissions Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Diesel Power Generation Air Transport of Personnel and Goods Tailings Management Area/Dam or Dyke Construction at Goose Property Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to VECs are expected to result from these project activities.	Not included	n/a
	Operations	Marine water and sediment	Water Use Tailings Storage Equipment Maintenance/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Sewage Treatment Plant and discharge Marine Laydown Area: Fuel Storage and Handling Marine Transport of Goods	Operation activities may increase dust deposition (with bound metals), which may result in changes to marine water and sediment quality. Operation activities may also create liquid wastes that enter the aquatic environment. Changes to marine water and sediment quality could affect marine fish/aquatic habitat, marine fish communities, seabirds/seaducks, and ringed seals.	Not included	Potential effects to freshwater and sediment quality from dust deposition or effluent discharge could affect fmarine fish/aquatic habitat, marine fish communities, seabirds/seaducks, and ringed seal and was this was included in the environmental risk assessment.
			Machine and Vehicle Emissions In-Pit and Surface Water Management Road and Airstrip Use & Maintenance Waste Rock Piles Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Incinerator Air Transport of Personnel and Goods Diesel Power Generation Underground: Drilling, Blasting, Excavation Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential effects to VECs are expected to result from these project activities.	Not included	n/a

(continued)

Table 6.4-4. Receptor-Project Interactions and their Rationale for Inclusion in the Environmental Risk Assessment (continued)

VEC	Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC	Pathway Analysis (Included/ Not Included?)	Rationale for Inclusion or Exclusion from the Risk Assessment
Terrestrial Environment VECs (caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, raptors)	Construction	Freshwater and sediment	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Refuelling/Fuel Storage and Handling Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Marine Laydown Area: on-land laydown areas/fuel storage Chemical and Hazardous Material Storage and Management Explosives Storage and Handling	Construction activities may increase dust deposition (with bound metals), which may result in changes to freshwater and sediment quality. Construction may also create liquid wastes that enter the aquatic environment via the terrestrial environment. Caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors that ingest the water and sediment could experience adverse health effects.	Not included	Not included because construction activities are expected to be less than operation activities and the only phase assessed was that with highest potential for effects (Operational phase).
			Water Use Air Transport of Personnel and Goods Diesel Power Generation Marine Transport of Goods Marine Laydown Area: in-water infrastructure Incinerator Machinery and Vehicle Emmissions Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to terrestrial VECs are expected to result from these project activities.	Not included	n/a
		Soil and vegetation	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Refuelling/Fuel Storage and Handling Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Marine Laydown Area: on-land laydown areas/fuel storage Explosives Storage and Handling	Construction activities may increase dust deposition (with bound metals), which may result in changes to soil and vegetation quality. Caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors that ingest soil and vegetation containing COPCs may experience adverse health effects.	Not included	Not included because construction activities are expected to be less than operation activities and the only phase assessed was that with highest potential for effects (Operational phase).
			Water Use Incinerator Diesel Power Generation Air Transport of Personnel and Goods Marine Transport of Goods Marine Laydown Area: in-water infrastructure Chemical and Hazardous Material Storage and Management Machinery and Vehicle Emmissions Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to terrestrial VECs are expected to result from these project activities.	Not included	n/a

(continued)

Table 6.4-4. Receptor-Project Interactions and their Rationale for Inclusion in the Environmental Risk Assessment (completed)

VEC	Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC	Pathway Analysis (Included/ Not Included?)	Rationale for Inclusion or Exclusion from the Risk Assessment
Terrestrial Environment VECs (caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, raptors) *(cont'd)*	Operations	Freshwater and sediment	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Piles Tailings Storage In-Pit and Surface Water Management Road and Airstrip Use & Maintenance Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Marine Transport of Goods Marine Laydown Area: Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling	Operation activities may increase dust deposition (with bound metals), which may result in changes to freshwater and sediment quality. Operation activities may also create liquid wastes that enter the aquatic environment. Caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors that ingest the water and sediment could experience adverse health effects.	Included	Potential effects to caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors due to effluent discharge or atmospheric deposition of COPCs to freshwater, sediments, and uptake via the aquatic food chain.
			Diesel Power Generation Water Use Incinerator Air Transport of Personnel and Goods Machine and Vehicle Emissions Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts toVECs are expected to result from these project activities.	Not included	n/a
		Soil and vegetation	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Piles Road and Airstrip Use & Maintenance Marine Laydown Area: Fuel Storage and Handling Explosives Storage and Handling Chemical and Hazardous Material Storage and Management Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling	Operation activities may increase dust deposition (with bound metals), which may result in changes to soil and vegetation quality. Caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors that ingest contaminated soil and vegetation may experience adverse health effects.	Included	Potential effects to caribou, grizzly bears, muskox, wolverine/furbearers, migratory birds, and raptors from consuming soil and vegetation were included in the environmental risk assessment.
			Diesel Power Generation Water Use Tailings Storage Air Transport of Personnel and Goods Marine Transport of Goods In-Pit and Surface Water Management Incinerator Machine and Vehicle Emissions Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts to VECs are expected to result from these project activities.	Not included	n/a

Notes:
VEC = valued ecosystem component
n/a = not applicable, because no potential impacts were identified.

Air

Changes to air quality due to Project activities due to the emission of air pollutants is not expected to affect the quality of freshwater fish/aquatic habitat and the health of freshwater fish communities and this was not included in the ERA. The inhalation of air pollutants by wildlife VECs was not assessed (Section 6.4.1.4.2) because the inhalation pathway is a much smaller contributor of contaminant exposure for wildlife than the ingestion pathway, and the wildlife VECs are expected to spend limited amounts of time in areas where air pollutants may be elevated. Furthermore, wildlife toxicity reference values for inhalation are unavailable.

Fresh Water and Sediments

COPCs are subject to a range of physical, geochemical and microbiological processes within the environment that influence their transport, distribution, and fate. The processes that are active will depend upon the properties of the COPC and the environmental media in which they reside.

Atmospheric emissions, predominately dust particles and associated metals, may get transported over a short distance and deposit and freshwater (lakes and streams). Particles in water may settle to sediments or remain dispersed in the water column. Partitioning of dust particles to sediments may lead to sorption, downstream transport, and potential (bio-) transformation of metal constituents. Benthic invertebrates and primary producers in the aquatic habitat may be exposed to COPCs associated with particles or COPCs dissolved in the water. Dispersed particles or dissolved COPCs may be taken up by fish VECs.

Liquid effluent has the potential to enter the freshwater environment (via runoff from the terrestrial environment), where COPCs can be dispersed and transported downstream, can contribute to nutrient loading, or may be (bio-) transformed or (bio-) degraded, depending on the type of effluent COPC. Introduction of COPCs to the freshwater environment may result in the freshwater VECs of fish and aquatic habitat (includes primary producers, aquatic invertebrates, and sediment), Arctic Grayling, and Lake Trout potentially being be exposed to COPCs via dermal contact, gill uptake (for fish), and ingestion. Terrestrial wildlife could also take up COPCs from the freshwater aquatic environment through drinking water or consumption of prey items (e.g., fish by grizzly bears).

Marine Water and Sediments

Similarly to the freshwater environment, atmospheric emissions and liquid effluent have the potential to enter the marine environment, where they can disperse in water and/or partition to sediments. Marine VECs of fish/aquatic habitat (includes primary producers, aquatic invertebrates, and sediment), Arctic Char, seabirds/ducks, and ringed seals could be exposed to COPCs via dermal contact, gill uptake (for fish), and ingestion. Seabirds/ducks and ringed seals also have the potential to be exposed directly to COPCs in the atmosphere via inhalation.

The marine water and sediments can also be indirectly affected by atmospheric and liquid emissions into streams that enter the marine environment within a distance that is short enough for particles not to be able to settle or for COPCs to sufficiently degrade before the stream enters the marine environment.

Terrestrial Environment (Soil and Vegetation)

Atmospheric emissions have the potential to enter the terrestrial environment by dust deposition on soils and vegetation. Small dust particles and associated COPCs can be adsorbed to soil particles and/or can be leached into the subsurface soils. Dust and associated COPCs can settle on plant surfaces, but can also be taken up by plant roots when incorporated into the soil surface.

The representative terrestrial VECs (caribou, muskox, wolverine and furbearers, grizzly bears, migratory birds, and raptors) could potentially be exposed to COPCs via food ingestion (from deposition of fugitive dust containing COPCs on soil or vegetation) or drinking water and could accumulate COPCs in their tissues. However, wildlife exposure to contaminants via inhalation and dermal contact are not pathways usually assessed in ERAs. Wildlife toxicity reference values for inhalation and dermal pathways are unavailable, plus the ingestion pathway is expected to be a much larger contributor to exposure, while inhalation and dermal exposure are expected to be very small (Sample et al. 1997; BC MOE 2013b). Thus wildlife exposure to contaminants via the inhalation and dermal contact pathways were not considered and the ERA will focus on the ingestion pathway.

6.4.1.7.5 Conceptual Model

A conceptual model is a representation of the characteristics of the site in diagrammatic form, and is developed within an ERA to identify potential sources, fate, and transport of COPCs potential exposure routes, and the possible interaction pathways between COPCs and receptors. Possible combinations of environmental components corresponding to significant exposure pathways were identified, while non-significant pathways were eliminated from further consideration.

A simplified schematic diagram of the sources of COPCs and pathways by which animals and plants may be exposed to emissions from the Project that are considered in the ERA is depicted in Figure 6.4-8. There are two general sources of emissions from the Project: atmospheric emissions (e.g., criteria air contaminants and fugitive dust with associated COPCs) and liquid effluent (e.g., effluent discharge and treated waste water). Fugitive dust and emission particulates have the potential to enter the atmosphere, travel some distance, and settle, where they can reside in different media such as marine water and freshwater, sediments, soil, and vegetation. These media can be taken up by wildlife, aquatic habitat, and fish community receptors through the ingestion exposure route (through the ingestion of water and food), dermal uptake (aquatic environment only), and gill uptake (aquatic environment only).

Liquid effluent has the potential to enter the marine and freshwater environments. Wildlife, aquatic habitat, and fish community receptors can then be exposed to the contaminants via ingestion of water. Dermal contact is another potential exposure route for aquatic habitat and fish communities; however, this exposure route would be negligible for wildlife receptors compared to ingestion and was scoped out of the ERA.

Project emissions released to the atmospheric, aquatic, and terrestrial environments have the potential to impact animals and plants. The conceptual model guides the remainder of the ERA where COPCs are selected, screened for the potential to cause adverse effects in receptors, and the risk to ecological VEC species is determined.

6.4.1.8 Predictive Environmental Modelling and Assumptions

6.4.1.8.1 Air Quality and Fugitive Dust

Predictive modelling was used to estimate metal concentrations in air. Only metal COPCs were included in the modelling because metals occur naturally in rocks and soils, may be released in fugitive dust, and concentrations may become elevated in air during Project activities. Other chemicals were not included in the predictive modelling because mitigation will minimize and/or eliminate their release to the environment (Section 6.4.1.3).

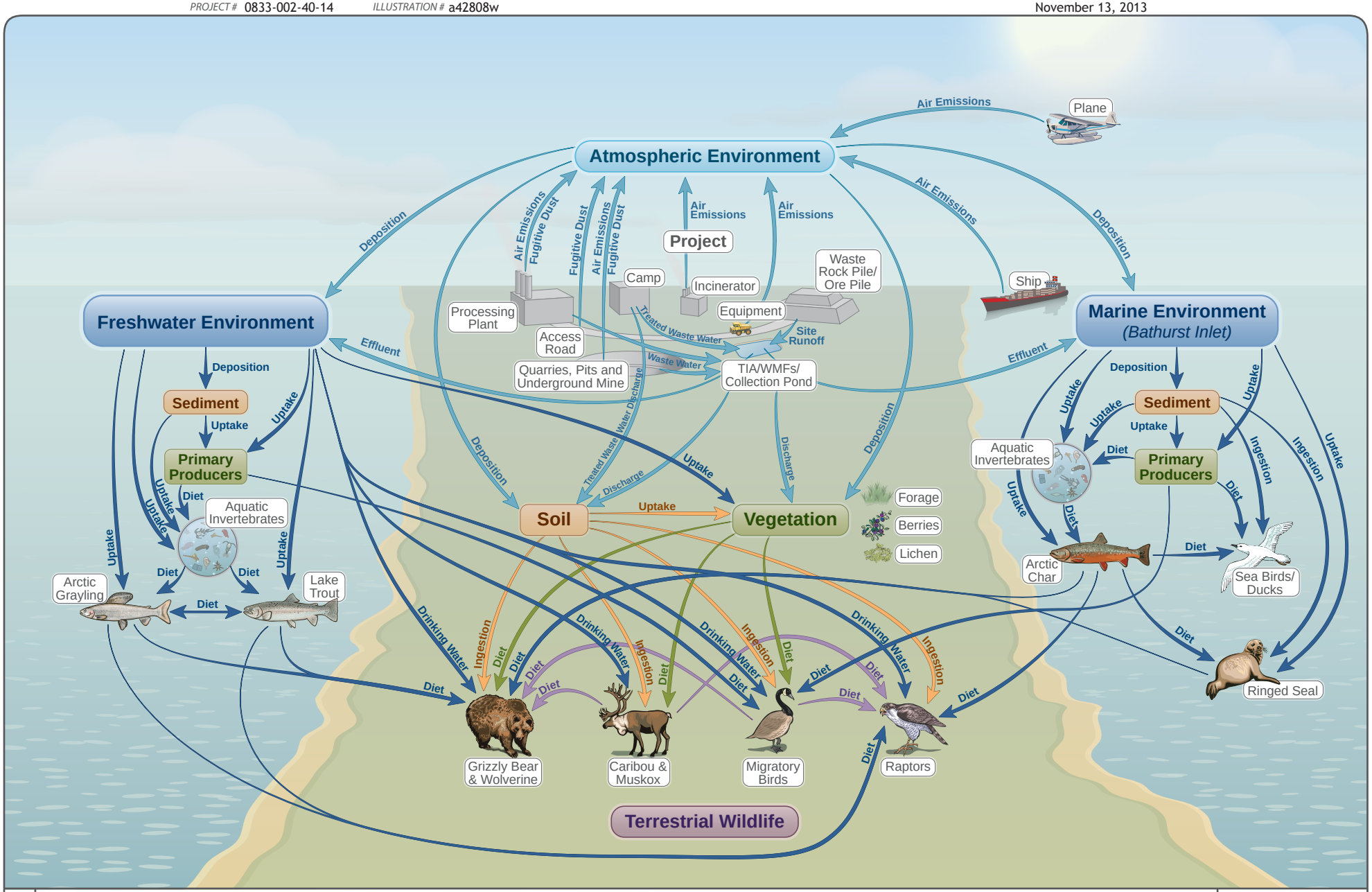


Figure 6.4-8

Sabina GOLD & SILVER CORP.

Conceptual Model for Back River Project, Environmental Risk Assessment

Figure 6.4-8

Rescan™ Engineers & Scientists

An atmospheric dispersion model was prepared to evaluate potential effects of the Project's activities on air quality, and the methods, results, and assumptions are presented in Volume 4, Chapter 1, and Rescan (2013i). A brief summary is provided here for convenience.

Predicted air concentrations of COPCs due to Project emissions were modelled with the US EPA-approved version of CALPUFF (version 5.8) and its related processors. CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that is capable of simulating the effect of time- and space-varying meteorological conditions on contaminant transport, transformation, and removal. In order to perform dispersion modelling using CALPUFF, meteorological data was processed by CALMET, to provide meteorological input data in the modelling.

Two air quality modelling domains for the Project were selected based on the atmospheric environment LSA, encompassing the area around each of the Goose and George Property PDAs, with boundaries of approximately 10 km in all directions from infrastructure (see Figure 1.4-1 in Volume 4, Chapter 1 for the air quality LSA modelling domains).

It is highly unlikely that outside of the atmospheric modelling domains (e.g., at the MLA or along the main winter roads) there will be Project-related dust deposition rates substantially higher than baseline. Sources or criteria air contaminants and fugitive dust in these areas are expected to be lower than what is expected to occur at either the Goose or George Properties. Also, there are no major sources of fugitive dust, other than site roads (not winter roads), in most areas outside of the atmospheric modelling domains. Potential effects at the MLA will be less than in the other two areas during the Operational phase and the impacts on air quality were considered to be insignificant.

The dispersion model was run using the worst-case emissions scenario, which was determined to occur in Year 3 of the Operational phase for the Goose Property Area and Year 7 of the Operational phase for the George Property Area (Rescan 2013i). The following were considered as potential emission sources of atmospheric contaminants in the air dispersion model (Rescan 2013i):

- stack (baghouse) emissions;
- processing plant (includes generator);
- underground mine (includes generator);
- generators in open pit;
- incinerator at camps;
- equipment, including trucks, drill rigs, bulldozers, both in the mine pits/underground and on the access road;
- aircraft;
- fugitive dust emissions from grading and bulldozing activities; and
- explosives (drilling and blasting).

The potential air contaminants modelled include the following (Rescan 2013i):

- nitrogen oxides (NO_x);
- sulphur oxides (SO_x);
- carbon monoxide (CO);

- total suspended particulate (TSP);
- particulate matter less than and equal to 10 microns in size (PM_{10});
- particulate matter less than and equal to 2.5 microns in size ($PM_{2.5}$); and
- fugitive dust.

The dispersion model was set up so that results were generated for a grid in addition to specific receptors locations (as shown in Volume 4, Chapter 1, Figures 1.2-1a and 1.2-1b), which included the following:

- UTM coordinates for each soil, vegetation, wetland sediment, and lake water quality sampling site during baseline studies located within the modelling domain (to be used in subsequent soil, vegetation, and water quality modelling; and,
- sites that were considered to be important for wildlife.

Fugitive dust predicted by the CALPUFF model is likely to contain metals. The model output data on maximal dust deposition and the baseline geochemistry for waste rock and ore composition (i.e., mean metal concentrations in rock samples) were used to estimate the metal concentration in dustfall (in $\mu g/m^2$-sec for a 30-day average; Rescan 2013i). The annual dustfall levels in Goose and George Property Areas are shown in Figures 6.4-9 and 6.4-10, respectively. Metal proportions in rock (split into potentially acid generating (PAG) and non-potentially acid generating (nPAG)) and ore were available from baseline samples (Volume 11). The following assumptions about metal content of dust were made:

- unpaved road dust had metal concentrations similar to non-potentially acid generating (nPAG) waste rock;
- fugitive dust from equipment activities (bulldozing/grading) had metal concentrations that were an average of all types of rock; and
- blasting and drilling fugitive dust had metal concentrations that were an average of all types of rock.

The CALPUFF model provides dustfall results in $\mu g/m^2$-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 3,600 seconds, 24 hours, and 365 days (to convert from seconds to years) and divided by 1,000,000 to convert from µg to g. Appendices V8-6A and V8-6B provide baseline and predicted metal concentrations associated with fugitive dust at George and Goose Property Areas, respectively.

6.4.1.8.2 Freshwater Quality

Modelling Related to Waterborne Emissions

There will be no effluent discharge from the TIA during the Operational phase of the Project. Although discharge from the TIA may occur during the Reclamation and Closure/Post-closure phases and discharge from the Water Management Facilities (George Property Area) or Collection Pond (MLA) may occur during all post-construction phases, it was assumed that effluent will not be released until water quality guidelines or environmental targets can be met in the receiving environment (as per the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan, Volume 10, Chapters 7 and 19, respectively).

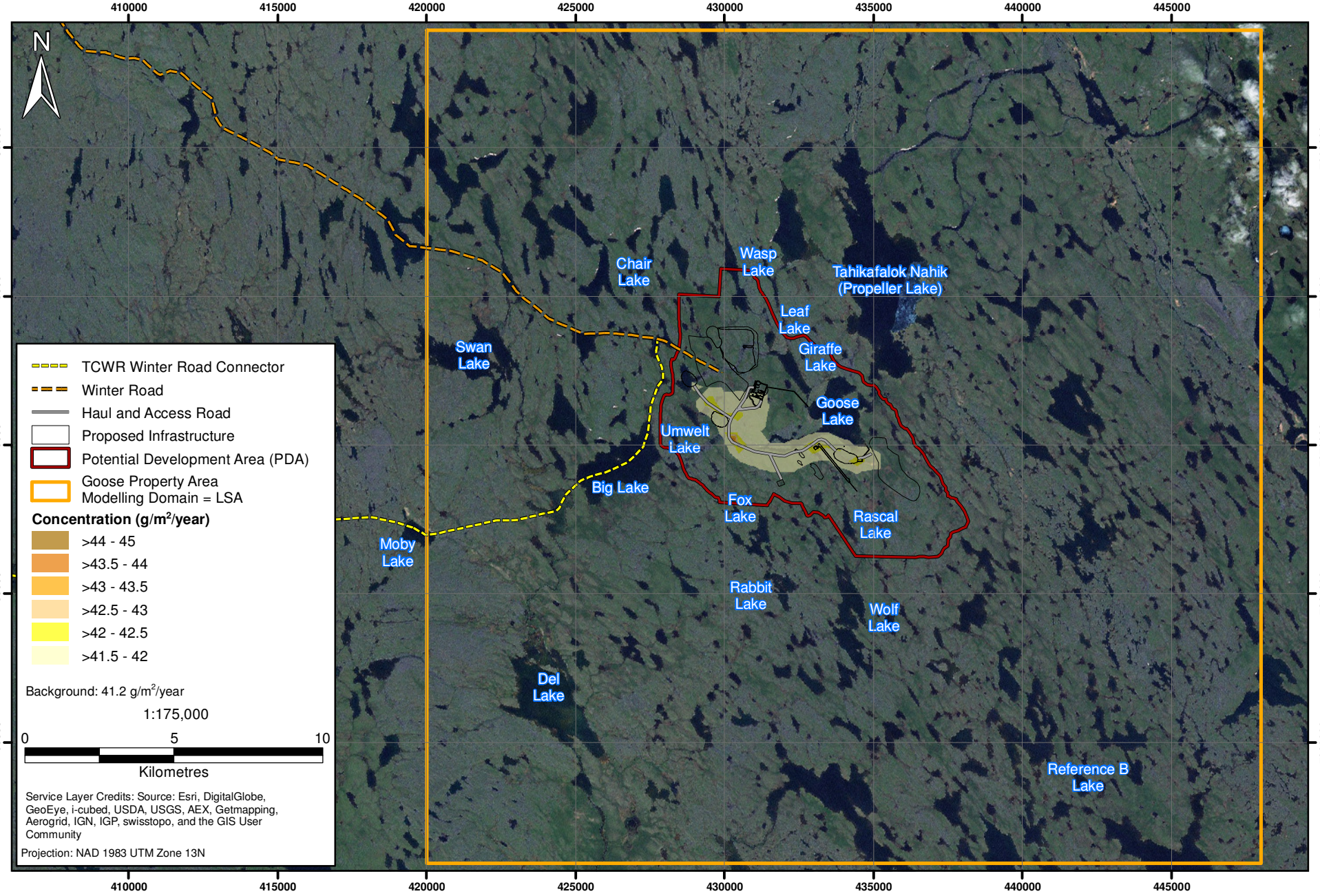


Figure 6.4-9

Sabina GOLD & SILVER CORP.

Annual Dust Deposition, Goose Property Area

Figure 6.4-9

Rescan an ERM company

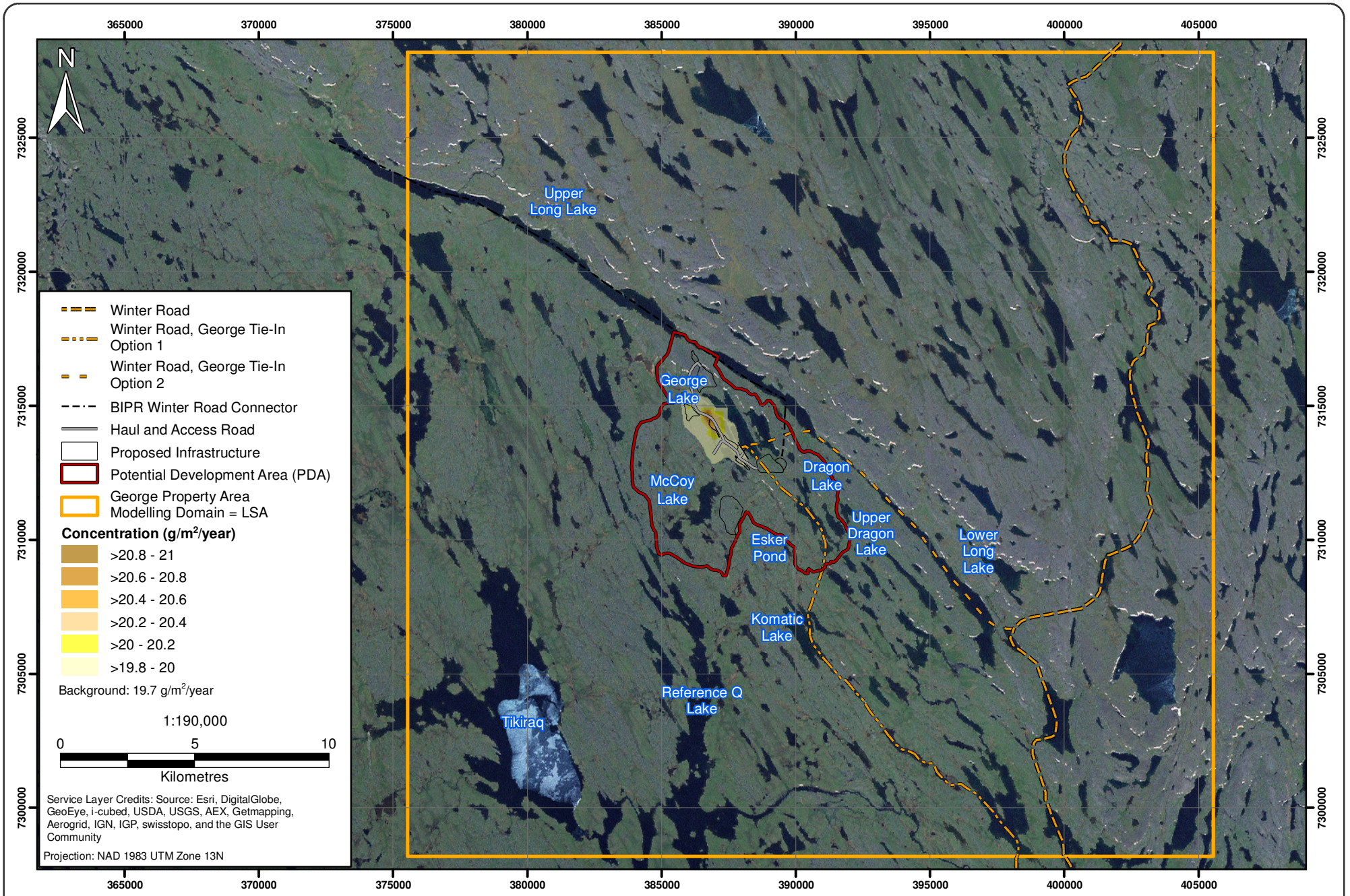


Figure 6.4-10

Sabina GOLD & SILVER CORP.

Annual Dust Deposition, George Property Area

Figure 6.4-10

Rescan an ERM company

In addition, mitigation and management plans, including best management practices (BMPs), for sewage treatment and effluent disposal, water management (Site Water Monitoring and Management Plan, Volume 10, Chapter 7), Spill Contingency Plans (Volume 10, Chapter 5), and a Risk Management and Emergency Response Plan (Volume 10, Chapter 3) will be implemented in order to minimize the potential for chemical contaminants to enter waterways. Since effluent discharge from the TIA to water is not expected during the Operational phase and water quality guidelines or targets are expected to be met in the receiving environment at all times when discharges do occur from any of the water management facilities, water quality modelling of freshwater environment LSA lakes and streams was not conducted for effluent discharge.

Modelling Related to Airborne Emissions (Dustfall)

The ERA assumes that activities of road building, maintenance, transport, and materials storage, will use appropriate technology and BMPs consistent with what is outlined in the Roads Management Plan (Volume 10, Chapter 14) and the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17) to properly mitigate and/or minimize effects.

The US EPA has published methods for use in HHRAs for calculating contaminant concentrations in water due to atmospheric particle deposition (US EPA 2005b), which are applicable to ERAs. Calculations of the incremental increase in water metal concentrations were based on estimated metal concentrations in dustfall determined using data from the CALPUFF air quality dispersion model and core sample geochemistry (Rescan 2013i). Air quality dispersion modelling was done for the upper-case scenario only (i.e., worst-case emissions scenario, when potential air quality effects were at their highest) for a one-year period for the Goose (Year 3 of Operational phase) and George (Year 7 of Operational phase) Property areas.

For the purposes of lake water quality modelling, it was assumed that the dust deposition occurred during the worst-case scenario years and that all particles deposited would remain entrained and fully mixed in the water column for the full year. No other losses of contaminants from dust deposition were included in the model (i.e., loss due to outflow from the lake or deposition and burial in the sediments). The worst-case scenario modelling provides a conservative overestimate of the potential for annual metal deposition to fresh water from dustfall, since air quality modelling was based on the worst-case scenario and not all years would be expected to have similarly high levels of activity. A cumulative deposition time of 10 years for the Operational phase was not applied since it was assumed that particles will partition to sediments over the period of one year or leave the lake via the outflow and therefore be removed from the water column.

Since the sites that were sampled during the water quality baseline assessment were included in the air quality dispersion model as receptor sites (see Rescan 2013i for additional details), it was possible to calculate incremental change in water metal concentrations due to dust deposition, such that each baseline lake sampling site had a predicted water metal concentration for the modelled year. For lake sampling sites that were located outside of the air quality modelling domains, it was assumed that the water metal concentration would remain unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

For each lake water quality sampling site, lake volume (V_{lake}), lake surface area (A_{lake}), and dust particle deposition rates (L_{DEP}) were incorporated and the incremental increase in water metal concentrations were calculated using the equation below, adapted from the US EPA (2005b):

$$C_{wtot} = \left(\frac{L_{DEP} \times A_{lake} \times 1\ year}{V_{lake}}\right) + C_{Bsln}$$

where:

C_{wtot} = Total water column COPC concentration (g COPC/m^3 water)
L_{DEP} = Yearly particle-bound COPC deposition to waterbody (g COPC/m^2-year)
A_{lake} = Surface area of lake (m^2)
V_{lake} = Average water volume of lake (m^3)
C_{Bsln} = Mean water COPC concentration at baseline (g COPC/m^3 water)

Benthic burial, outflow from the lake, and COPC volatilization were conservatively assumed to be zero.

Deposition rates for metals were based on the results of the air quality dispersion model (Rescan 2013i). The CALPUFF model provides dustfall results in µg/m^2-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 3,600 seconds, 24 hours, and 365 days (to convert from seconds to years) and divided by 1,000,000 to convert from µg to g.

Once the incremental increase in metal concentration was calculated, it was added to the mean baseline COPC concentration at that site in the lake (C_{Bsln}) to arrive at a predicted water metal concentration (C_{wtot}). The results for each lake water quality sampling site are presented in Appendix V8-6C.

Emissions during Reclamation and Closure/Post-closure phases were considered to be negligible and those during the Construction phase were expected be lower than during the Operational phase (based upon the Air Quality section of the DEIS Volume 4, Chapter 1).

For freshwater streams, predictions of water quality changes due to contaminants in dustfall (i.e., air emissions) were not conducted. Streams are constantly flowing, so there is limited opportunity for dust deposition to accumulate and affect water quality at any given site since dust and any associated contaminants would be regularly flushed away. This is assumption is supported by the assessment of dust-borne contaminant loading to lakes, where it was found that contaminant loading was not a significant source of metal contaminants (Appendix V8-6C).

It is highly unlikely that outside of the atmospheric modelling domains (e.g., in the MLA; see Section 6.4.1.6.1) there will be Project-related dust deposition rates substantially higher than baseline since there are no major sources of fugitive dust in these areas. In addition, the quality of any fugitive dust is unlikely to change substantially outside of air quality modelling domains since the quality of the sources of dust will not change relative to baseline, so dust deposition of contaminants should be similar to baseline conditions.

6.4.1.8.3 Freshwater Sediment Quality

The sediment quality chapter of the DEIS (Volume 6, Chapter 5) contains complete baseline information (including methodologies and results) and Section 6.1.2 in this chapter contains a summary of sediment quality baseline information.

Since aqueous effluents will not be discharged unless criteria outlined in the future water license can be met, sediment quality is expected to remain largely unchanged relative to baseline or is expected to have concentrations less than sediment quality guidelines.

It is possible that changes in sediment quality may originate from atmospheric dust deposition and particle-associated metal COPCs. The US EPA has published methods for use in HHRAs for calculating

contaminant concentrations in soil due to atmospheric deposition (US EPA 2005b). These calculations were adopted for deposition to sediments, assuming that particles will partition completely from the water column to sediments. Calculations of the incremental increase in sediment metal concentrations were done based on estimated metal concentrations in dustfall determined using data from the air quality dispersion model and core sample geochemistry (Section 6.4.1.6.1 or Rescan 2013i). Air quality dispersion modelling was done for the upper-case scenario only (i.e., worst-case scenario, when potential air quality effects were at their highest) for a one-year period for the Goose (Year 3 of Operational phase) and George (Year 7 of Operational phase) Property Areas.

For the purposes of sediment quality modelling, it was assumed that the dust deposition that occurred during the worst-case scenario years occurred each year throughout the Operational phase. This would provide a conservative overestimate of the potential for metal deposition to sediments from dustfall, since air quality modelling was based on the upper-case scenario and not all years would be expected to have similarly high levels of activity.

Since the sites that were sampled during the lake sediment baseline assessment were included in the air quality dispersion model as receptor sites (see Rescan 2013i for additional details), it was possible to calculate incremental change in lake sediment metal concentrations due to dust deposition, such that each baseline sediment sampling site had a predicted sediment metal concentration at the end of the Operational phase. For sediment sampling sites that were located outside of the air quality modelling domains, it was assumed that the sediment metal concentration would remain unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

Incremental increase in sediment metal concentrations were calculated using the equation below, adopted from the US EPA (2005b):

$$C_{Sed} = \left(\frac{L_{DEP} \times t_D}{d_{bs} \times C_{BS} \times 1000}\right) + C_{Bsln}$$

where:

C_{Sed} = Average sediment concentration over exposure duration (mg COPC/kg sediment)
L_{DEP} = Yearly particle COPC deposition to waterbody (mg COPC/m^2-year)
t_D = Time period over which deposition occurs (10 years)
d_{bs} = Depth of upper benthic sediment layer (0.03 m)
C_{BS} = Bed sediment concentration (1.0 g/cm^3)
1000 = Unit conversion factor (from g/cm^3 to kg/m^3)
C_{Bsln} = Baseline sediment COPC concentration (mg/kg)

Deposition rates for metals were based on the results of the air quality dispersion model (Section 6.4.1.6.1 or Rescan 2013i). The CALPUFF model provides dustfall results in µg/m^2-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 3,600 seconds, 24 hours, and 365 days (to convert from seconds to years) and divided by 1,000,000 to convert from µg to g.

The time period over which deposition may occur was assumed to be 10 years. A cumulative deposition time of 10 years was applied since this is the duration of the Operational phase and the worst-case scenario rates of dust deposition were conservatively assumed to occur every year throughout the whole phase. Metals deposited with fugitive dust were assumed to mix within the top 0.03 m of sediment (d_{bs}), as recommended by the US EPA (2005b) for the depth of the upper benthic sediment layer. The bed sediment concentration (C_{bs}) was set at the default value of 1.0 g/cm^3 sediment, as recommended by the US EPA (2005b). Partitioning from water to sediment was assumed to be 100%.

Degradation was considered to only have significant effects on organic chemicals (e.g., PAHs) and not metals (US EPA 2005b), thus a loss constant was not necessary.

Once the incremental increase in sediment metal concentration was calculated, it was added to the mean baseline metal concentration (C_{Bsln}) at that lake site to arrive at a predicted mean sediment metal concentration. These results for each sediment sampling site are provided in Appendix V8-6D.

Emissions during Reclamation and Closure/Post-closure phases were considered to be negligible and those during the Construction phase were expected be lower than during the Operational phase (based upon the Air Quality section of the DEIS Volume 4, Chapter 1).

As described for freshwater quality of streams, predictions of stream sediment quality changes due to contaminants in dustfall (i.e., air emissions) were not conducted. Streams are constantly flowing and any contaminants deposited to the surface would be regularly flushed away. This assumption is supported by the assessment of dust-borne contaminant loading to lake water and sediment, where it was found that contaminant loading was not a significant source of metal contaminants (Appendices V8-6C and V8-6D). Since the settling of the dust-borne contaminants in streams is expected to be even lower than in lakes due to the dynamic nature of the streams and low surface area in comparison to the lakes, dust-borne contaminant loading to the steams sediment is expected to be negligible as well.

Streams outside of the atmospheric modelling domains (e.g., in the MLA, along winter roads) are expected to have Project-related dust deposition rates substantially lower than what would occur at either Goose or George Property. Winter road use and maintenance would not be associated with the generation of fugitive dust. Thus sediment quality of streams in the MLA or in the vicinity of winter roads was assumed to be similar to baseline.

6.4.1.8.4 Marine Water and Sediment Quality

Water quality modelling of the marine environment was done for a spill scenario (Rescan 2013f, Appendix V9-3A); however, the spill modelling results were not assessed as part of the ERA since it is outside of the course of normal Project activities and represents a single, very specific, emergency scenario. It is considered to be an unlikely occurrence and the type of effect to ecological VECs as a result of a spill could be highly variable depending on the type and volume of material spilled, location, extent, and response to the spill.

During normal Project activities, brine from the desalination water treatment plant may be discharged to the marine receiving environment in Bathurst Inlet and the potential for effects to Bathurst Inlet from this discharge was assessed in Volume 11. This discharge is not expected to affect the concentration of metals or other contaminants in the marine environment.

Discharge of effluent from the Collection Pond located in the MLA may occur during all post-construction phases. However, it was assumed that effluent will not be released until water quality guidelines or environmental targets can be met in the receiving environment (as per the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan, Volume 10, Chapter 7 and 19, respectively). Since effluent will be discharged in a manner that ensures that water quality guidelines or targets are met in the receiving environment at all times, water quality modelling of marine environment was not conducted.

It was assumed that outside of the atmospheric modelling domains (e.g., in the MLA; see Section 6.4.1.6.1) Project-related dust deposition rates would be similar to baseline levels and the quality of dust deposited should be similar to that of baseline conditions. The amount of dust

deposition on marine surface waters relative to the volume of seawater in Bathurst Inlet is considered to be negligible and would occur in a localized, near-shore area, such that contaminant loading from atmospheric deposition to Bathurst Inlet is unlikely to affect water quality. Air emissions from vehicles, ships, and camp incinerator within the MLA are much lower than the air emissions within the George and Goose Property Areas. Therefore, no air quality modelling was conducted for the MLA (Volume 4, Chapter 1). As a result, mean predicted marine water and sediment concentrations within the MLA were assumed to be the same as the mean baseline concentrations since they are not expected to change significantly.

6.4.1.8.5 Soil Quality

The US EPA has published methods for use in risk assessments for calculating contaminant concentrations in soil due to atmospheric deposition (US EPA 2005b). Calculations of the incremental increase in soil metal concentrations were done based on estimated metal concentrations in dustfall determined using data from the air quality dispersion model and core sample geochemistry (Section 6.4.1.6.1 or Rescan 2013i). Air quality dispersion modelling was done for the upper-case scenario only (i.e., worst-case scenario, when potential air quality effects were at their highest) for a one-year period for the Goose (Year 3 of Operational phase) and George (Year 7 of Operational phase) Property Areas. For the purposes of soil quality modelling, it was assumed that the dust deposition that occurred during the worst-case scenario years occurred each year throughout the 10 year Operational phase. This would provide a conservative overestimate of the potential for metal deposition to soil from dustfall, since air quality modelling was based on the upper-case scenario and not all years would be expected to have similarly high levels of activity.

Since the sites that were sampled during the soil baseline assessment were included in the air quality dispersion model as receptor sites (see Rescan 2013i for additional details), it was possible to calculate incremental change in soil metal concentrations due to dust deposition, such that each baseline soil sampling site had a predicted soil metal concentration at the end of the Operational phase. For soil sampling sites that were located outside of the air quality modelling domains around Goose and George properties, it was assumed that the soil metal concentration remained unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

Incremental increase in soil metal concentrations were calculated using the equation below, as suggested by the US EPA (2005b):

$$C_S = 100 \times \left(\frac{D}{Zs \times BD}\right) \times tD$$

where:

- C_S = Average soil concentration over exposure duration (mg COPC/kg soil)
- 100 = Unit conversion factor (from mg-m^2 to kg-cm^2)
- D = Yearly dry deposition rate of contaminant (g/m^2-year)
- t_D = Time period over which deposition occurs (10 years)
- Z_s = Soil mixing zone depth (2 cm)
- BD = Soil bulk density (1.5 g/cm^3)

Deposition rates for metals were based on the results of the air quality dispersion model (Section 6.4.1.6.1 or Rescan 2013h). The CALPUFF model provides dustfall results in µg/m^2-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 31.5[1].

The time period over which deposition may occur was assumed to be 10 years. A cumulative deposition time of 10 years was applied since this is the duration of the Operational phase and the worst-case scenario rates of dust deposition (that would occur in Year 3 for Goose Property Area and Year 7 for George Property Area of the Operational phase) were conservatively assumed to occur every year throughout the whole phase. Metals deposited with fugitive dust were assumed to mix within the top 2 cm of soil (Z_s), as recommended by the US EPA (2005b) for untilled soils. The bulk density (BD) was set at the default value of 1.5 g soil/cm^3 soil, as recommended by the US EPA (2005b). Weathering and degradation were considered to only have significant effects on organic contaminants (e.g., PAHs) and not metals (US EPA 2005b), thus a soil loss constant was not necessary.

Once the incremental change in soil metal concentration was calculated, it was added to the baseline metal concentration at that site to arrive at a predicted soil metal concentration. The predicted metal concentrations for each soil sampling site are provided in Appendix V8-6E.

Air emissions in the form of fugitive dust during Reclamation and Closure/Post-closure phases were considered to be negligible and those during the Construction phase were expected be lower than during the Operational phase (Volume 4, Chapter 1).

6.4.1.8.6 Vegetation Quality

In order to predict vegetation concentrations of metals, a BTF should be used to account for metal uptake from soil. BTFs can be used to represent the relationship between metal concentrations in soil relative to metal concentrations in plant tissues.

Since BTF values can be quite variable, site-specific BTF values were calculated wherever possible in order to predict metal uptake in plants from the soil. This was done by calculating a BTF for each baseline sampling site where both soil and vegetation were collected at the same time. Sampling locations where soil and vegetation were co-sampled during baseline studies for the terrestrial LSA included sites: 54, 64, 80, 94, 101, 104, 108, and W026.

Soil and vegetation metal concentrations from baseline studies were used to calculate site-specific BTFs for soil to lichen (Table 6.4-5), and soil to berries (Table 6.4-6). Only sites with matched soil and vegetation metal concentrations in the terrestrial LSA were included in the BTF calculations. If either the soil or vegetation metal concentrations during baseline sampling were below method detection limits, then a site-specific BTF could not be calculated and instead published BTF values from Staven et al. (2003) and Baes et al. (1984) were used. The raw baseline data can be found in Rescan (2013b, 2013e) and the soil and vegetation chapters of the DEIS, Volume 5, Chapters 3 and 4.

The BTF values (Tables 6.4-5 and 6.4-6) were used to predict metal concentrations in vegetation via root uptake or uptake into the lichen thallus by multiplying them with the predicted soil concentrations (Section 6.4.1.6.5, Appendix V8-6E). These predictions are presented in Appendix V8-6F for lichen and sedge, and Appendix V8-6G for berries.

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[1] Unit conversion factor includes conversion from seconds to hours (3600 seconds/hour), hours to days (24-hours per day), days to years (365 days/year), and µg to g (1,000,000 µg/g).

Plants also experience direct deposition of dustfall to their above ground surfaces, and this concentration was calculated using the equation provided by the US EPA (2005b):

$$Pd = \frac{1000 \times D \times Rp \times [1.0 - exp(-kp \times Tp)]}{Yp \times kp}$$

where:

Pd = Plant (above ground produce) concentration due to direct deposition (mg COPC/kg DW)
1000 = Units Conversion factor (mg/g)
D = Yearly average dry deposition (g/m^2-year)
Rp = Interception fraction of the edible portion of plant (unitless)
kp = Plant surface loss coefficient (year^{-1})
Tp = Length of plant exposure to deposition per harvest of the edible portion of the plant (year)
Yp = Yield or standing crop biomass of the edible portion of the plant (productivity; kg DW/m^2)

The CALPUFF model provides dustfall results in µg/m^2-sec and to convert this unit into g/m^2-year the dustfall result was multiplied by 31.5[2]. The interception fraction of the edible portion of plant (*Rp*) was set to 0.39 for berries, which is the default value provided by the US EPA (2005b), and 0.769 for lichens and sedge which is the value the US EPA recommends for silage (US EPA 2005b). The plant surface loss coefficient (*kp*) was set to the default value of 18 year^{-1} recommended by the US EPA (2005b). The length of plant exposure to deposition per harvest of the edible portion of the plant (*Tp*) was set to 0.329 year since the vegetation experiences approximately 4 months of ice-free growing conditions annually (120 days divided by 365 days). The yield or standing crop biomass of the edible portion of the plant (*Yp*) was set to 0.25 kg DW/m^2 for berries, which the US EPA (2005b) recommends for exposed fruits, and was set to 5.66 for lichens and sedge, which the US EPA (2005b) recommends for exposed vegetables.

The total predicted metal concentration in vegetation was then calculated as the concentration predicted in the plant or lichen due to root or thallus uptake plus the concentration on the vegetation surface due to deposition. Results are provided in Appendix V8-6H for lichens and sedge and Appendix V8-6I for berries, alongside a comparison to the measured baseline concentration.

6.4.1.9 Screening Process for Contaminants of Potential Concern

6.4.1.9.1 General Methodology for Selecting Contaminants of Potential Concern

Contaminants measured during field studies of the atmospheric environment (Volume 4), freshwater environment (Volume 6), marine environment (Volume 7), terrestrial environment (Volume 5), and human environment (Volume 8) under baseline conditions are listed in Table 6.4-7. Metals are the primary type of contaminants that will be the subject of this ERA since other chemicals that may be in use or present during Project activities are unlikely to have an effect on ecological receptors after mitigation and management measures are implemented (Section 6.4.1.3). Air pollutants (e.g., NO_2, SO_2, ozone) were not assessed as having the potential to affect the health of ecological receptors, since inhalation was not considered to be an exposure route for ecological receptors (Section 6.4.1.5.2).

[2] Unit conversion factor includes conversion from seconds to hours (3600 seconds/hour), hours to days (24-hours per day), days to years (365 days/year), and µg to g (1,000,000 µg/g).

Table 6.4-5. Site-specific Biotransfer Factors for Soil to Lichen (*Cladina stygia and Stereocaulon paschale*) and Sedge (*Carex aquatilis*)

Metals	54 *C. stygia*	64 *C. stygia*	80 *C. stygia*	94 *S. paschale*	101 *C. stygia*	104 *C. stygia*	108 *S. paschale*	108 *C. stygia*	LBS 9 *C. stygia*	LBS 10 *C. stygia*	LBS 11 *C. stygia*	LBS 13 *C. stygia*	NE3 *C. stygia*	W026 *C. aquatilis*	Average BTF for Human Health LSA[1]	Average BTF for Terrestrial LSA[1]	Average BTF for all Sites[1]	Published BTF[2]
Aluminum	0.159	0.159	0.0312	0.0423	0.0248	0.0371	0.0171	0.0240	0.0278	0.0496	0.0233	0.0178	0.142	0.0000943	0.0594	0.0618	0.0581	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00013
Arsenic	0.0218	0.439	0.0417	0.0448	0.0377	0.0441	0.0236	0.0346	0.0143	0.0288	0.00711	0.00836	0.159	0.00766	0.0717	0.0859	0.0696	-
Barium	0.502	1.01	1.37	0.629	0.739	0.591	0.503	0.446	0.627	0.354	0.0575	0.511	1.00	0.0816	0.642	0.723	0.641	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-	-	0.122	-	-	-	0.01
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
Cadmium	-	-	-	-	-	-	-	-	-	-	0.438	0.962	-	0.0353	0.700	-	0.700	-
Calcium	1.22	1.22	1.40	1.23	0.720	0.795	0.694	0.459	0.516	0.759	0.132	0.738	1.24	0.288	0.824	0.967	0.855	-
Chromium	-	0.0603	-	-	-	-	-	-	-	0.0231	0.0201	-	0.0844	-	0.0470	0.0603	0.0470	-
Cobalt	3.10	1.14	0.326	0.434	0.0680	0.361	0.110	0.204	-	0.0761	0.0119	0.0737	0.0965	0.00859	0.506	0.718	0.500	-
Copper	0.832	0.798	0.412	0.261	0.111	0.148	0.114	0.0820	0.0653	0.153	0.0126	0.132	0.502	0.0599	0.280	0.345	0.279	-
Iron	0.0328	0.0840	0.0219	0.0218	0.0122	0.0298	0.0115	0.0209	0.0131	0.0323	0.0189	0.0112	0.0478	-	0.0280	0.0294	0.0276	-
Lead	0.184	0.446	0.189	0.0994	0.132	0.0810	0.101	0.154	0.322	0.313	0.311	0.0962	0.559	-	0.241	0.173	0.230	-
Lithium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.025[3]
Magnesium	0.107	0.252	0.147	0.099	0.163	0.191	0.0909	0.0762	0.0466	0.0776	0.0237	0.0570	0.217	0.0645	0.121	0.141	0.119	-
Manganese	0.688	0.783	0.637	0.282	0.563	0.892	1.01	1.10	0.472	0.111	0.0460	0.237	1.50	0.520	0.670	0.744	0.640	-
Mercury	2.79	7.10	8.23	-	-	-	-	-	4.50	8.57	0.779	4.32	3.50	0.0118	4.97	6.04	4.97	-
Molybdenum	-	-	-	-	-	-	-	-	-	-	-	-	-	0.181	-	-	-	0.8
Nickel	3.34	0.865	0.233	0.212	0.101	0.127	0.130	0.076315789	-	0.0767	0.0187	0.0660	0.161	0.0897	0.472	0.636	0.451	-
Phosphorus	1.95	1.05	1.20	1.14	0.960	0.855	0.702	0.771	0.661	0.884	0.320	1.29	1.79	-	1.04	1.08	1.04	-
Potassium	4.43	2.65	2.67	1.69	2.10	1.79	1.69	2.16	2.79	1.92	0.135	2.97	2.58	-	2.32	2.40	2.27	-
Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00027
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3
Strontium	1.63	0.866	1.09	1.72	0.432	0.659	0.603	0.411	0.286	0.552	0.124	0.541	0.111	0.0919	0.609	0.926	0.694	-
Thallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.004
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Titanium	0.0258	0.0454	0.0146	0.0128	0.0131	0.0118	0.0118	0.0278	0.0250	0.0796	0.263	0.0172	0.116	-	0.0543	0.0204	0.0511	-
Uranium	0.203	0.187	0.0373	0.0687	0.0446	0.0446	0.0210	0.0248	0.0223	0.0615	0.0180	0.0238	0.16	-	0.0707	0.0789	0.0705	-
Vanadium	-	0.0394	-	-	-	-	-	0.0198	-	0.0365	0.0304	-	0.0627	-	0.0378	0.0296	0.0378	-
Zinc	1.71	1.47	1.59	0.583	0.966	0.640	0.653	0.831	0.598	0.355	0.149	0.581	2.05	0.565	0.966	1.06	0.937	-

Notes:

BTF = Biotransfer Factor, LSA = Local Study Area

Metal concentrations for a site (either in vegetation and/or soil) that were below method detection limits were eliminated from the BTF calculation and are shown as (-) in the table.

[1] *Calculation of average BTFs does not include site W026 as that sample is of sedge, not lichen like the other sites*

[2] *Source: Staven et al. (2003), unless otherwise noted.*

[3] *Source: Baes et al. (1984)*

Sites within the Human Health LSA = 54, 64, 80, 101, 104, 108, LBS9, LBS10, LBS11, LBS13, NE3, W026.

Sites within the Terrestrial LSA = 54, 64, 80, 94, 101, 104, 108, W026.

Table 6.4-6. Site-specific Biotransfer Factors for Soil to Bog Blueberry (*Vacciunium uliginosum*) and Bog Cranberry (*V. vitis-idaea*)

Metals	54 *V. vitis-idaea*	54 *V. uliginosum*	94 *V. uliginosum*	108 *V. vitis-idaea*	108 *V. uliginosum*	LBS 9 *V. uliginosum*	LBS 10 *V. uliginosum*	LBS 11 *V. uliginosum*	LBS 12 *V. uliginosum*	LBS 13 *V. uliginosum*	NE3 *V. vitis-idaea*	NE3 *V. uliginosum*	Average BTF for Human Health LSA	Average BTF for Terrestrial LSA	Average BTF for all Sites	Published BTF[1]
Aluminum	0.00132	-	-	0.000576	-	0.000541	-	0.0000723	-	0.000290	0.00443	-	0.00120	0.00107	0.00120	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00008
Arsenic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.006
Barium	0.206	0.0849	0.0751	0.164	0.0795	0.257	0.155	0.0110	0.214	0.185	0.432	0.135	0.175	0.136	0.167	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0015
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
Cadmium	-	-	-	-	-	-	-	0.313	-	0.674	-	-	0.494	-	0.494	-
Calcium	0.505	0.187	0.173	0.230	0.0898	0.221	0.0980	0.0649	0.314	0.221	0.993	0.244	0.288	0.282	0.278	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0045
Cobalt	0.0333	0.0172	0.00570	0.00888	0.00620	-	-	-	-	0.00636	-	-	0.0144	0.0174	0.0129	-
Copper	0.116	0.0657	0.0469	0.0843	0.0454	0.0759	0.118	0.0116	0.0782	0.0546	0.806	0.287	0.158	0.0790	0.149	-
Iron	0.000298	-	-	0.000270	-	0.000310	0.000159	0.0000992	0.000206	0.000145	0.00130	-	0.000348	0.000289	0.000348	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
Lithium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.025[c]
Magnesium	0.0833	0.0390	0.0165	0.0381	0.0211	0.0373	0.0192	0.00986	0.0183	0.0192	0.212	0.0645	0.0511	0.0469	0.0482	-
Manganese	1.07	0.616	0.187	0.497	0.231	0.0547	0.0714	0.0257	0.114	0.0827	1.76	0.274	0.436	0.612	0.415	-
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.37
Molybdenum	-	-	-	-	-	-	0.108	0.0186	-	-	-	-	0.063	-	0.0633	-
Nickel	0.104	0.0495	0.0131	0.0217	0.0243	0.0418	0.0183	0.00632	0.0136	0.0244	0.0495	0.0619	0.0378	0.0528	0.0357	-
Phosphorus	1.45	1.10	0.585	0.588	0.371	0.613	0.849	0.298	1.22	0.688	1.84	0.905	0.902	0.924	0.876	-
Potassium	8.84	5.37	1.78	3.89	1.96	3.25	3.29	0.229	3.50	2.38	6.77	3.23	3.88	5.11	3.71	-
Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0008
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3
Strontium	0.264	0.0679	0.0705	0.0832	0.0361	0.377	0.0429	0.0233	0.0708	0.208	0.0283	0.00797	0.110	0.131	0.107	-
Thallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0004
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.006
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0055[c]
Uranium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.004
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0055[c]
Zinc	0.185	0.131	0.0987	0.377	0.105	0.215	0.133	0.0439	1.06	0.122	0.719	0.355	0.313	0.180	0.295	-

Notes:

BTF = Biotransfer Factor, LSA = Local Study Area

Metal concentrations for a site (either in vegetation and/or soil) that were below method detection limits were eliminated from the BTF calculation and are shown as (-) in the table.

[1] *Source: Staven et al. (2003), unless otherwise noted.*

[2] *Source: Baes et al. (1984)*

Sites within the Human Health LSA = 54, 108, LBS9, LBS10, LBS11, LBS12, LBS13, NE3.

Sites within the Terrestrial LSA = 54, 94, 108.

LSA = local study area

Table 6.4-7. Metals and other Contaminants of Potential Concern Measured or Assessed during Baseline Studies

COPC	Atmospheric Environment	Freshwater Environment - Sediments	Freshwater Environment - Streams & Lakes	Marine Environment - Sediments	Marine Environment - Bathurst Inlet Water	Terrestrial Environment - Soil	Terrestrial Environment - Vegetation	Human Environment - Country Foods
NO_2	X	-	-	-	-	-	-	-
SO_2	X	-	-	-	-	-	-	-
O_3	X							
CO	X							
TSP	X	-	-	-	-	-	-	-
$PM_{2.5}$	X	-	-	-	-	-	-	-
PM_{10}	X	-	-	-	-	-	-	-
Fugitive dust	X	-	-	-	-	-	-	-
Anions & cations	-	-	-	-	-	-	-	-
Aluminum	X	X	X	X	X	X	X	X
Antimony	X	X	X	X	X	X	X	-
Arsenic	X	X	X	X	X	X	X	X
Barium	X	X	X	X	X	X	X	-
Beryllium	X	X	X	X	X	X	X	-
Bismuth	X	X	X	X	X	X	X	-
Boron	X	-	X	-	X	-	-	-
Cadmium	X	X	X	X	X	X	X	X
Calcium	X	X	X	X	X	X	X	-
Cesium	-	-	-	-	X	-	-	-
Chromium	X	X	X	X	X	X	X	X
Cobalt	X	X	X	X	X	X	X	-
Copper	X	X	X	X	X	X	X	X
Gallium	-	-	-	-	X	-	-	-
Iron	X	X	X	X	X	X	X	-
Lead	X	X	X	X	X	X	X	X
Lithium	X	X	X	X	X	X	X	-
Magnesium	X	X	X	X	X	X	X	-
Manganese	X	X	X	X	X	X	X	-
Mercury	X	X	X	X	X	X	X	X
Molybdenum	X	X	X	X	X	X	X	-
Nickel	X	X	X	X	X	X	X	X
Phosphorus	X	X	X	X	X	X	X	-
Potassium	X	X	X	X	X	X	X	-
Rhenium	-	-	-	-	X	-	-	-

(continued)

Table 6.4-7. Metals and other Contaminants of Potential Concern Measured or Assessed during Baseline Studies (completed)

COPC	Atmospheric Environment	Freshwater Environment - Sediments	Freshwater Environment - Streams & Lakes	Marine Environment - Sediments	Marine Environment - Bathurst Inlet Water	Terrestrial Environment - Soil	Terrestrial Environment - Vegetation	Human Environment - Country Foods
Rubidium	-	-	-	-	X	-	-	-
Selenium	X	X	X	X	X	X	X	X
Silicon	X	-	X	-	X	-	-	-
Silver	X	X	X	X	X	X	X	-
Sodium	X	X	X	X	X	X	X	-
Strontium	X	X	X	X	X	X	X	-
Sulphur	-	X	-	X	-	-	-	-
Tellurium	-	-	-	-	X	-	-	-
Thallium	X	X	X	X	X	X	X	X
Thorium	-	-	-	-	X	-	-	-
Tin	X	X	X	X	X	X	X	-
Titanium	X	X	X	X	X	X	X	-
Tungsten	-	-	-	-	X	-	-	-
Uranium	X	X	X	X	X	X	X	-
Vanadium	X	X	X	X	X	X	X	-
Yttrium	-	-	-	-	X	-	-	-
Zinc	X	X	X	X	X	X	X	X
Zirconium	-	-	-	-	X	-	-	-

Notes:

COPC = contaminant of potential concern

NO_2 = nitrogen dioxide

SO_2 = sulphur dioxide

O_3 = ozone

CO = carbon monoxide

TSP = total suspended particles

$PM_{2.5}$ = particulate matter up to and including 2.5 µm in size

PM_{10} = particulate matter up to and including 10 µm in size

(X) = measured or assessed

(-) = not analyzed

Metals occur naturally in environmental media (e.g., water, soil, sediment, and vegetation) due to local physical and geological processes, and their concentrations could potentially change as a result of Project activities due to deposition of dust containing metals or due to discharge of effluents containing metals.

The screening process for metals to be included or excluded from the ERA is shown as a flowchart in Figure 6.4-11. When considering each environmental medium (i.e., water, sediment, soil, and vegetation), predicted metal concentrations were screened against two assessment criteria: applicable guidelines and baseline concentrations. Modelled concentrations were first screened against the following applicable CCME Guidelines:

- *Water Quality Guidelines for the Protection of Aquatic Life - Freshwater and Marine* (CCME 2013c);
- *Interim Sediment Quality Guidelines (ISQGs) and Probable Effects Levels (PELs) for the Protection of Aquatic Life - Freshwater and Marine* (CCME 2013a); and
- *Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural* (CCME 2013b).

Hazard quotients were calculated by dividing the predicted concentration of a metal by the guideline limit in each relevant media. COPCs with a HQ less than 1.0 were screened out of the ERA, since these metals would not be expected to cause adverse effects in ecological receptors due to exposure in the environmental media. Metals without a guideline were carried through to the second step of screening since the goal was to identify any COPCs that have a significant change in concentration in any environmental media as a result of Project activities.

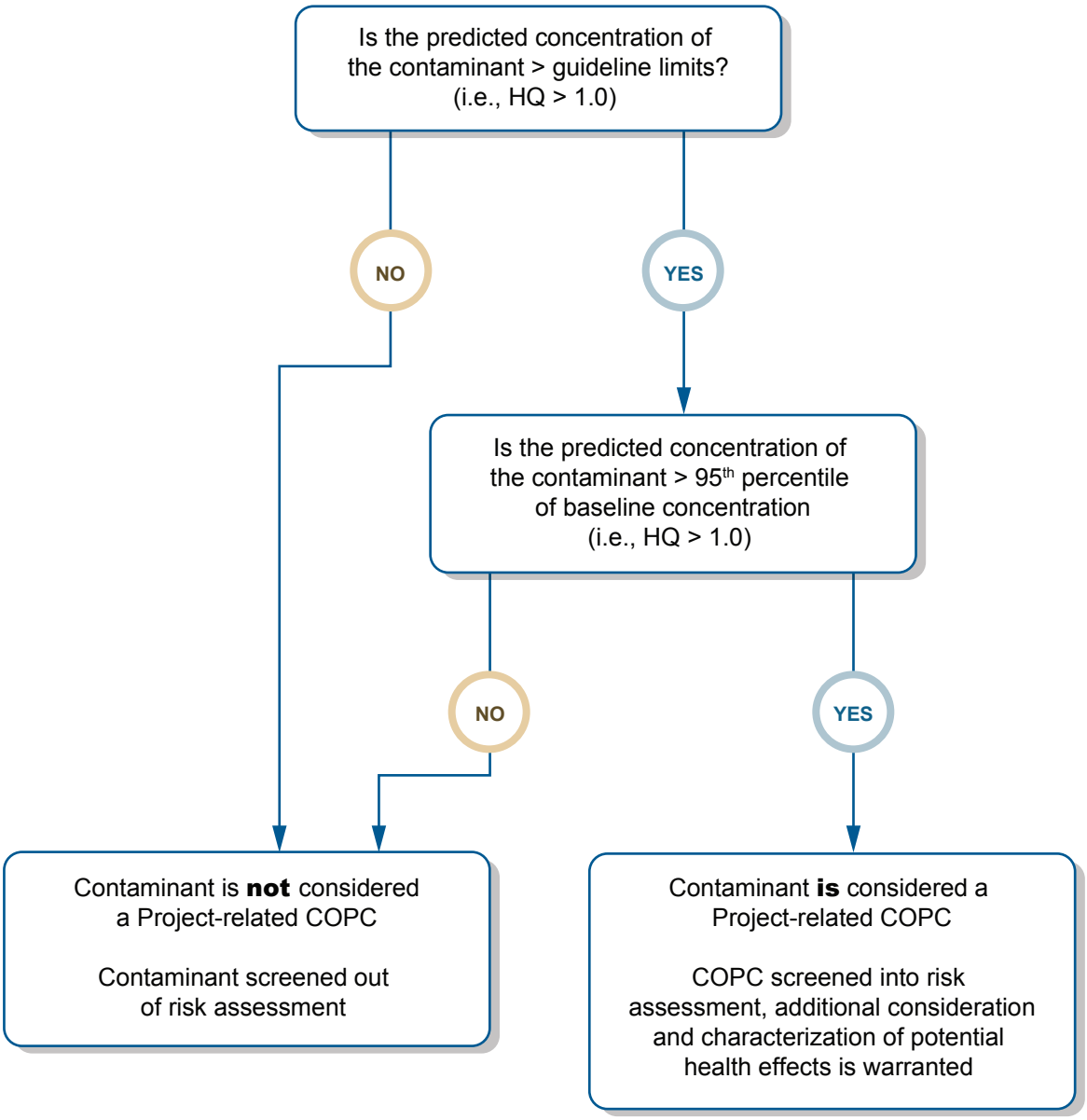
Metals with a HQ greater than 1.0 relative to the guideline limit and metals with no guidelines were retained for a second screening step. In the second screening step, the predicted metal concentrations were compared to the 95th percentile of the baseline concentrations. This baseline concentration was selected because, considering spatial variability, field sampling variability, variability in laboratory methods, and conservatism within the modelling, any contaminant concentration less than the 95th percentile baseline concentration is unlikely to be sufficiently distinguishable from background levels to be considered a Project-related effect. This step was done to ensure that all COPCs identified and carried through the ERA process were only those COPCs with concentrations that were predicted to increase due to Project-related activities and it eliminates COPCs which already exceeded guidelines during baseline studies (which is not a Project-related effect). If a predicted metal concentration was greater than the 95th percentile concentration (i.e., HQ greater than 1.0), then the metal would be identified as a COPC and would be carried forward in the ERA for further evaluation.

At the end of the screening process for each environmental medium, any metals that had either:

a) HQ greater than 1.0 relative to guideline **and** a HQ greater than 1.0 relative to baseline concentrations, or

b) no guideline **and** a HQ greater than 1.0 relative to baseline concentrations

were retained as COPCs in the ERA to be further assessed for their potential to cause health effects in freshwater, marine, or terrestrial receptors.



Notes: COPC = contaminant of potential concern
HQ = hazard quotient

Figure 6.4-11

Screening Process for Selection of Contaminants of Potential Concern

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6.4.1.9.2 Screening of Contaminants of Potential Concern in Freshwater and Sediment

Modelling of the water quality in the TIA was carried out for the Operational phase (Volume 11). However, since discharge of effluent from the TIA to the aquatic environment will not occur during this phase, there is no direct linkage between the TIA water and freshwater VECs such as benthic invertebrates and fish. In addition, mitigation measures will be applied to exclude wildlife and birds from accessing the TIA (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20). Therefore, the water and sediment quality in the TIA was not screened against guidelines and not assessed further.

Screening of COPCs in freshwater due to dust deposition was limited to surface water metal concentrations from the lakes. Since it was assumed that Project-related dust deposition into stream waters are negligible (see Section 6.4.1.6.2), no changes in water quality of the streams are expected as a result of dust deposition from Project activities.

Appendix V8-6C provides the 95th percentile of the baseline and the predicted lake water quality concentrations as result of dust deposition for each lake sampling site within the George and Goose Property Area. Predicted lake water metal concentrations were compared to the CCME *Freshwater Quality Guidelines for the Protection of Aquatic Life* (CCME 2013c) and to baseline lake water metal concentrations (95th percentile of data collected in 1993, 1997, 2011,2012, and 2013; n = 239). Results of these comparisons and HQ calculations are presented in Table 6.4-8.

None of the predicted metal concentrations in lakes were greater than the CCME Guidelines, except for copper in the George Property Area (HQ relative to guideline of greater than one). The 95th percentile of baseline concentrations of copper was also greater than the CCME Freshwater Quality Guidelines for the Protection of Aquatic Life due to natural geological features that create high metal concentrations and are not due to Project-related activities. The predicted mean concentration of copper was slightly greater than the CCME Guideline but was below the 95th percentile of baseline concentration and therefore assumed to be within the range of natural variation for the area. All of the HQs calculated relative to baseline concentrations were less than one. As a result, no COPCs were identified in freshwater for further evaluation in the ERA.

Similar to screening of COPCs in freshwater, screening of COPCs in freshwater sediments were limited to the lakes. Since it was assumed that project related dust deposition into stream waters are negligible (see Section 6.4.1.6.2 and 6.4.1.6.3), the dust deposition into the streams sediment was assumed to be negligible as well.

Appendix V8-6D provides the 95th percentile of the baseline and the predicted lake sediment quality concentrations as result of dust deposition for each lake sampling site within the George and Goose Property Area. Predicted lake sediment metal concentrations were compared to the CCME *Interim Sediment Quality Guidelines for the Protection of Aquatic Life - Freshwater* (CCME 2013a) and to baseline sediment metal concentrations (95th percentile of data collected in 2007, 2010, 2011, 2012, and 2013; n = 188).

Arsenic and copper at both Properties, and chromium in sediments of Goose Property lakes were predicted to be greater than CCME Guidelines during the Operational phase and had HQs greater than one relative to the guidelines (Table 6.4-9). However, the 95th percentile of baseline concentrations for these same metals was greater than the CCME Guidelines; this is due to natural geological features that create high metal concentrations in sediment and not due to Project-related emissions. None of the predicted metal concentrations exceeded the 95th percentile of the baseline concentrations and HQs relative to baseline were less than one. As a result, no COPCs were identified in freshwater sediment for further evaluation in the ERA.

6.4.1.9.3 Screening of Contaminants of Potential Concern in Marine Water and Sediment

Concentrations of metals in the MLA marine water and sediment are not expected to change significantly from baseline concentrations. Air emissions from vehicles, ships, and the camp incinerator within the MLA are much lower than the air emissions within the George and Goose Property Areas and no air quality modelling was conducted for the MLA (Volume 4, Chapter 1). Since no COPCs were identified in water and sediment quality in the Goose and George property areas (Section 6.4.1.7.2) where emissions and potential for changes in environmental quality are higher, it is probable that no COPCs would be identified in the MLA either.

Therefore, the mean predicted marine water and sediment metal concentrations within the MLA were assumed to remain within the range of natural baseline water and sediment metal concentrations (i.e., less than the 95th percentile of baseline concentrations), which would mean that a HQ calculated relative to baseline would be less than one. As a result, no COPCs were identified in marine water or sediment for further evaluation in the ERA.

6.4.1.9.4 Screening of Contaminants of Potential Concern in Soil

Predicted soil metal concentrations from dust deposition during Year 3 (Goose Property Area) and year seven (for George Property Area) of the Operational phase of the Project were compared to the CCME *Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural* (CCME 2013c) and the 95th percentile of baseline soil metal concentrations. Results of these comparisons and HQ calculations can be seen in Table 6.4-10 for sites within the terrestrial LSA.

None of the mean predicted metal concentrations were greater than the CCME Guidelines for soil quality. All of the calculated HQs relative to guidelines were less than one. As a result, comparison of predicted mean soil metal concentrations to baseline data was not required and no COPCs were identified in soil for further evaluation in the ERA.

6.4.1.9.5 Screening of Contaminants of Potential Concern in Vegetation

There are currently no guidelines available for use in comparisons of measured or predicted vegetation tissue metal concentrations. Therefore, comparisons of vegetation or berry baseline metal concentrations (from samples collected in 2012) were compared to mean predicted metal concentrations in vegetation or berries for sites within the Terrestrial LSA. Results of this comparison can be seen in Table 6.4-11 for lichens and sedge and Table 6.4-12 for berries.

None of the mean predicted metal concentrations in vegetation (lichen, sedge, and berries) were greater than the 95th percentile of baseline concentrations. As a result, no COPCs were identified in vegetation for further evaluation in the ERA.

6.4.1.10 Risk Assessment — Marine Environment

6.4.1.10.1 Identification of Contaminants of Potential Concern

Atmospheric dust deposition will be negligible and effluent discharges will be carefully controlled in the MLA. Marine water quality is expected to be the same as baseline (or within the 95th percentile of baseline concentrations). Therefore, based on information currently available and assuming that mitigation measures are fully implemented (Section 6.4.1.3), no impacts to marine fish and aquatic habitat (i.e., benthic invertebrates), fish community (i.e., Arctic Char), seabirds/seaducks, and marine mammal (ringed seal) VECs are expected from emissions or discharges associated with Project activities.

Table 6.4-8. Lake Water Screening for Contaminants of Potential Concern for Sites within the Freshwater Environment Local Study Area

		George Property Area							George Property Area						
Physical Tests	**CCME Guideline[1] (mg/L)**	**Predicted Mean Lake Water Concentration (mg/L)**	**Predicted Concentration > Guideline?**	**Hazard Quotient Relative to Guideline**	**95th Percentile of Baseline Lake Water Concentration[2] (mg/L)**	**Predicted Concentration > Baseline 95th Percentile?**	**Hazard Quotient Relative to Baseline**	**Retained as a COPC?**	**Predicted Mean Lake Water Concentration (mg/L)**	**Predicted Concentration > Guideline?**	**Hazard Quotient Relative to Guideline**	**95th Percentile of Baseline Lake Water Concentration[2] (mg/L)**	**Predicted Concentration > Baseline 95th Percentile?**	**Hazard Quotient Relative to Baseline**	**Retained as a COPC?**
pH[3]	6.5 - 9.0	-	No	-	8.228	-	-	No	n/d	No	-	8.06	-	-	No
Hardness	-	-	-	-	64.2	-	-	No	n/d	-	-	35.2	-	-	No
TSS	-	2.39	-	-	4.00	No	0.598	No	1.62	-	-	2.00	No	0.81	No
Total Metals															
Aluminum[4]	0.1	0.0432	No	0.432	0.0748	No	0.578	No	0.0223	No	0.223	0.0370	No	0.60	No
Antimony	-	0.000478	-	-	<0.002	No	-	No	0.000083	-	-	0.000095	No	0.87	No
Arsenic	0.005	0.000431	No	0.0863	0.000977	No	0.441	No	0.000255	No	0.0510	0.000468	No	0.54	No
Barium	-	0.00313	-	-	0.0133	No	0.236	No	0.00608	-	-	0.0197	No	0.31	No
Beryllium	-	0.0000577	-	-	<0.0002	No	-	No	0.0000951	-	-	<0.0002	No	-	No
Bismuth	-	0.000729	-	-	0.00123	No	0.595	No	0.000290	-	-	<0.0005	No	-	No
Boron	1.5	0.0121	No	0.00809	0.0258	No	0.470	No	0.005791	No	0.00386	0.0108	No	0.54	No
Cadmium[4]	0.000021	0.0000106	No	0.506	0.0000300	No	0.354	No	0.00000699	No	0.333	0.0000180	No	0.39	No
Calcium	-	5.97	-	-	15.36	No	0.389	No	3.16	-	-	7.58	No	0.42	No
Chromium[5]	0.001	0.000578	-	-	0.00157	No	0.368	No	0.000237	-	-	0.000795	No	0.30	No
Cobalt	-	0.000589	-	-	0.000996	No	0.592	No	0.000170	-	-	0.000685	No	0.25	No
Copper[4]	0.002	0.00210	Yes	1.05	0.00307	No	0.685	No	0.00194	No	0.969	0.00380	No	0.51	No
Iron	0.3	0.0831	No	0.277	0.218	No	0.381	No	0.0614	No	0.205	0.235	No	0.26	No
Lead	0.001	0.000221	No	0.221	0.00113	No	0.196	No	0.000348	No	0.348	0.000547	No	0.64	No
Lithium	-	0.00250	-	-	<0.005	No	-	No	0.00255	-	-	<0.005	No	-	No
Magnesium	-	2.15	-	-	6.38	No	0.338	No	1.66	-	-	4.20	No	0.40	No
Manganese	-	0.00874	-	-	0.0398	No	0.220	No	0.00470	-	-	0.0120	No	0.39	No
Mercury	0.000026	0.0000259	No	0.996	0.00000613	Yes	4.23	No	0.00000556	No	0.214	<0.00001	No	-	No
Molybdenum	0.073	0.000116	No	0.00159	<0.00005	No	-	No	0.0000357	No	0.00049	0.0000590	No	0.61	No
Nickel[4]	0.0643	0.00447	No	0.0695	0.0123	No	0.364	No	0.00400	No	0.0622	0.0113	No	0.35	No
Phosphorus	4	0.00561	No	0.00140	0.0109	No	0.514	No	0.00398	No	0.0010	0.00975	No	0.41	No
Potassium	-	0.438	-	-	0.807	No	0.542	No	0.454	-	-	0.913	No	0.50	No
Selenium	0.001	0.000120	No	0.120	0.000324	No	0.371	No	0.0000664	No	0.0664	<0.0002	No	-	No
Silver	0.0001	0.0000193	No	0.193	<0.00001	No	-	No	0.00000511	No	0.0511	<0.00001	No	-	No
Sodium	-	0.950	-	-	1.74	No	0.545	No	0.798	-	-	1.88	No	0.42	No
Strontium	-	0.0245	-	-	0.0460	No	0.531	No	0.0166	-	-	0.0495	No	0.34	No
Thallium	0.0008	0.000710	No	0.887	<0.00005	No	-	No	0.000108	No	0.135	<0.0001	No	-	No
Tin	-	0.000731	-	-	0.00273	No	0.268	No	0.000101	-	-	<0.0001	No	-	No
Titanium	-	0.00348	-	-	<0.0003	No	-	No	0.00498	-	-	<0.01	No	-	No
Uranium	0.015	0.0000107	No	0.000716	0.000304	No	0.035	No	0.00000644	No	0.00043	0.0000160	No	0.40	No
Vanadium	-	0.000254	-	-	<0.00001	No	-	No	0.000226	-	-	<0.001	No	-	No
Zinc	0.03	0.00506	No	0.169	0.0197	No	0.257	No	0.00188	No	0.063	0.00510	No	0.37	No

Notes:

COPC = contaminant of potential concern, CCME = Canadian Council of Ministers of the Environment

[1] *CCME (2013e). Canadian Water Quality Guidelines for the Protection of Aquatic Life, long term.*

[2] *Values provided are the 95th percentile concentration of metals in lakes sampled in 1993, 1997, 2011, 2012, and 2013 (n = 113 for George Property Area lakes; n = 126 for Goose Property Area lakes).*

[3] *Units are pH rather than mg/L.*

[4] *CCME Guideline pH or hardness dependent.*

[5] *CCME Guideline for hexavalent chromium.*

(-) no value, < means that the concentration for the parameter was below detection limits

Grey shading indicates concentrations that exceed the CCME Guidelines, or a hazard quotient that exceeds 1.

Table 6.4-9. Lake Freshwater Sediment Screening for Contaminants of Potential Concern for Sites within the Freshwater Environment Local Study Area

		Goose Property Area							George Property Area						
Total Metals	CCME Guideline[1] (mg/kg)	Predicted Mean Lake Sediment Concentration (mg/kg)	Predicted Concentration > Guideline?	Hazard Quotient Relative to Guideline	95th Percentile of Baseline Lake Sediment Concentration[2] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?	Predicted Mean Lake Sediment Concentration (mg/kg)	Predicted Concentration > Guideline?	Hazard Quotient Relative to Guideline	95th Percentile of Baseline Lake Sediment Concentration[2] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?
Aluminum[5]	-	14,872	-	-	32,200	No	0.462	No	9,484	-	-	15,100	No	0.628	No
Antimony	-	0.177	-	-	0.398	No	0.445	No	0.0800	-	-	0.140	No	0.571	No
Arsenic	5.9	95.6	Yes	16.2	125	No	0.762	No	20.3	Yes	3.44	54.8	No	0.371	No
Barium	-	56.3	-	-	141	No	0.400	No	51.2	-	-	86.6	No	0.592	No
Beryllium	-	0.483	-	-	1.06	No	0.458	No	0.414	-	-	0.765	No	0.541	No
Bismuth	-	0.249	-	-	0.500	No	0.497	No	0.117	-	-	0.220	No	0.533	No
Cadmium[5]	0.6	0.398	No	0.663	1.12	No	0.355	No	0.303	No	0.505	0.634	No	0.478	No
Calcium	-	2395	-	-	3355	No	0.714	No	2,391	-	-	3,623	No	0.660	No
Chromium	37.3	52.8	Yes	1.42	120	No	0.440	No	27.5	No	0.738	41.9	No	0.658	No
Cobalt	-	37.4	-	-	73.9	No	0.506	No	20.0	-	-	36.7	No	0.547	No
Copper[5]	35.7	77.3	Yes	2.17	159	No	0.488	No	74.6	Yes	2.09	139	No	0.538	No
Iron	-	31,898	-	-	50,800	No	0.628	No	22,948	-	-	66,650	No	0.344	No
Lead	35	6.90	No	0.197	12.0	No	0.577	No	5.32	No	0.152	8.12	No	0.655	No
Lithium	-	28.9	-	-	66.4	No	0.436	No	11.8	-	-	18.5	No	0.639	No
Magnesium	-	8,818	-	-	19,775	No	0.446	No	3,664	-	-	5,934	No	0.618	No
Manganese	-	556	-	-	1,845	No	0.301	No	148	-	-	449	No	0.331	No
Mercury	0.17	0.0302	No	0.178	0.0554	No	0.545	No	0.0559	No	0.329	0.101	No	0.554	No
Molybdenum	-	1.62	-	-	3.71	No	0.438	No	0.979	-	-	1.76	No	0.556	No
Nickel[5]	-	97.6	-	-	175	No	0.558	No	69.0	-	-	127	No	0.543	No
Potassium	-	1,019	-	-	2,923	No	0.349	No	755	-	-	1,157	No	0.653	No
Selenium	-	0.349	-	-	0.658	No	0.530	No	0.445	-	-	0.800	No	0.557	No
Silver	-	0.227	-	-	0.500	No	0.455	No	0.162	-	-	0.376	No	0.431	No
Sodium	-	104	-	-	210	No	0.497	No	106	-	-	184	No	0.576	No
Strontium	-	11.6	-	-	22.2	No	0.525	No	14.6	-	-	27.1	No	0.538	No
Thallium	-	0.161	-	-	0.500	No	0.322	No	0.0987	-	-	0.141	No	0.699	No
Tin	-	1.21	-	-	2.50	No	0.482	No	1.02	-	-	<1	No	-	No
Titanium	-	460	-	-	1203	No	0.382	No	302	-	-	434	No	0.695	No
Uranium	-	1.35	-	-	2.53	No	0.533	No	1.32	-	-	2.17	No	0.606	No
Vanadium	-	37.0	-	-	83.5	No	0.443	No	30.4	-	-	43.2	No	0.705	No
Zinc	123	145	Yes	1.18	311	No	0.467	No	71	No	0.581	120	No	0.594	No

Notes:

COPC = contaminant of potential concern, CCME = Canadian Council of Ministers of the Environment

[1] CCME (2013b). Canadian Interim Sediment Quality Guidelines for the Protection of Aquatic Life.

[2] Values provided are the 95th percentile concentration of metals in lake sediment sampled in 2007, 2010, 2011, 2012, and 2013 (n = 58 for George Property Area Lakes; n = 130 for Goose Property Area Lakes). Concentrations below method detection limits were set to half the method detection limit.

(-) no value, < means that the concentration for the parameter was below detection limits

Table 6.4-10. Soil Screening for Contaminants of Potential Concern for Sites within the Terrestrial Local Study Area

Metals	Predicted Mean Soil Concentration (mg/kg)	CCME Soil Guidelines[1] (mg/kg)	Predicted Concentration > Guideline?	Hazard Quotient Relative to Guideline	95th Percentile of Baseline Soil Concentration[2] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?
Aluminum	4,560	-	-	-	8,463	No	0.539	No
Antimony	<0.10	20	No	-	<0.10	No	-	No
Arsenic	6.93	12	No	0.578	20.0	No	0.346	No
Barium	38.0	750	No	0.0507	93.2	No	0.408	No
Beryllium	0.149	4	No	0.0371	0.446	No	0.333	No
Bismuth	<0.20	-	-	-	<0.20	No	-	No
Cadmium	0.112	1.4	No	0.0799	0.402	No	0.278	No
Calcium	2,203	-	-	-	5,622	No	0.392	No
Chromium	14.5	64	No	0.226	30.8	No	0.471	No
Cobalt	6.65	40	No	0.166	11.26	No	0.591	No
Copper	18.4	63	No	0.292	65.7	No	0.280	No
Iron	9,059	-	-	-	15,380	No	0.589	No
Lead	2.35	70	No	0.0336	4.17	No	0.564	No
Lithium	6.87	-	-	-	15.8	No	0.436	No
Magnesium	2,428	-	-	-	5,193	No	0.468	No
Manganese	68.1	-	-	-	141	No	0.483	No
Mercury	0.0334	6.6	No	0.00506	0.1208	No	0.276	No
Molybdenum	0.380	5	No	-	0.81	No	0.467	No
Nickel	19.6	50	No	0.392	50.0	No	0.392	No
Phosphorus	481	-	-	-	976	No	0.493	No
Potassium	431	-	-	-	688	No	0.626	No
Selenium	0.186	1	No	0.186	0.594	No	0.314	No
Silver	<0.10	20	No	-	<0.10	No	-	No
Sodium	72.3	-	-	-	130	No	0.556	No
Strontium	14.4	-	-	-	32.9	No	0.438	No
Thallium	0.0384	1	No	0.0384	0.081	No	0.472	No
Tin	<2.0	5	No	-	<2.0	No	-	No
Titanium	235	-	-	-	429	No	0.548	No
Uranium	0.598	23	No	0.0260	1.61	No	0.371	No
Vanadium	18.4	130	No	0.142	32.0	No	0.574	No
Zinc	16.9	200	No	0.0846	35.8	No	0.473	No

Notes:

CCME = Canadian Council of Ministers of the Environment

[1] *CCME (2013c). Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural.*

[2] *95th percentile of soil metal concentrations for data collected in 2012.*

(-) = no value, < indicates the value or mean was below the method detection limit for that parameter.

Table 6.4-11. Vegetation Screening for Contaminants of Potential Concern for Sites within the Terrestrial Local Study Area

Metals	Predicted Mean Concentration (mg/kg)	95th Percentile of Baseline Concentration[1] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?
Aluminum	302	685	No	0.440	No
Antimony	< 0.050	< 0.050	No	-	No
Arsenic	0.287	0.647	No	0.444	No
Barium	17.9	26.3	No	0.679	No
Beryllium	< 0.5	< 0.5	No	-	No
Bismuth	< 0.150	< 0.150	No	-	No
Cadmium	0.0175	0.0706	No	0.248	No
Calcium	1315	1814	No	0.725	No
Chromium	< 0.50	< 0.50	No	-	No
Cobalt	2.38	7.19	No	0.330	No
Copper	3.34	7.14	No	0.468	No
Iron	281	551	No	0.510	No
Lead	0.462	0.862	No	0.536	No
Lithium	< 0.50	< 0.50	No	-	No
Magnesium	442	530	No	0.834	No
Manganese	61.1	104	No	0.588	No
Mercury	0.0240	0.0588	No	0.409	No
Molybdenum	< 0.050	< 0.050	No	-	No
Nickel	6.67	25.2	No	0.265	No
Phosphorus	339	403	No	0.84	No
Potassium	983	1169	No	0.841	No
Selenium	< 1.0	< 1.0	No	-	No
Silver	< 0.050	< 0.050	No	-	No
Sodium	< 100	< 100	No	-	No
Strontium	5.91	8.99	No	0.657	No
Thallium	< 0.050	< 0.050	No	-	No
Tin	< 0.250	< 0.250	No	-	No
Titanium	6.90	12.9	No	0.535	No
Uranium	0.0331	0.0853	No	0.388	No
Vanadium	<0.50	< 0.50	No	-	No
Zinc	16.4	21.7	No	0.756	No

Notes:
[1] 95th percentile baseline metal concentrations in vegetation samples collected in 2012.
(-) = no value, < indicates the value or mean was below the method detection limit for that parameter.

Table 6.4-12. Berries Screening for Contaminants of Potential Concern for Sites within the Terrestrial Local Study Area

Metals	Predicted Mean Concentration (mg/kg)	95th Percentile of Baseline Concentration[1] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?
Aluminum	2.58	5.52	No	0.467	No
Antimony	< 0.010	< 0.010	No	-	No
Arsenic	< 0.010	< 0.010	No	-	No
Barium	3.57	6.11	No	0.585	No
Beryllium	< 0.10	< 0.10	No	-	No
Bismuth	< 0.030	< 0.030	No	-	No
Cadmium	0.0121	0.0265	No	0.458	No
Calcium	287	458	No	0.626	No
Chromium	< 0.10	< 0.10	No	-	No
Cobalt	0.0508	0.0894	No	0.568	No
Copper	0.916	1.38	No	0.665	No
Iron	1.76	3.02	No	0.583	No
Lead	< 0.020	< 0.020	No	-	No
Lithium	< 0.10	< 0.10	No	-	No
Magnesium	123	176	No	0.701	No
Manganese	38.2	59.4	No	0.643	No
Mercury	< 0.0010	< 0.0010	No	-	No
Molybdenum	0.00980	0.0194	No	0.505	No
Nickel	0.522	0.994	No	0.525	No
Phosphorus	222	279	No	0.796	No
Potassium	1422	2048	No	0.694	No
Selenium	< 0.20	< 0.20	No	-	No
Silver	< 0.010	< 0.010	No	-	No
Sodium	< 200	<200	No	-	No
Strontium	0.640	1.36	No	0.472	No
Thallium	< 0.010	< 0.010	No	-	No
Tin	0.181	0.259	No	0.697	No
Titanium	< 1.0	< 1.0	No	-	No
Uranium	< 0.0020	< 0.0020	No	-	No
Vanadium	< 0.10	< 0.10	No	-	No
Zinc	3.40	7.26	No	0.468	No

Notes:
[1] 95th percentile baseline metal concentrations in berry samples collected in 2012.
(-) = no value, < indicates the value or mean was below the method detection limit for that parameter.

6.4.1.11 Risk Assessment — Terrestrial Wildlife

6.4.1.11.1 Identification of Contaminants of Potential Concern

No Project-related COPCs were identified during the screening process for the freshwater environment (Section 6.4.1.7.2) or the terrestrial environment (soil in Section 6.4.1.7.4; vegetation in Section 6.4.1.7.5). Freshwater water and sediment, soil, and vegetation metal concentrations were within the 95th percentile of baseline concentrations and/or were below freshwater, sediment, or soil quality guidelines. Therefore, based on information currently available and assuming that mitigation measures are fully implemented (Section 6.4.1.3), no health impacts for the wildlife VECs in the terrestrial environment (caribou, muskox, wolverine and furbearers, grizzly bears, migratory birds, and raptors) are expected from emissions or discharges associated with Project activities.

6.4.1.12 Uncertainties in the Environmental Risk Assessment

The process of evaluating risks to ecological VECs from exposure to COPCs in environmental media involves multiple steps, each containing inherent uncertainties that ultimately affect the final risk estimates. These uncertainties exist in numerous areas, including the collection of samples, laboratory analysis, estimation of potential exposures or prediction of COPC concentrations in environmental media (modelling), and derivation of TRVs, potentially resulting in either an over- or under-estimation of risk. However, for the present study, where uncertainties existed, a conservative approach was taken to overestimate rather than underestimate potential risks.

There is inherent uncertainty associated with the use of any model as real world processes, such as atmospheric conditions, are simplified. Baseline sampling did not include the concentration of metals in air associated with PM_{10} and this was calculated based on the proportion of metals in dustfall, which has several assumptions involved. Furthermore, predicted concentrations of metals associated with PM_{10} were also calculated based on the proportion of metals in Back River rocks, again with several assumptions. In general, air dispersion models accurately but conservatively predict atmospheric concentrations and deposition levels so that model results are often interpreted with the understanding that the predicted effects are likely overestimated.

Freshwater and sediment were collected inside the LSA during baseline studies from several years (1993, 1997, 2011, 2012, and 2013; n = 239 for water and n = 188 for sediments) and used to establish baseline concentrations and total (baseline plus Project) model predictions. Soil samples (n = 35) were collected inside the LSA in 2012. Vegetation samples co-located with soil samples and inside the LSA (berry n = 15, lichen n = 18, and sedge n = 3) were collected in 2012. These datasets are considered large enough to provide a good indication of the COPC concentrations in these environmental media in the LSA and provide adequate statistical estimates for screening purposes.

Laboratory non-detects of metal concentrations in water, sediments, and soils add uncertainty as the non-detects are set to half their method detection limit for calculation purposes (i.e., statistical summaries of means and 95th percentiles) and for screening of COPCs. This approach assumes that, on average, all values between the detection limit and zero could be present, and that the average value of non-detects could be as high as half the detection limit. Generally, replacement of non-detects with values half of their detection limit is a conservative estimate and recommended when there is a likelihood that the COPC is actually present (actual concentration is larger than zero), but does not over-estimate the concentration (actual concentration is smaller than the detection limit) and therefore does not over-estimate potential risk (US EPA 1991).

Biotransfer factors were used to model Project-related plant COPC concentrations. Modelling of plant COPC concentrations has a higher level of uncertainty than measuring concentrations. Biotransfer

factors were calculated on a site-specific basis from baseline concentrations in co-collected soil and plant baseline samples wherever possible. This method assumes that the plant obtained the COPCs entirely from the soil that was analyzed and excludes uptake from other sources. This approach is conservative as it would over-estimate the actual soil-to-plant BTF. Where concentrations were below method detection limits, BTFs could not be calculated reliably and were substituted with non-site specific literature-based BTFs. This added an additional level of uncertainty.

6.4.1.13 Conclusions of the Environmental Risk Assessment for Contaminants

No Project-related COPCs, including metals, were identified in the freshwater, marine, or terrestrial environments. Thus, there is negligible potential risk of the Project on health of fish and aquatic habitat, fish communities, wildlife, migratory birds, and raptor VECs.

6.4.2 Human Health Risk Assessment (HHRA) for Contaminants

6.4.2.1 Introduction to Human Health Risk Assessment

Risk assessment is a tool used to characterize potentially adverse health effects from Project-related contaminant emissions.

The following five steps are generally included in the risk assessment:

1. Problem Formulation: identifies a representative set of receptors that may be present, COPCs that may be present at levels potentially harmful to receptors, and pathways by which receptors may be exposed to COPCs. A conceptual model, which is a pictorial representation of the exposure pathways and routes of COPCs associated with this specific assessment, is one of the major outcomes of the Problem Formulation.
2. Exposure Assessment: the extent to which receptors might be exposed to the COPCs. Calculates the estimated daily intake (EDI) of COPCs by receptors for each relevant exposure pathway identified in the Problem Formulation. The calculations use site-specific COPC concentrations in environmental media (e.g., air, water, sediment, soil, vegetation, and country foods) and receptor-specific characteristics (e.g., body weight, ingestion rate, and consumption frequency).
3. Effects Assessment: identifies tolerable daily intakes (TDIs), or levels of daily exposure that can be taken into the body without appreciable health risk. These are referred to as toxicity reference values (TRVs) by some regulatory agencies. For COPCs with guidelines, these values were used instead of TRVs.
4. Risk characterization: determines the potential occurrence of adverse health effects by comparing the EDI with the TRV or the predicted concentration of a COPC with the guideline limit for that COPC.
5. Uncertainty Analysis and Data Gaps: evaluation of the assumptions, uncertainties and conservatism made throughout the assessment and their effects on the conclusions.

The main pathways through which human health can be affected by the environment are through air quality, drinking water, and consumption of country foods. The HHRA is organized to assess the potential for effects to human health from each of these general pathways.

6.4.2.2 Potential Valued Components and Scoping for the HHRA

Canadian federal and provincial governments and health officials have accepted the World Health Organization's (WHO) definition of holistic health:

> *A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.* (WHO 1948)

This was expanded to include:

> *The extent to which an individual or group is able, on the one hand, to realize aspirations and to satisfy needs, and on the other, to change or cope with the environment. Health is therefore seen as a resource for everyday life, not the objective of living; it is seen as a positive concept emphasizing social and personal resources, as well as physical capacities.* (WHO 1984)

This definition indicates that all aspects of well-being should be considered when assessing human health, including physical, social, emotional, spiritual, and environmental impacts on health. There are many determinants of human health, such as: the physical environment (including environmental contaminants), heredity, lifestyle (e.g., smoking, drinking, diet, exercise, and coping skills), occupation, education, and the social and economic environment a person lives in (Health Canada 2000).

The selection of potential VECs or VSECs for the Project was based on a scoping process developed by NIRB and Sabina Gold & Silver Corp., which involved public consultation with all potentially-affected communities, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations.

There are many VECs or subjects of note related to the human environment included in the DEIS:

- Archaeology;
- paleontology (subject of note);
- non-traditional land and resource use;
- socio-economics (VEC = economic development, business opportunities, employment, education, and training);
- health, safety and community well-being; and
- country foods.

However, not all of these VSECs or subjects of note are relevant for the HHRA since they would not be considered susceptible to effects from contaminants or noise, or would not be pathways for contaminant exposure in human receptors. In addition, some of the VECs listed in the previous section (6.3.1.1) for the ERA would be relevant for the HHRA since the VECs may be pathways through which contaminant exposure to human receptors could occur. Further scoping of the VECs and VSECs for inclusion in the HHRA is detailed in Section 6.3.2.2.

6.4.2.3 Valued Components Included in HHRA

The Project has the potential to adversely affect human health, directly and indirectly, during the Site Preparation, Construction, Operational, Reclamation and Closure, and Post-closure phases. The inclusion of human health into the ERA process in Canada has been mandated by the federal government (e.g., Health Canada) and by Nunavut under various requirements, such as:

- Nunavut Impact Review Board (NIRB 2006): *Guide to the Preparation of Environmental Impact Statements* recommends identifying, predicting, evaluating, and communicating information about the impacts of a development proposal on human health.

Health Canada (2004a, 2010e) suggests that environmental assessments contain information, as applicable, on:

- noise effects;
- air quality effects;
- drinking and recreational water quality;
- contamination of country foods (fish, wild game, berries, etc.);
- radiological effects;
- electric and magnetic fields effects;
- federal air, water, and soil quality guidelines/standards used in HHRAs; and
- First Nations and Inuit health.

Humans, and consequently human health, have the potential to interact with Project components, and health is of high importance to society and individuals. The physical component of human health was considered in the HHRA because the physical health of humans living in or travelling through the Project area has the potential to be affected directly through either biochemical pathways (e.g., contaminants in water, air, or country food) or biophysical pathways (noise).

Radiological effects and electric/magnetic field effects were not considered since the Project is not expected to lead to alterations in radiological, electric, or magnetic levels. Ultimately, the selection of VECs or VSECs for inclusion in the HHRA was also directed by the EIS Guidelines for the Project.

Of the VSECs included in the Project DEIS, archaeology or paleontology would not be affected by contaminants or noise and were therefore excluded from the HHRA. Volume 8, Chapters 3 (Socio-economics) and 4 (Land Use), of this DEIS contain an assessment of other non-physical determinants of health that are not included in this HHRA, such as education, employment, health and community well-being, and land use.

6.4.2.4 Spatial Boundaries

The spatial boundaries for the HHRA are defined, in part, by the extent to which the Project might be expected to have effects on the environment (i.e., air quality, drinking water quality, quality of country foods), which could in turn affect human health. The following criteria were used to determine the spatial boundaries:

- the physical or socio-economic extent of project activities and potential Project impacts;
- the location and distribution of VECs or VSECs, including the spatial extent of ecosystems and protected areas potentially affected by the Project; and
- the spatial extent of the known current use of lands and resources for traditional purposes.

Four general spatial boundaries were used in the HHRA:

1. Project Footprint — includes all physical structures and activities that comprise the Project as specified in the Project Description (Volume 1, Chapter 3).
2. Potential Development Area (PDA) — includes the Project Footprint, plus a buffer area.
3. LSA — includes both the Project Footprint and the PDA and is the area where there is a reasonable expectation of immediate impacts from the Project activities on valued environmental and socio-economic components. The LSA includes the PDA plus a buffer.
4. RSA — a broader area where there is a potential for direct, indirect, or cumulative environmental or socio-economic impacts and includes lands, waters, and potentially affected communities in the Nunavut Settlement Area (NSA).

The LSA and RSA for the country foods effects assessment (Volume 8, Chapter 5) and HHRA are the same. The HHRA LSA includes two boxes around the Goose and George Property Areas (the same shape and size as the air quality LSA) and a smaller box around the MLA on the Bathurst Inlet peninsula. The LSA also includes a 1-km buffer zone along the main winter roads connecting the properties. The LSA encompasses many of the baseline sampling locations for tissue metal concentrations in fish, and water, sediment, vegetation, and soil quality.

The HHRA RSA is the same as the one used by terrestrial and country foods VECs and covers all the areas included in the HHRA LSA. It was delineated based on the expected use of the region by wildlife species assessed as VECs. The RSA extends 35 km from the Goose and George properties, the MLA, and the main winter road access corridors. The RSA was selected to reflect a larger area anticipated to provide habitat for raptors, carnivores and caribou, which have large home ranges. The HHRA LSA and RSA can be seen in Figure 6.4-12.

The potential health effects from the Project from changes to air quality, drinking water quality, and quality of country foods are evaluated separately, although it is acknowledged that the combination of effects can act synergistically or additively to affect the overall health and feeling of well-being of people at the Project site and of temporary users of adjacent areas.

6.4.2.5 Temporal Boundaries

Human health could potentially be affected throughout all phases of the Project. Temporal boundaries 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. The Project is expected to have negligible potential impacts on VECs outside of these temporal boundaries. Temporal boundaries were defined based on for the following Project phases:

- Site Preparation — 2 years;
- Construction phase — 2 years;
- Operational phase — 10 years;
- Reclamation and Closure phase — 10 years;
- Post-closure phase — 5 years;
- Other potential phases:
  - Temporary Closure — less than 2 years, and
  - Care and Maintenance phase — 2 to 10 years.

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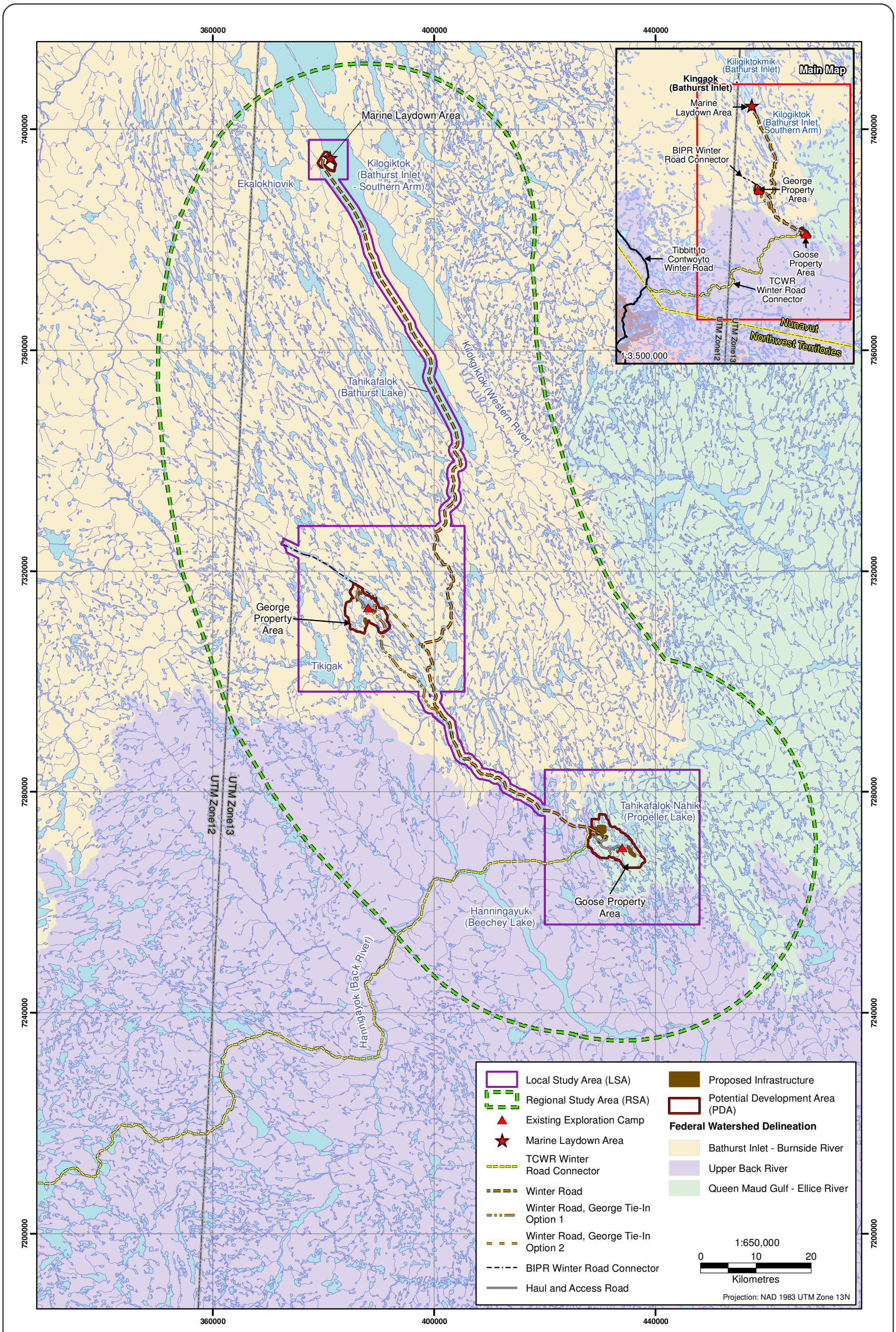


Figure 6.4-12

Sabina GOLD & SILVER CORP.

Human Health Risk Assessment Local and Regional Study Areas, Back River Project

Figure 6.4-12

Rescan an ERM company

There are two main pathways for contaminants to enter the environment: airborne emissions (e.g., dust, particulates, and gases) and liquid emissions (e.g., effluent discharge). For the purposes of the HHRA and based on the information available at the time of writing, the phase in which the greatest potential for effects to human receptors was selected for assessment, with consideration of the potential for both air and water emissions during those phases. This was done to represent the upper bound of expected Project-related changes and therefore represents the phase or phases associated with the greatest level of risk; risk during other phases would be expected to be lower. Selection of Project phases for assessment and the rational for their selection is described in the following sections.

6.4.2.5.1 Potential for Human Health Effects Related to Air Quality

The Operational phase was selected for assessment, since this phase was considered to have the highest potential for Project-related air emissions (Volume 4, Chapter 1 and Appendix V4-1B). Other phases of the Project would be expected to have lower emissions, and thus lower potential risk to human health due to air quality.

6.4.2.5.2 Potential for Human Health Effects Related to Drinking Water Quality

The Operational phase was considered to have the highest potential for effects to human health through the consumption of drinking water. This is the phase during which people (e.g., off-duty workers) are most likely to be present in close proximity to Project site (see Section 6.4.2.5.4).

Although there will be no discharge of effluent to the freshwater environment during this phase, the potential for fugitive dust emissions are highest during the Operational phase (Volume 4, Chapter 1 and Appendix V4-1B). Contaminants can be carried from sources to receptors by fugitive dust, which can be then deposited on surface waters as dustfall. Therefore, the Operational phase represents the upper bound or worst-case for potential water quality effects due to dust deposition (i.e., air emissions).

6.4.2.5.3 Potential for Human Health Effects Related to Quality of Country Foods

Based on the information available at the time of assessment, the Operational phase was considered to have the greatest potential for effects to health of consumers of country foods (Volume 8, Chapter 5). This also aligns with the air quality assessment, which used Year 3 of the Operational Phase for Goose Property and Year 7 of the Operational phase for George Property as the worst case scenario (Volume 4, Chapter 1). The Operational phase was selected since the greatest level of Project-related activity will occur during this phase and therefore it is likely to have the greatest potential for both air and liquid/water emissions of potential contaminants that could affect the quality of country foods.

6.4.2.6 Mitigation Measures

No additional mitigation measures were considered in the assessment beyond what was outlined in the previous chapters. Mitigation measures for air quality were covered in Volume 4, Chapter 1. Mitigation measures for surface water quality were covered in Volume 6, Chapter 4. Mitigation measures for country foods were covered in Volume 8, Chapter 5.

6.4.2.6.1 Mitigation Measures for Fuels, Other Petroleum Products, and Hazardous Substances

Certain atmospheric emissions from the Project were excluded from consideration as COPCs. These include volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins, furans, and acid gases. Although dioxins and furans may be deposited on the surrounding landscape and enter the local food web from soil, water, and vegetation, use of controlled incineration technology is predicted to substantially reduce the potential contamination exposures (Webster and Mackay 2007).

An Incineration Management Plan (Volume 10, Chapter 11) will be in place during all phases of the Project in order to minimize emissions from incineration activities. This plan will include the installation of an incinerator that complies with Nunavut standards (Government of Nunavut 2002) and the Canada-Wide Standards for Dioxins and Furans (CCME 2000a) and Canada-Wide Standards for Mercury emissions (CCME 2000b). An Air Quality Monitoring and Management Plan (Chapter 17, Volume 10) will also be implemented. Due to mitigation, such as installing modern incineration equipment, and regular maintaining vehicle, generator, and incinerator emission controls, Project related PAH releases to the environment are unlikely to be at high enough concentrations to affect human health (Volume 6, Chapter 4). VOCs were not included in the assessment because standards or objectives for ambient VOC concentrations have yet to be established for Nunavut and Canada and emission levels from the Project are expected to be minimal. Acid gases are not expected to affect human health.

Fuels, petroleum products, and other hazardous substances used in mine development and operation could affect human health if not properly managed. Since the potential for effects to human health is related to the quality of environmental media, protection of the environment is important for minimizing potential effects to human health.

Petroleum products, such as fuel and hydraulic oil, will be present at the Project throughout the various phases (except post-closure). Flocculants and chemical reagents, such as ammonium nitrate and lime, will be used and stored at the site. Hazardous substances may be present during the Site Preparation, Construction, Operational, and Closure and Reclamation phases of the Project. This includes materials such as fuel, waste oil, explosives, cyanide, sulphuric acid, chlorine, laboratory chemicals and solvents, lead acid batteries, and oil filters.

Fuels, other petroleum products (e.g., oils), and hazardous substances stored and used during Project development inside the LSA will require mitigation and management measures to ensure that they do not enter the freshwater, marine, and terrestrial environments. The Fuel Management Plan (Chapter 4), Spill Contingency Plan (Chapter 5), Oil Pollution Emergency Plan (Chapter 6), Mine Waste Rock and Tailings Management Plan (Chapter 9), Landfill and Waste Management Plan (Chapter 10), Hazardous Materials Management Plan (Chapter 12), Explosives Management Plan (Chapter 13), and Shipping Management Plan (Chapter 15) can be found in Volume 10. Proper storage, handling, and clean-up of any spills of fuels/petroleum products and potentially hazardous substances will reduce the potential for these products to affect ecological receptors. Details of a few of the key mitigation strategies related to these substances are listed as follows:

- bulk fuel storage areas, hazardous materials storage areas, and explosives storage facilities will be bermed and lined with impermeable barriers to minimize the potential for leaks and spills to reach the aquatic environment, thereby minimizing the potential for these chemicals or fuels to affect ecological receptors;
- cyanide destruction will occur in the mill, in order to decrease the levels of cyanide that may be found in the TIA;
- petroleum product storage tanks will have appropriate secondary containment systems to prevent hydrocarbon/fuel release to the environment;
- refuelling and maintenance activities will be done at least 30 m away from water (except in case of equipment breakdown or approved activities near water) and refuelling will be done only when drainage capture/collection is installed or drip trays are in use;
- all machinery that has the potential to have a fluid release or leak will be inspected prior to each shift and repaired as necessary, and oily water treatment plants at equipment

maintenance facilities will be used to minimize the introduction of hydrocarbon contaminants into the environment, minimizing their potential for uptake by aquatic organisms;

- an Aquatic Effects Management Plan (Volume 10, Chapter 19) will be implemented to monitor for changes in the aquatic environment as a result of Project activities; and
- if water or waste could pose a risk to wildlife, appropriate measures will be taken to exclude wildlife from these areas (e.g., fencing and noise makers; Wildlife Management Plan, Volume 10, Chapter 20).

In addition, other hazardous substances such as hydraulic fluid, explosives, laboratory chemicals and solvents, lead acid batteries, and oil filters may be present during various Project phases. Safe handling and storage of hazardous materials is governed by the Hazardous Materials Management Plan (Volume 10, Chapter 12) and therefore these materials are not expected to pose a risk to human health through contamination of air, water, or country foods.

Accidental releases of fuels, other petroleum products, and hazardous substances will be responded to efficiently and safely as described in the Spill Contingency Plans (Volume 10, Chapter 5). In particular, the following key spill mitigation measures will minimize and prevent exposure of human receptors:

- Ships used in the transport of fuel will be conventional double-hulled, compartmentalized petroleum tankers, with Shipboard Oil Pollution Emergency Plans and appropriate response gear;
- The bulk fuel storage facility, pipeline, and all transfer-related equipment will be inspected and maintained in order to minimize the potential for fuel leaks or spills to the aquatic and terrestrial environments;
- An Oil Pollution Emergency Plan (Volume 10, Chapter 6) will be implemented, including the measures to be used to contain and clean up a potential spill of oil in the marine and freshwater environments; and
- Ship and MLA spill response equipment and personnel will be prepared for deployment prior to fuel transfer operations, to ensure a rapid response in the event of a spill to the marine environment, and transfer hoses/pipeline will be monitored hourly for leaks or defects during fuel transfers.

Because spills will be contained and cleaned up according to the Oil Pollution Emergency Plan (Volume 10, Chapter 6), the effects of fuel, lubricants, and other COPCs on marine country foods (shellfish, fish, waterfowl, and marine mammals) will be low.

In addition, in the marine environment, shipping will be limited to five to ten ships per year during the Construction phase and three to five ships per year during the Operational phase. Ships will not be permitted to discharge untreated sewage or oil-containing bilge water in the vicinity of the MLA, in accordance with the Vessel Pollution and Dangerous Chemicals Regulation (2001). The use of organotin anti-fouling compounds is prohibited for vessels in Canadian waters and will not be used by vessels servicing the Project. This will minimize the potential for release of contaminants to the marine environment within the LSA and will, therefore, minimize effects to marine water and sediments. Therefore, the sources of fuels/petroleum products and other potentially hazardous substances and their potential effects on human health are considered negligible and will not be considered further.

6.4.2.7 Problem Formulation and Pathway Analysis

The purpose of this section is to establish whether there is a reasonable possibility that there is a linkage between a Project-related source of contaminants and human receptors. There are two main

potential sources of Project-related contaminants: atmospheric emissions of criteria air contaminants (CACs) and fugitive dust; and liquid effluent (e.g., effluent, site runoff).

Atmospheric emissions and contaminants associated with fugitive dust have the potential to enter the atmosphere, travel some distance, and settle where they can reside in different media such as marine and freshwater waterbodies, marine and freshwater sediment, soil and vegetation, and country foods. Liquid effluent has the potential to enter the terrestrial environment due to direct discharges, or enter the marine and freshwater environments (water and sediment) through runoff from the terrestrial environment.

6.4.2.7.1 Sources of Potential Project-related Contaminants

Since human health can be affected by changes in air, drinking water, or country foods quality, potential Project-related sources of contaminants were identified that could lead to changes in in these pathways. Air quality can be affected by the generation of atmospheric emissions from Project components or activities. Drinking water quality could be affected by Project components or activities that affect freshwater quality. The quality of country foods could be changed due to Project-related sources of contaminants in the atmospheric, freshwater, marine, or terrestrial environments.

Potential Sources of Project-Related Contaminants Specific to Air Quality

A detailed inventory of Project-related emissions sources, points of release and quantities of air contaminants released can be found in the Air Quality Modelling Report (Volume 4, Chapter 1, Appendix V4-1B or Rescan 2013i).

Project emissions to air are expected from the use of diesel as a fuel, from travel along unpaved roads, from blasting and ore preparation, and from the combustion of solid wastes at the camps. Diesel engines emit hydrocarbons, CO, $PM_{2.5}$, and PM_{10}, and were an input parameter to the air quality model. The Project is expected to contribute to air emissions from the combustion of diesel for transportation throughout the Project time frame, and for power generation during the Construction and Operational phases. Diesel emissions will be reduced during the Reclamation and Closure and Post-closure phases of the Project.

Incinerators will be used at all camps during the Construction and Operational phases to manage combustible solid wastes and to reduce the need for transportation and disposal of solid wastes off site. Combustion of wastes will result in the release of air contaminants to the environment during Construction, Operational, and Reclamation and Closure phases. Therefore, CAC emissions from incinerators were included into the air quality model.

Air emissions may also result from rock blasting in Goose and George Property Area deposits and at the processing plant. The detonation of explosives generates gases such as CO, NO_x, ammonia, and SO_2. Blasting will also create particulate matter that may contain metals. However, it is expected that blasting effects would be localized (Volume 4, Chapter 1) and will therefore have a very limited effect on the health of off-duty workers and people off-site. Criteria air contaminant emissions, dustfall, and associated metals from rock blasting were included in the air quality model.

CACs are primarily produced by combustion of diesel and other fuels, and includes carbon monoxide (CO), nitrogen oxides (NO_x), sulphur oxides (SO_x), ozone (O_3), and particulate matter that is less than 2.5 microns or 10 microns in size ($PM_{2.5}$, and PM_{10}, respectively). Fugitive dust is typically generated by blasting or equipment use and may be associated with COPCs such as metals. To summarize, sources of Project-related atmospheric contaminants considered in the air quality model included:

- stacks;
- the processing plant (including generators inside);
- the underground mines;
- generators in the pits and at camps;
- incinerators;
- equipment (such as mining and personnel trucks, drill rigs, and bulldozers in mines and on access roads);
- aircraft;
- shipping vessels; and
- dust emissions from grading and bulldozing, and explosives from drilling and blasting.

Potential Sources of Project-related Contaminants Specific to the Freshwater Environment

During the various Project phases, activities and components such as drilling, blasting, and excavation, air transportation, road use, and road maintenance can introduce fugitive dust into the air. Fugitive dust could then be deposited on surface waters, where contaminants associated with the fugitive dust (e.g., metals) could enter either the water or sediment.

Potential sources of effluent include the water management structures (TIA, WMF, and Collection Pond), treated effluent from sewage treatment plants at the camps, and water that has been in contact with Project infrastructure (e.g., site infrastructure, pits, underground mines, roads, etc.).

The water management facilities will collect and store effluents or run-off that may contain contaminants. Compounds used in explosives (e.g., ammonia, nitrate, and fuel/oil) may be present in run-off from waste rock storage areas or in effluent or tailings from the mill; effluent from these areas will be collected and directed to the appropriate water management facility. Contaminants may be present in treated sewage effluent which will be discharged to the land during the Construction phase, until water management facilities are built and effluent will then be directed to these structures. Site contact water, which may contain metals or other chemicals, will be collected and directed towards the water management structures in each of the Project areas (Goose Property Area, George Property Area, and the MLA).

Water quality modelling was conducted for effluent contained within the TIA. The Water Quality Prediction Report (Volume 11) provides details on the sources, points of release, and quantities (loadings) of potential contaminants (e.g., metals and blasting residues) to the TIA.

Discharge of effluent from water management structures during the Operational phase (i.e., WMF and Collection Pond only) could introduce contaminants to the terrestrial or aquatic environments, depending on the discharge location. The intended discharge location for these facilities is to land (> 500 m from water), but it is possible that run-off from the discharge locations may make its way to surface waters over time, carrying contaminants to the aquatic environment.

Some quarries' and road runoff will go to the environment but the quantities of contaminants associated with these potential sources were considered to be negligible relative to other sources (e.g., fugitive dust from blasting and road use). Any in-water works, such as stream crossings and diversion structures are considered to be potential sources of total suspended solids/turbidity and not COPCs.

Potential Sources of Project-related Contaminants Specific to the Marine Environment

Marine shipping during Construction and Operational phases can generate air pollutants through the combustion of diesel fuel. These air pollutants include CO, NO_x, SO_2, $PM_{2.5}$, and PM_{10}. Fugitive dust will arise from rock blasting, vehicle movement, handling of fine materials, and incineration of garbage. Generally dust will occur sporadically and be suspended for a relatively short time prior to deposition. The COPCs could then be taken up by benthic invertebrates, fish, and marine wildlife and could accumulate in the food chain.

Compounds used in explosives during construction of the MLA may be present in run-off that will be directed to the Collection Pond at the MLA. Metals occur naturally in environmental media (e.g., water, soil, sediment, and vegetation) due to local physical and geological processes, and their concentrations could potentially change due to Project activities depositing dust containing metals or due to metal leaching/acid rock drainage/metal leaching (ML/ARD).

Direct discharge of brine from the desalinization plant at the MLA into Bathurst Inlet is proposed; however, all other effluents or contact water in the MLA will be directed to the Collection Pond, and may be discharged to the tundra (> 500 m away from water). Although potential discharges may occur at some distance from the marine environment, run-off containing contaminants from the discharge location may reach the marine environment over time.

Potential Sources of Project-related Contaminants Specific to the Terrestrial Environment

Fugitive dust will arise from rock blasting, vehicle movement, and handling of fine materials. Generally dust will occur sporadically and be suspended for a relatively short time prior to deposition. Dust particles can be a carrier of metals naturally occurring in rocks and can deposit onto soils and vegetation. The COPCs could then be taken up by terrestrial wildlife and could accumulate in the country foods.

Discharge of effluent from water management structures during the Operational phase (WMF and Collection Pond only) could introduce small amounts of contaminants to the terrestrial environments (>500 m from water), where soil and vegetation may take up COPCs. The COPCs could then be taken up by terrestrial wildlife and could accumulate in country foods.

6.4.2.7.2 Potential Human Receptor Exposure Routes

Humans can be exposed to sources of Project-related contaminants via the ingestion, inhalation, and dermal contact exposure routes, as described in the following sections.

Inhalation

Inhalation is a potential exposure route if a contaminant is present in the air. Metals in dust, fine particulate matter, and other CACs released into the atmosphere from the Project and its activities could potentially affect air quality in HHRA LSA during Construction, Operational, and Reclamation and Closure phases of the Project. The inhalation exposure route was included as a potential exposure pathway in the HHRA.

Ingestion

Ingestion is a potential exposure route if the contaminant is ingested though country food, drinking, or hand-to-mouth behaviour.

Airborne contaminants and fugitive dust from the Project and its activities (Site Preparation, Construction, Operational, and Reclamation and Closure phases) could be deposited on the edible

portions of berries consumed by humans. COPCs from atmospheric deposition onto soil or vegetation could also be taken up by wildlife species via their diet, which could subsequently be taken in by people consuming country foods.

Inadvertent soil ingestion could also expose humans to contaminants from atmospheric deposition or effluent discharge. However, soil ingestion and hand-to-mouth behavior were not included as pathways because they are mainly of concern for children, and children are not likely to be present in the HHRA LSA and would not be affected by COPCs in soil.

Contaminants could also be deposited to surface water and may directly affect worker or public health if the water is ingested. Specific waterbodies in the study area used by Inuit for collecting drinking water were not identified historically (KIA 2012) or recently (Rescan 2013d). Drinking water was reported to be collected from rivers, streams and lakes as needed by trappers, hunters, and recreational users. Workers living in the George and Goose Camps will receive drinking water from George and Goose lakes and even though the water from George and Goose lakes will be treated, the assessment of drinking water for off-shift workers is included in this HHRA.

Dermal Contact

Dermal absorption is a potential exposure route if the contaminant can be absorbed through the skin. COPCs present in atmospheric or liquid/effluent emission from the Project and its activities could potentially be deposited onto soil or enter water in the HHRA LSA during the Site Preparation, Construction, Operational, and Remediation and Closure phases of the Project. Direct dermal contact with either soil or water could lead to contaminant uptake in off-duty workers or the public

Dermal contact is generally only considered in relation to exposure of children, but children are not expected in the HHRA LSA. Therefore, this route of exposure will not be included in the HHRA as dermal exposure to COPCs is not considered to represent a significant health risk in adults due to limited contact with soil and water (US EPA 1995).

6.4.2.7.3 Human Receptor Locations

The Project area is located in an isolated part of Nunavut with very limited road access. This area supports limited hunting, fishing, trapping, gathering, and recreational activities by Inuit, residents, and tourists (typically in tour groups).

The nearest land users to the Project are Inuit who temporarily access the traditional camping and hunting areas within in the HHRA LSA and RSA. While there are main travel routes within the area, Inuit land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables (Rescan 2013d).

Other potential land users are tourists visiting and exploring the area inside the HHRA LSA and RSA. There are also workers at an exploratory Arctic Char fishery near Kingaok. For this assessment it was assumed that the people who frequent these areas are potential receptors.

The important areas that tourists and locals may use are shown in Figures 6.4-13 and 6.4-14 (Rescan 2013d), many of which occur outside of the HHRA LSA and RSA. Activities or locations outside of the LSA or RSA will not be considered further, since the potential for Project-related effects to human health outside of these areas is negligible.

Activities and locations of potential human receptors with the HHRA LSA are summarized in the following paragraphs (Rescan 2013d).

Within the LSA, tourists may:

- visit the Bathurst Inlet Lodge camp at Fishing Creek (located near the MLA).

Within the LSA, local people may:

- be staff at the Bathurst Inlet Lodge camp at Fishing Creek (located near the MLA);
- be land users from Cambridge Bay, Omingmaktok, and Kingaok who trap, fish, and gather country foods throughout the area;
- hunt moose and caribou along the western shores of Bathurst Inlet in the summer and fall, and at times while travelling Bathurst Inlet by boat;
- fish throughout Bathurst Inlet and at many freshwater lakes in the area;
- harvest marine country foods (e.g., clams, mussels, sea urchin, starfish, and crab) in areas along Bathurst Inlet; and
- pass through on the way to Beechey Lake, a common destination for land users from Kingaok, Omingmaktok, and Cambridge Bay.

The area around Beechey Lake is used for hunting (caribou), trapping (wolf and wolverine), fishing, gathering (eider duck and Canada goose eggs), camping, and variety of other recreational activities. Beechey Lake is a main destination for hunters from Cambridge Bay who travel south from the community during the winter and typically overnight at Omingmaktok; these individuals continue their travel south through Bathurst Inlet on snowmobiles while fishing Arctic Char along the way. There are numerous places to make camp in the Beechey Lake area, including many old cabins and some that are currently used. Fishing often takes place in the Beechey Lake area as people camp there and hunt, fish, trap, and gather.

Specific waterbodies in the LSA used by Inuit for collecting drinking water were not identified historically (KIA 2012) or recently (Rescan 2013d). While travelling near the mine site, it is expected that Inuit land users may obtain fuel as well as drinking water from the Project camps. Therefore, when considering drinking water sources for the human health risk assessment, only drinking water sources for the camps (George and Goose lakes) were assessed. Both lakes are located nearest to Project infrastructure and activities, and therefore this approach is considered conservative.

Within the RSA, tourists may:

- visit the Huikitak River Conservation Area from June to September;
- visit the Bathurst Inlet Lodge camps and take tours at Bathurst Lake;
- partake in the Bathurst Inlet Lodge canoe route at Hanningayuk (Beechey Lake);
- attend small ship expeditionary cruises in August and September offered by the Adventure Canada tour company. Their advertised “Into the Northwest Passage tour” includes travel through Gjoa Haven, Bathurst Inlet, Coronation Gulf, and Kugluktuk (Adventure Canada 2013). Shore visits include hikes on the open tundra at Bathurst Inlet.

PROJECT # 0194096-0040 GIS # BAC-04-010 December 16 2013

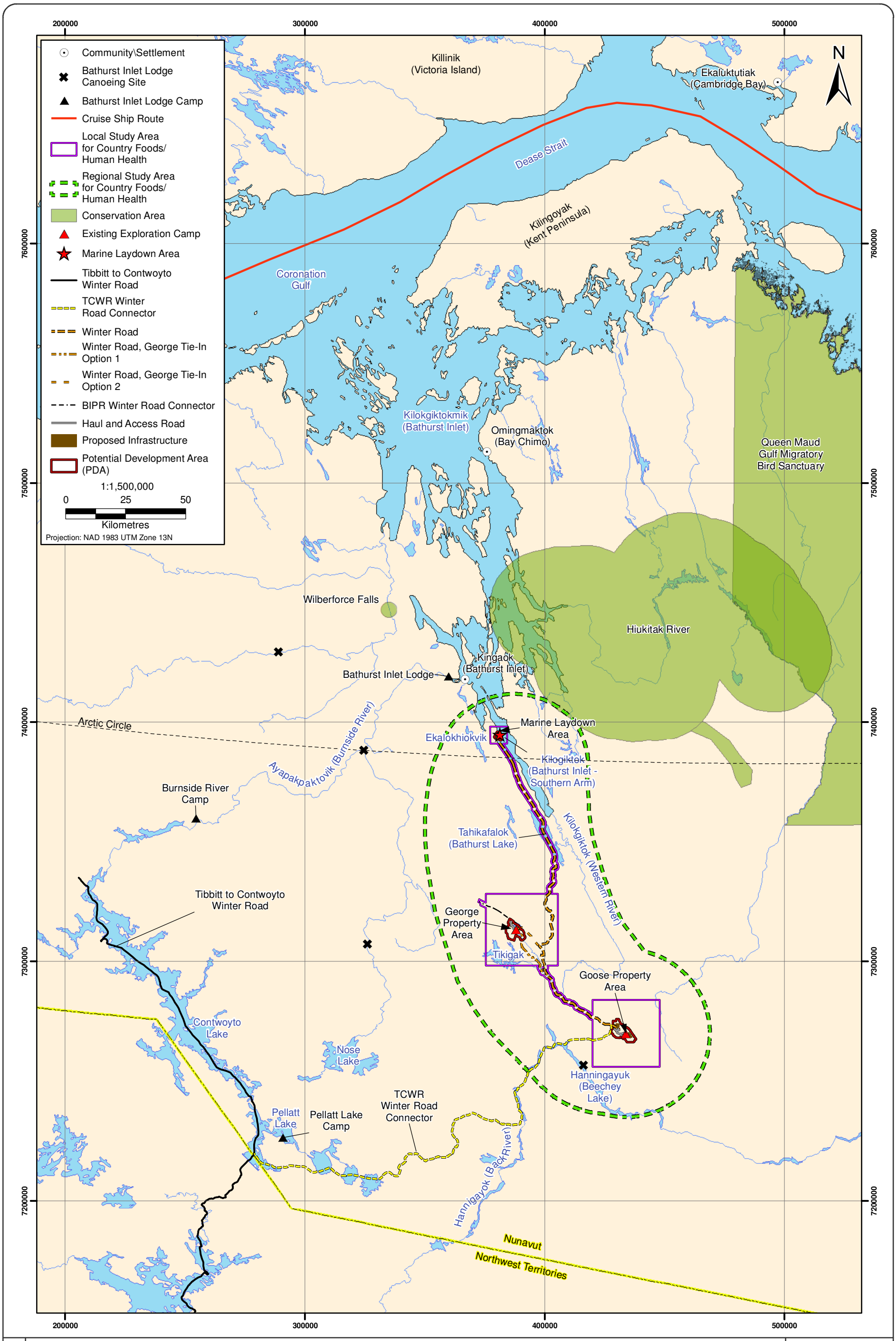


Figure 6.4-13

Sabina GOLD & SILVER CORP.

Tourist Receptors in Relation to the Human Health Local and Regional Study Areas of the Back River Project

Figure 6.4-13

Rescan an ERM company

PROJECT # 0194096 0040 GIS # BAC-04-011 December 17 2013

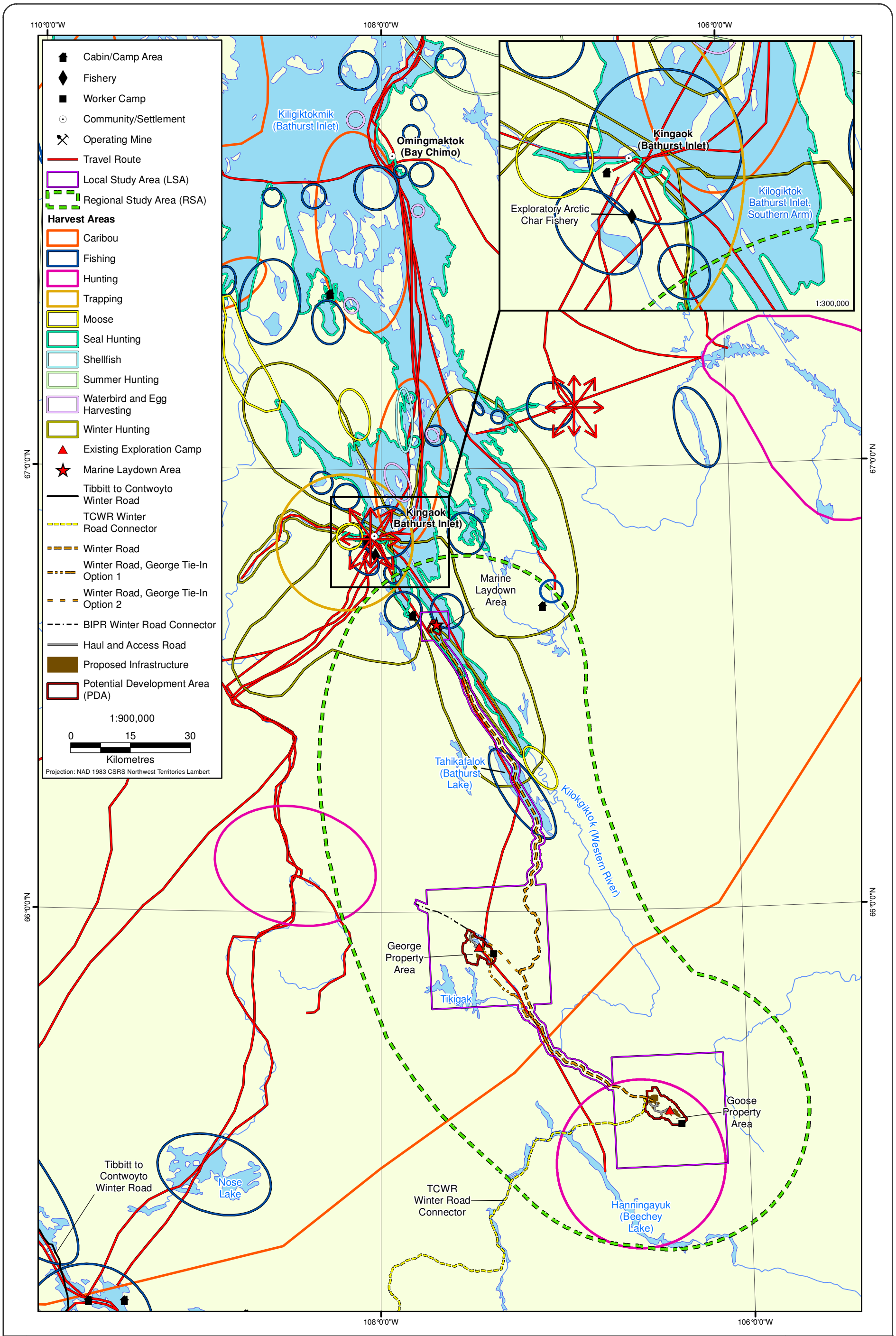


Figure 6.4-14

Sabina GOLD & SILVER CORP.

Local Human Receptors in Relation to the Human Health Local and Regional Study Areas of the Back River Project

Figure 6.4-14

Rescan an ERM company

Within the RSA, locals may:

- be staff at the Bathurst Inlet Lodge camp at Bathurst Lake or staff guiding the Bathurst Inlet Lodge canoe route at Hanningayuk (Beechey Lake);
- be staff at the exploratory Arctic Char fishery located near Kingaok;
- hunt seals throughout Bathurst Inlet, which prominent hunting areas located on the western shores of Bathurst Inlet, north of the community of Kingaok. Open water in Bathurst Inlet is particularly optimal for seal harvesting. Hunters from Omingmaktok and Kingaok hunt seal in the spring and fall along the shores of Bathurst Inlet;
- harvest bird and bird eggs in numerous harvesting areas located along the shores of Bathurst Inlet, Bathurst Lake, Beechey Lake, and many others;
- hunt caribou within one main caribou hunting area located partially within the RSA (an area through which the Bathurst herd migrates north of the Hackett River);
- harvest fox just south of the community of Kingaok;
- ice fish; individuals from Kingaok and Omingmaktok indicated ice fishing takes places over the Christmas holidays and jigging takes place during spring break in Bathurst Inlet;
- fish for Arctic Char (as reported by land users from Cambridge Bay) at the southern end of Bathurst Bay;
- harvest plants and other vegetation (as reported by land users in Kingaok and Omingmaktok); and
- pass through on a travel route within the RSA, such as a common route used by people from Kingaok, Omingmaktok, and Cambridge Bay that extends from Cambridge Bay to the community of Kingaok and on to either Beechey Lake or Contwoyto Lake.

In addition to tourist and local users, workers employed by the Project will also be present within the HHRA LSA and RSA. Although on-duty workers would be present in the LSA, their exposure to COPCs would be managed under the Occupational Health and Safety Plan (Volume 10, Chapter 25) and will not be assessed in the HHRA. However, the health of off-duty employees residing on site will be included in the assessment as recommended by Health Canada (2010d).

6.4.2.7.4 Receptor-Project Interactions

An interaction matrix outlining the links between human health and Project components and activities is shown in Table 6.4-13. Linkages between Project emissions and potential residual effects to the health of humans were considered and screened via a pathway analysis. First, all potential effects pathways for the Project were listed (Table 6.4-13). Project components are expected to interact with health of human receptors through three interaction pathways: air, drinking water, and country foods pathways.

At the outset, all of the Project components or activities during the Construction and Operational phases were screened for potential linkages to human health through air quality, drinking water, or consumption of country foods. Both of these phases were included in the scoping since they are most likely to be associated with potential for effects to human health; ultimately though, only Operational phase activities were assessed in the HHRA (see Section 6.4.2.3 for rationale). The Reclamation and Closure or Post-Closure phases were not included in the scoping exercise because potential effects to human health were considered negligible compared to the Construction and Operational phases.

In the second step, Project components or activities were screened out by considering timing and magnitude of potential emissions, environmental design features (e.g., Project design elements), and mitigation (e.g., environmental best practices, management policies and procedures). Pathways with no linkage are not included in the ERA. By screening for those pathways and Project-related emissions that are most likely to have effects on human receptors, receptor-Project interaction pathways are short-listed for a comprehensive assessment for potential human health effects in the HHRA.

The potential interactions between Project emissions and receptors are shown in Figure 6.4-15 and described in the following sections.

Air Quality

Blasting, transportation (e.g., vehicles, aircraft/helicopters), and machinery use during Construction and Operational phases will create airborne particulates. Other atmospheric emissions will also be created by use of incinerators at camps or exhaust from vehicles, aircraft, ships or generators. Airborne material may directly be inhaled by people, affecting their respiratory health through the inhalation pathway.

The Operational phase consists of mine development and ore processing, and people (e.g., off-duty workers) will be present in the LSA during this phase. The Operational phase will likely have the highest potential for effects on human health due to the potential for changes in air quality and water quality. Year 3 of the Operational phase at the Goose Property Area and Year 7 of the Operational phase at the George Property Area are expected to have the greatest air emissions, thus those years were modelled as the worst-case scenarios (Volume 4, Chapter 1).

Drinking Water

Water quality is an essential ecosystem component and good water quality is important for the maintenance of safe potable water sources for workers and the public. Specific waterbodies used by Inuit for collecting drinking water were not identified in the study area historically (KIA 2012) or recently (Rescan 2013d). However, drinking water may be collected from rivers, streams and lakes as needed by trappers, hunters, and recreational users.

Atmospheric emissions, predominately dust particles and associated metals, may get transported over a short distance and deposit and freshwater (lakes and streams). Particles in water may settle to sediments or remain dispersed in the water column. Alteration of drainage patterns, rates, and quantities of diverted non-contact water to new waterways may change downstream flows, water levels, channel/bank stability in streams and lakes and may affect fresh water and sediment quality. Liquid effluent (e.g., treated wastewater, site runoff) has the potential to enter the freshwater environment via runoff from the terrestrial environment. Changes in surface water quality could affect the quality of drinking water and therefore human health.

Country Foods

Country foods are animals, plants and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation (Health Canada 2010e). Harvesting of country foods currently occurs in the country foods RSA and LSA, as recorded in land use baseline studies (Rescan 2013d). Primary harvesters are Inuit from the Kitikmeot Region, trapline owners, public hunters, and commercial guides and their clients.

Table 6.4-13. Human Receptor-Project Interactions and their Rationale for Inclusion in the Human Health Risk Assessment

Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC/VSEC	Pathway Analysis (Included/Not Included?)	Rationale for Inclusion or Exclusion from the Analysis
Construction	Air	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Emmissions Diesel Power Generation Air Transport of Personnel and Goods Landfill Construction/Solid Waste Management Incinerator Marine Laydown Area: on-land laydown areas/fuel storage Marine Laydown Area: in-water infrastructure Marine Transport of Goods Machinery and Vehicle Refuelling/Fuel Storage and Handling	Construction activities, waste incineration, and fuel combustion produce air emissions (dust, air contaminants, fuel combustion emissions) may result in short-term changes in air pollutant concentrations, which may directly affect human health through the inhalation pathway.	Not included	Not included, because construction emissions are expected to be less than operations emissions and worst-case scenario (Operation phase) is assessed.
		Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Water Use Sewage Treatment Plant and discharge Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to human health through the air interaction pathway are expected to result from these Project activities.	Not included	n/a
	Drinking Water	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Water Use Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Refuelling/Fuel Storage and Handling Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Chemical and Hazardous Material Storage and Management Explosives Storage and Handling	Construction activities may produce short-term changes in air pollutant concentrations and dust deposition, which may result in changes in water quality affecting drinking water sources. Alteration of drainage patterns, rates, and quantities of diverted non-contact water to new water ways may change downstream flows, water levels, channel/bank stability in streams and lakes and may affect fresh water and sediment quality, which may affect the quality of drinking water and therefore human health. Release of insufficiently-treated sewage may enter the water and result in the degradation of drinking water quality affecting human health.	Not included	Not included, because construction activities are expected to result in smaller changes to drinking water quality than operations activities, and worst-case scenario (Operational phase) is assessed.
		Machinery and Vehicle Emmissions Diesel Power Generation Air Transport of Personnel and Goods Incinerator Marine Laydown Area: on-land laydown areas/fuel storage Marine Laydown Area: in-water infrastructure Marine Transport of Goods Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to human health through the air interaction pathway are expected to result from these Project activities.	Not included	n/a
	Country Foods	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Machinery and Vehicle Refuelling/Fuel Storage and Handling Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Marine Laydown Area: on-land laydown areas/fuel storage Marine Laydown Area: in-water infrastructure Marine Transport of Goods	Short-term changes in air pollutant concentrations may result in changes in contaminant concentrations in soil and water which may affect human health through effects on country foods. Alteration of drainage patterns, rates, and quantities of diverterted non-contact water to new water ways may change downstream flows, water levels, channel/bank stability in streams and lakes and may affect fresh water and sediment quality, which may affect human health through effects on country foods. Release of insufficiently-treated sewage may enter the water (fresh water or marine water) and result in the degradation of aquatic country foods and human health.	Not included	Not included, because construction activities are expected to result in smaller changes to quality of country foods than operations activities, and worst-case scenario (Operational phase) is assessed.
		Water Use Machinery and Vehicle Emmissions Diesel Power Generation Air Transport of Personnel and Goods Incinerator Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No potential impacts to human health through the country food interaction pathway are expected to result from these Project activities.	Not included	n/a

(continued)

Table 6.4-13. Human Receptor-Project Interactions and their Rationale for Inclusion in the Human Health Risk Assessment (completed)

Project Phase	Operable Interaction Pathway	Project Components and Activities	Potential Effects to VEC/VSEC	Pathway Analysis (Included/Not Included?)	Rationale for Inclusion or Exclusion from the Analysis
Operations	Air	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Piles Road and Airstrip Use & Maintenance Diesel Power Generation Incinerator Air Transport of Personnel and Goods Machine and Vehicle Emissions Marine Transport of Goods	Operation activities (driling, blasting, excavation, milling, materials handling, waste incineration, and fuel combustion) can produce air emissions (dust, air contaminants, fuel combustion emissions) that may result in changes in air pollutant concentrations, which may directly affect human health through the inhalation pathway.	Included	Potential air quality effects to human health were included in the human health assessment for the worst case scenario during the Operational phase for the inhalation pathway.
		Tailings Storage In-Pit and Surface Water Management Water Use Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Marine Laydown Area: Fuel Storage and Handling Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts to human health through the inhalation pathway are expected to result from these Project activities.	Not included	n/a
	Drinking Water	Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Piles Tailings Storage In-Pit and Surface Water Management Road and Airstrip Use & Maintenance Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Marine Laydown Area: Fuel Storage and Handling Marine Transport of Goods	Operational phase activities may produce changes in air pollutant concentrations and dust deposition, which may result in changes in water quality affecting drinking water sources. Alteration of drainage patterns, rates, and quantities of diverted non-contact water to new water ways may change downstream flows, water levels, channel/bank stability in streams and lakes and may affect fresh water and sediment quality, which may affect the quality of drinking water and therefore human health. Release of insufficiently-treated sewage may enter the water and result in the degradation of drinking water quality affecting human health.	Included	Potential freshwater quality effects to human health were included in the human health assessment for the worst case scenario during Operational phase for the ingestion pathway.
		Camps and Mill Facility (Goose) Water Use Diesel Power Generation Incinerator Air Transport of Personnel and Goods Machine and Vehicle Emissions Environmental & Socio-economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts to human health through changes in drinking water quality are expected to result from these Project activities.	Not included	n/a
	Country Foods	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Underground: Drilling, Blasting, Excavation Waste Rock Piles Tailings Storage In-Pit and Surface Water Management Road and Airstrip Use & Maintenance Diesel Power Generation Incinerator Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Air Transport of Personnel and Goods Machine and Vehicle Emissions Marine Laydown Area: Fuel Storage and Handling Marine Transport of Goods	Changes in air pollutant concentrations may result in changes in contaminant concentrations in soil and water, which may affect human health through effects on country foods. Alteration of drainage patterns, rates, and quantities of diverterted non-contact water to new water ways may change downstream flows, water levels, channel/bank stability in streams and lakes and may affect fresh water and sediment quality, which may affect human health through effects on country foods. Release of insufficiently-treated sewage may enter the water (fresh water or marine water) and result in the degradation of aquatic country foods and human health.	Included	Potential effects from country foods to human health were included in the human health assessment for the worst case scenario during Operational phase for the ingestion pathway.
		Water Use Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No potential impacts to human health through the country food interaction pathway are expected to result from these Project activities.	Not included	n/a

Note: n/a = not applicable, because no potential impacts were identified

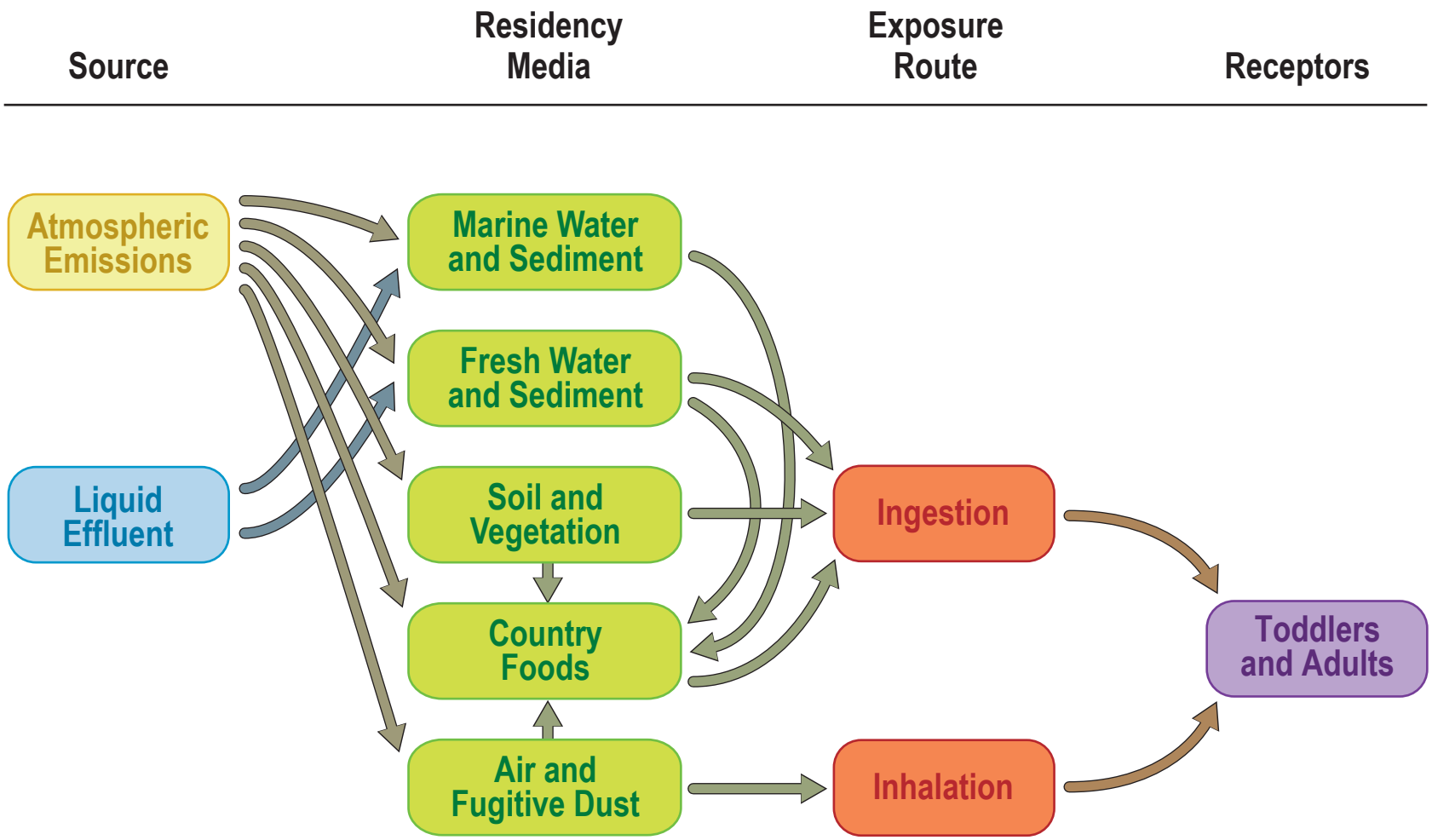


Figure 6.4-15

Sabina GOLD & SILVER CORP.

Potential Human Receptor Exposure Pathways,
Back River Project

Figure 6.4-15

Rescan Engineers & Scientists

Water quality is important for maintaining the quality of the food web, including vegetation, fish and wildlife. Water quality is closely linked with conservation and fish productivity and fish habitat resources (Volume 6, Chapter 6: Fish and Aquatic Habitat). Atmospheric emissions, predominately dust particles and associated metals, may get transported over a short distance and deposit and freshwater (lakes and streams). Particles in water may settle to sediments or remain dispersed in the water column. Benthic invertebrates and primary producers in the aquatic habitat may be exposed to COPCs associated with particles or COPCs dissolved in the water. Dispersed particles or dissolved COPCs may be taken up by fish VECs.

Atmospheric emissions also have the potential to enter the terrestrial environment by dust deposition on soils and vegetation. Small dust particles and associated COPCs can be adsorbed to soil particles and/or can be leached into the subsurface soils. Dust and associated COPCs can settle on plant surfaces, but can also be taken up by plant roots when incorporated into the soil surface. Wildlife could then potentially be exposed to COPCs via food ingestion, which can in turn affect the quality of country foods for human consumption.

Liquid effluent (e.g., treated wastewater, site runoff) has the potential to enter the freshwater environment via runoff from the terrestrial environment. Introduction of COPCs to the freshwater environment may result in uptake of COPCs by fish. Terrestrial wildlife could also take up COPCs from the freshwater aquatic environment through drinking water or consumption of prey items (e.g., fish by grizzly bears). COPCs that may be present in fish or wildlife could then be taken in by consumers of country foods.

6.4.2.7.5 Conceptual Model

A conceptual model is a representation of the characteristics of the site in diagrammatic form, and is developed as part of a HHRA to identify potential sources, fate, and transport of COPCs (Section 6.4.2.5.1), potential exposure routes (Section 6.4.2.5.2), and the possible interaction pathways between COPCs and receptors (Sections 6.4.2.5.3 and 6.4.2.5.4). Possible combinations of environmental components corresponding to significant exposure pathways were identified, while non-significant pathways were eliminated from further consideration.

Figure 6.4-16 is a simplified schematic diagram of the interaction pathways by which human receptors may potentially be exposed to Project emissions released to the atmospheric, aquatic, and terrestrial environments. The conceptual model guides the remainder of the HHRA where COPCs are selected, screened for the potential to cause adverse effects in receptors, and the risk to human health is determined.

6.4.2.8 Predictive Environmental Modelling

6.4.2.8.1 Air Quality and Fugitive Dust

An atmospheric dispersion model was prepared to evaluate potential effects of the Project's activities on air quality, and the methods, results, and assumptions are presented in Volume 4, Chapter 1, and Rescan (2013i). A brief summary is provided here for convenience.

Predicted air concentrations of COPCs due to Project emissions were modelled with the US EPA-approved version of CALPUFF (version 5.8) and its related processors. CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that is capable of simulating the effect of time- and space-varying meteorological conditions on contaminant transport, transformation, and removal. In order to perform dispersion modelling using CALPUFF, meteorological data was processed by CALMET, to provide meteorological input data in the modelling.

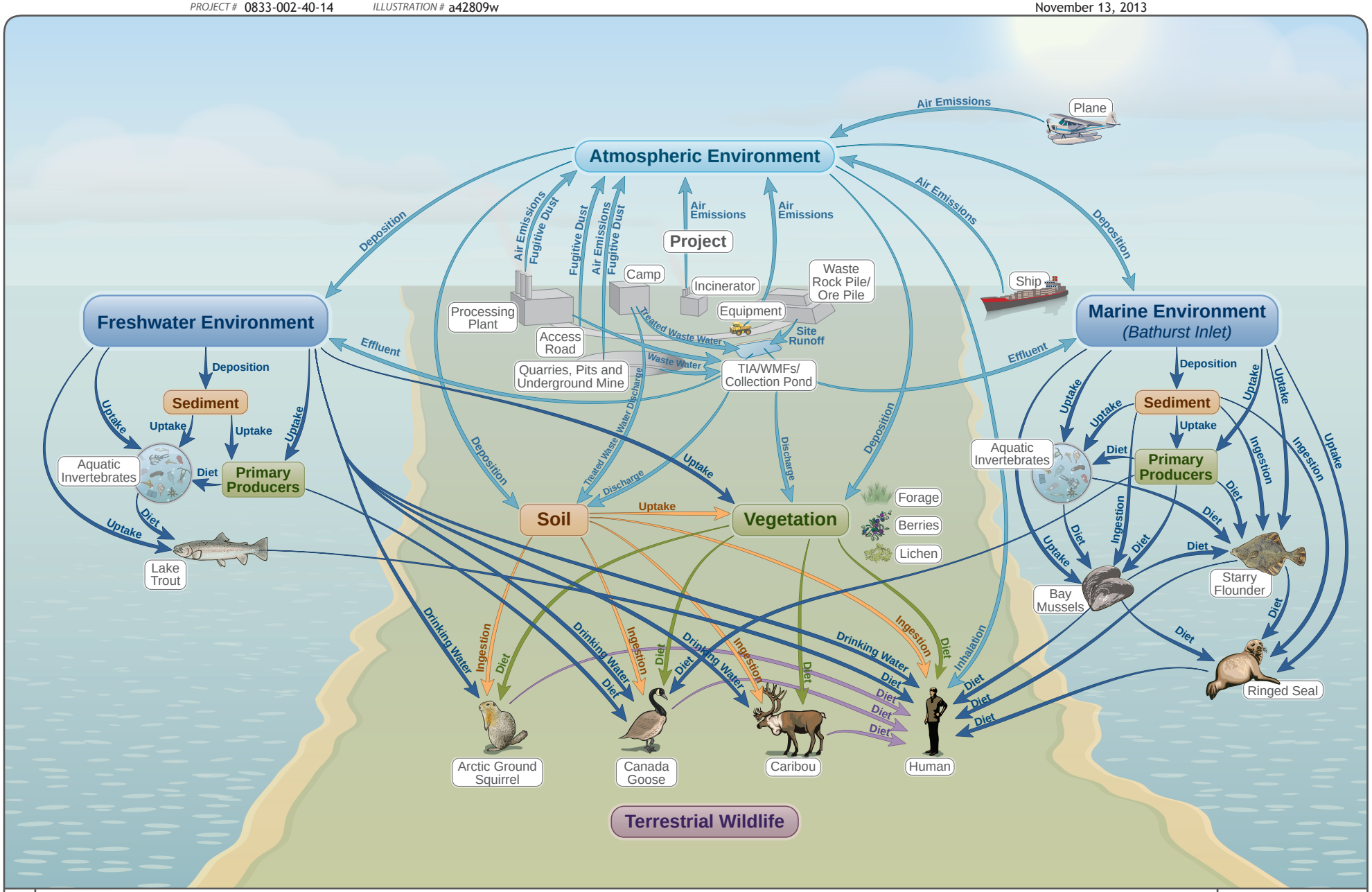


Figure 6.4-16

Sabina GOLD & SILVER CORP.

Conceptual Model for Back River Project, Human Health Risk Assessment

Figure 6.4-16

Rescan™ Engineers & Scientists

Two air quality modelling domains for the Project were selected based on the air quality LSA, encompassing the area around each of the Goose and George Property Areas, with boundaries of approximately 10 km in all directions from infrastructure (see Figure 1.4-1 in Volume 4 for the atmospheric environment LSA modelling domains). The sizes of the air quality modelling domains were established such that the majority of air contaminant species would approach background concentrations within the modelling domains.

It is highly unlikely that outside of the atmospheric modelling domains (e.g., at the MLA or along the main winter roads) there will be Project-related dust deposition rates substantially higher than baseline. Sources or criteria air contaminants and fugitive dust in these areas are expected to be lower than what is expected to occur at either the Goose or George Properties. Also, there are no major sources of fugitive dust, other than site roads (not winter roads), in most areas outside of the atmospheric modelling domains. Potential effects at the MLA will be less than in the other two areas during the Operational phase and the impacts on air quality were considered to be insignificant.

The dispersion model was run using the worst-case scenario, which was determined to occur in Year 3 of the Operational phase for the Goose Property Area and Year 7 of the Operational phase for the George Property Area (Rescan 2013i).

The following were considered as potential emission sources of atmospheric contaminants in the air dispersion model (Rescan 2013i):

- stack (baghouse) emissions;
- processing plant (includes generator);
- underground mine (includes generator);
- generators in open pit;
- incinerator at camps;
- equipment, including trucks, drill rigs, bulldozers, both in the mine pits/underground and on the access road;
- aircraft;
- fugitive dust emissions from grading and bulldozing activities; and,
- explosives (drilling and blasting).

The potential air contaminants modelled include the following (Rescan 2013i):

- nitrogen oxides (NO_x);
- sulphur oxides (SO_x);
- carbon monoxide (CO);
- total suspended particulate (TSP);
- particulate matter less than and equal to 10 microns in size (PM_{10});
- particulate matter less than and equal to 2.5 microns in size ($PM_{2.5}$); and,
- fugitive dust.

CACs are primarily produced by combustion of diesel and other fuels. Fugitive dust will arise from rock blasting or drilling, vehicle movement, and handling of fine materials. Generally dust will occur sporadically and be suspended for a relatively short time prior to deposition. Dust particles can be a carrier of metals naturally occurring in rocks and will be deposited onto soils, water, and vegetation.

The dispersion model was set up so that results were generated for a grid in addition to specific receptors locations (as shown in Volume 4, Figures 1.4-1 and 2.1-1), which included the following:

- off-duty workers residing in the camps;
- UTM coordinates for each soil, vegetation, wetland sediment, and lake water quality sampling site during baseline studies located within the modelling domain (to be used in subsequent soil and vegetation quality modelling; Sections 6.4.2.6.4 and 6.4.2.6.5);
- receptor points on transects around selected road sites to allow mapping of a dusting profile from roads; and
- sites that were considered to be important for wildlife.

Since emissions will not vary appreciably from one section of roadway to another, a section representative of typical road conditions was selected and the predicted pattern and gradients of air contaminant concentrations with distance from the chosen road section was assumed to be indicative of the air contaminant concentrations along the entire road.

Fugitive dust predicted by the CALPUFF model is likely to contain metals. The model output data on maximal dust deposition and the baseline geochemistry for waste rock and ore composition (i.e., mean metal concentrations in rock samples) were used to estimate the metal concentration in dustfall (in $\mu g/m^2$-sec for a 30-day average; Rescan 2013i). The annual dustfall levels in Goose and George Property Areas are shown in Figures 6.4-9 and 6.4-10, respectively. Metal proportions in rock (split into potentially acid generating (PAG) and non-potentially acid generating (nPAG)) and ore were available from baseline samples (Volume 11). The following assumptions about metal content of dust were made:

- unpaved road dust had metal concentrations similar to non-potentially acid generating (nPAG) waste rock;
- fugitive dust from equipment activities (bulldozing/grading) had metal concentrations that were an average of all types of rock; and
- blasting and drilling fugitive dust had metal concentrations that were an average of all types of rock.

The CALPUFF model provides dustfall results in $\mu g/m^2$-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 3,600 seconds, 24 hours, and 365 days to convert from seconds to years and divided by 1,000,000 to convert from µg to g. Appendices V8-6A and V8-6B provide baseline and predicted metal concentrations associated with fugitive dust at George and Goose Property Areas.

This proportion of metals in dustfall was also used to calculate the concentration of metals on PM_{10}, which could potentially be inhaled by human receptors. Appendix V8-6J provides baseline and predicted metal concentrations associated with PM_{10} concentrations at George and Goose Camps.

6.4.2.8.2 Freshwater Quality

Modelling Related to Waterborne Emissions

There will be no effluent discharge from the TIA during the Operational phase of the Project. Although discharge from the TIA may occur during the Reclamation and Closure/Post-closure phases and discharge from the Water Management Facility (George Property Area) or Collection Pond (MLA) may occur during all post-construction phases, it was assumed that effluent will not be released until water quality guidelines or environmental targets can be met in the receiving environment (as per the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan, Volume 10, Chapters 7 and 19, respectively).

In addition, mitigation and management plans, including best management practices (BMPs), for sewage treatment and effluent disposal, water management (Site Water Monitoring and Management Plan, Volume 10, Chapter 7), Spill Contingency Plans (Volume 10, Chapter 5), and a Risk Management and Emergency Response Plan (Volume 10, Chapter 3) will be implemented in order to minimize the potential for chemical contaminants to enter waterways. Since effluent discharge from the TIA to water is not expected during the Operational phase and water quality guidelines or targets are expected to be met in the receiving environment at all times when discharges do occur from any of the water management facilities, water quality modelling of freshwater environment LSA lakes and streams was not conducted for effluent discharge.

Modelling Related to Airborne Emissions (Dustfall)

The US EPA has published methods for use in HHRAs for calculating contaminant concentrations in water due to atmospheric particle deposition (US EPA 2005b). Calculations of the incremental increase in water metal concentrations were based on estimated metal concentrations in dustfall determined using data from the CALPUFF air quality dispersion model and core sample geochemistry (Section 6.4.1.6.1 or Rescan 2013i). Air quality dispersion modelling was done for the upper-case scenario only (i.e., worst-case emissions scenario, when potential air quality effects were at their highest) for a one-year period for the Goose (Year 3 of Operational phase) and George (Year 7 of Operational phase) Property areas.

For the purposes of lake water quality modelling, it was assumed that the dust deposition occurred during the worst-case scenario years and that all particles deposited would remain entrained and fully mixed in the water column for the full year. No other losses of contaminants from dust deposition were included in the model (e.g., loss due to outflow from the lake or deposition and burial in the sediments). The worst-case scenario modelling provides a conservative overestimate of the potential for annual metal deposition to fresh water from dustfall, since air quality modelling was based on the worst-case scenario and not all years would be expected to have similarly high levels of activity. A cumulative deposition time of 10 years for the Operational phase was not applied since it was assumed that particles will partition to sediments over the period of one year or leave the lake via the outflow and therefore be removed from the water column.

Since the sites that were sampled during the water quality baseline assessment were included in the air quality dispersion model as receptor sites (see Rescan 2013i for additional details), it was possible to calculate incremental change in water metal concentrations due to dust deposition, such that each baseline lake sampling site had a predicted water metal concentration for the modelled year. For lake sampling sites that were located outside of the air quality modelling domains, it was assumed that the water metal concentration would remain unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

For each lake water quality sampling site, lake volume (V_{lake}), lake surface area (A_{lake}), and dust particle deposition rates (L_{DEP}) were incorporated and the incremental increase in water metal concentrations were calculated using the equation below, adapted from the US EPA (2005b):

$$C_{wtot} = \left(\frac{L_{DEP} \times A_{lake} \times 1\ year}{V_{lake}}\right) + C_{Bsln}$$

where:

C_{wtot} = Total water column COPC concentration (g COPC/m^3 water)
L_{DEP} = Yearly particle-bound COPC deposition to waterbody (g COPC/m^2-year)
A_{lake} = Surface area of lake (m^2)
V_{lake} = Average water volume of lake (m^3)
C_{Bsln} = Mean water COPC concentration at baseline (g COPC/m^3 water)

Benthic burial, outflow from the lake, and COPC volatilization were conservatively assumed to be zero.

Deposition rates for metals were based on the results of the air quality dispersion model (Section 6.4.1.6.1 or Rescan 2013i). The CALPUFF model provides dustfall results in µg/m^2-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 3,600 seconds, 24 hours, and 365 days (to convert from seconds to years) and divided by 1,000,000 to convert from µg to g.

Once the incremental increase in metal concentration was calculated, it was added to the mean baseline COPC concentration at that site in the lake (C_{Bsln}) to arrive at a predicted water metal concentration (C_{wtot}). The results for each lake water quality sampling site are presented in Appendix V8-6K.

Emissions during Reclamation and Closure/Post-closure phases were considered to be negligible and those during the Construction phase were expected be lower than during the Operational phase (based upon the Air Quality section of the DEIS Volume 4, Chapter 1).

For freshwater streams, predictions of water quality changes due to contaminants in dustfall (i.e., air emissions) were not conducted. Streams are constantly flowing, so there is limited opportunity for dust deposition to accumulate and affect water quality at any given site since dust and any associated contaminants would be regularly flushed away. This is assumption is supported by the assessment of dust-borne contaminant loading to lakes, where it was found that contaminant loading was not a significant source of metal contaminants (Appendix V8-6K).

It is highly unlikely that outside of the atmospheric modelling domains (e.g., in the MLA; see Section 6.4.2.6.1) there will be Project-related dust deposition rates substantially higher than baseline since there are no major sources of fugitive dust in these areas. In addition, the quality of any fugitive dust is unlikely to change substantially outside of air quality modelling domains since the quality of the sources of dust will not change relative to baseline, so dust deposition of contaminants should be similar to baseline conditions.

6.4.2.8.3 Marine Water and Sediment Quality

Water quality modelling of the marine environment was done for a spill scenario (Rescan 2013f, Appendix V9-3A); however, the spill modelling results were not assessed as part of the ERA since it is outside of the course of normal Project activities and represents a single, very specific, emergency scenario. It is considered to be an unlikely occurrence and the type of effect to human health as a result of a spill could be highly variable depending on the type and volume of material spilled, location, extent, and response to the spill.

During normal Project activities, brine from the desalination water treatment plant may be discharged to the marine receiving environment in Bathurst Inlet and the potential for effects to Bathurst Inlet from this discharge was assessed in Volume 11. This discharge is not expected to affect the concentration of metals or other contaminants in the marine environment.

Discharge of effluent from the Collection Pond located in the MLA may occur during all post-construction phases. However, it was assumed that effluent will not be released until water quality guidelines or environmental targets can be met in the receiving environment (as per the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan, Volume 10, Chapter 7 and 19, respectively). Since effluent will be discharged in a manner that ensures that water quality guidelines or targets are met in the receiving environment at all times, water quality modelling of marine environment was not conducted.

It was assumed that outside of the atmospheric modelling domains (e.g., in the MLA; see Section 6.4.2.6.1) Project-related dust deposition rates would be similar to baseline levels and the quality of dust deposited should be similar to that of baseline conditions. The amount of dust deposition on marine surface waters relative to the volume of seawater in Bathurst Inlet is considered to be negligible and would occur in a localized, near-shore area, such that contaminant loading from atmospheric deposition to Bathurst Inlet is unlikely to affect water quality. Air emissions from vehicles, ships, and camp incinerator within the MLA are much lower than the air emissions within the George and Goose Property Areas. Therefore, no air quality modelling was conducted for the MLA (Volume 4, Chapter 1). As a result, mean predicted marine water and sediment concentrations within the MLA were assumed to be the same as the mean baseline concentrations since they are not expected to change significantly.

6.4.2.8.4 Soil Quality

The US EPA has published methods for use in risk assessments for calculating contaminant concentrations in soil due to atmospheric deposition (US EPA 2005b). Calculations of the incremental increase in soil metal concentrations were done based on estimated metal concentrations in dustfall determined using data from the air quality dispersion model and core sample geochemistry (Section 6.4.1.6.1 or Rescan 2013i). Air quality dispersion modelling was done for the upper-case scenario only (i.e., worst-case scenario, when potential air quality effects were at their highest) for a one-year period for the Goose (Year 3 of Operational phase) and George (Year 7 of Operational phase) Property Areas. For the purposes of soil quality modelling, it was assumed that the dust deposition that occurred during the worst-case scenario years occurred each year throughout the 10 year Operational phase. This would provide a conservative overestimate of the potential for metal deposition to soil from dustfall, since air quality modelling was based on the upper-case scenario and not all years would be expected to have similarly high levels of activity.

Since the sites that were sampled during the soil baseline assessment were included in the air quality dispersion model as receptor sites (see Rescan 2013i for additional details), it was possible to calculate incremental change in soil metal concentrations due to dust deposition, such that each baseline soil sampling site had a predicted soil metal concentration at the end of the Operational phase. For soil sampling sites that were located outside of the air quality modelling domains around Goose and George properties, it was assumed that the soil metal concentration remained unchanged from baseline levels since it was expected that the quantity and quality of metals deposited in dustfall at these locations would remain the same as during baseline studies.

Incremental increase in soil metal concentrations were calculated using the equation below, as suggested by the US EPA (2005b):

$$C_S = 100 \times \left(\frac{D}{Zs \times BD}\right) \times tD$$

where:

C_S = Average soil concentration over exposure duration (mg COPC/kg soil)
100 = Unit conversion factor (from mg-m^2 to kg-cm^2)
D = Yearly dry deposition rate of contaminant (g/m^2-year)
t_D = Time period over which deposition occurs (years)
Z_s = Soil mixing zone depth (cm)
BD = Soil bulk density (g/cm^3)

The CALPUFF model provides dustfall results in µg/m^2-second and to convert this unit into g/m^2-year the dustfall result was multiplied by 31.5[3].

The time period over which deposition may occur was assumed to be 10 years. A cumulative deposition time of 10 years was applied since this is the duration of the Operational phase and the worst-case scenario rates of dust deposition (that would occur in Year 3 for Goose Property Area and Year 7 for George Property Area of the Operational phase) were conservatively assumed to occur every year throughout the whole phase. Metals deposited with fugitive dust were assumed to mix within the top 2 cm of soil (Z_s), as recommended by the US EPA (2005b) for untilled soils. The bulk density (BD) was set at the default value of 1.5 g soil/cm^3 soil, as recommended by the US EPA (2005b). Weathering and degradation were considered to only have significant effects on organic contaminants (e.g., PAHs) and not metals (US EPA 2005b), thus a soil loss constant was not necessary.

Once the incremental change in soil metal concentration was calculated, it was added to the baseline metal concentration at that site to arrive at a predicted soil metal concentration. The predicted metal concentrations for each soil sampling site are provided in Appendix V8-6L.

Air emissions in the form of fugitive dust during Reclamation and Closure/Post-closure phases were considered to be negligible and those during the Construction phase were expected be lower than during the Operational phase (Volume 4, Chapter 1).

6.4.2.8.5 Vegetation Quality

In order to predict vegetation concentrations of metals, a BTF should be used to account for metal uptake from soil. BTFs can be used to represent the relationship between metal concentrations in soil relative to metal concentrations in plant tissues.

Since BTF values can be quite variable, site-specific BTF values were calculated wherever possible in order to predict metal uptake in plants from the soil. This was done by calculating a BTF for each baseline sampling site where both soil and vegetation were collected at the same time. Sampling locations where soil and vegetation were co-sampled during baseline studies were identified. For the Human Health LSA this included sites: 54, 64, 80, 101, 104, 108, LBS 9, LBS 10, LBS 11, LBS 12, LBS 13, NE3, and W026.

[3] Unit conversion factor includes conversion from seconds to hours (3600 seconds/hour), hours to days (24-hours per day), days to years (365 days/year), and µg to g (1,000,000 µg/g).

Soil and vegetation metal concentrations from baseline studies were used to calculate site-specific BTFs for soil to lichen (Table 6.4-5), and soil to berries (Table 6.4-6). Only sites with matched soil and vegetation metal concentrations in the terrestrial LSA were included in the BTF calculations. If either the soil or vegetation metal concentrations during baseline sampling were below method detection limits, then a site-specific BTF could not be calculated and instead published BTF values from Staven et al. (2003) and Baes et al. (1984) were used. The raw baseline data can be found in Rescan (2013b, 2013e) and the soil and vegetation chapters of the DEIS, Volume 5, Chapters 3 and 4.

The BTF values (Tables 6.4-5 and 6.4-6) were used to predict metal concentrations in vegetation via root uptake or uptake into the lichen thallus by multiplying them with the predicted soil concentrations (Section 6.4.2.6.5, Appendix V8-6L). These predictions are presented in Appendix V8-6M for lichen and sedge, and Appendix V8-6N for berries.

Plants also experience direct deposition of dustfall to their above ground surfaces, and this concentration was calculated using the equation provided by the US EPA (2005b):

$$Pd = \frac{1000 \times D \times Rp \times [1.0 - exp(-kp \times Tp)]}{Yp \times kp}$$

where:

Pd = Plant (above ground produce) concentration due to direct deposition (mg COPC/kg DW)
1000 = Units Conversion factor (mg/g)
D = Yearly average dry deposition (g/m^2-year)
Rp = Interception fraction of the edible portion of plant (unitless)
kp = Plant surface loss coefficient (year^{-1})
Tp = Length of plant exposure to deposition per harvest of the edible portion of the plant (year)
Yp = Yield or standing crop biomass of the edible portion of the plant (productivity; kg DW/m^2)

The CALPUFF model provides dustfall results in µg/m^2-sec and to convert this unit into g/m^2-year the dustfall result was multiplied by 31.5[4]. The interception fraction of the edible portion of plant (*Rp*) was set to 0.39 for berries, which is the default value provided by the US EPA (2005b), and 0.769 for lichens and sedge which is the value the US EPA recommends for silage (US EPA 2005b). The plant surface loss coefficient (*kp*) was set to the default value of 18 year^{-1} recommended by the US EPA (2005b). The length of plant exposure to deposition per harvest of the edible portion of the plant (*Tp*) was set to 0.329 year since the vegetation experiences approximately 4 months of ice-free growing conditions annually (120 days divided by 365 days). The yield or standing crop biomass of the edible portion of the plant (*Yp*) was set to 0.25 kg DW/m^2 for berries, which the US EPA (2005b) recommends for exposed fruits, and was set to 5.66 for lichens and sedge, which the US EPA (2005b) recommends for exposed vegetables.

The total predicted metal concentration in vegetation was then calculated as the concentration predicted in the plant or lichen due to root or thallus uptake plus the concentration on the vegetation surface due to deposition. Results are provided in Appendix V8-6O for lichens and sedge and Appendix V8-6P for berries, alongside a comparison to the measured baseline concentration.

[4] Unit conversion factor includes conversion from seconds to hours (3600 seconds/hour), hours to days (24-hours per day), days to years (365 days/year), and µg to g (1,000,000 µg/g).

6.4.2.9 Screening Process for Contaminants of Potential Concern

6.4.2.9.1 General Methodology for Selecting Contaminants of Potential Concern

Metals are the primary type of contaminants that will be the subject of this ERA since other chemicals that may be in use or present during Project activities are unlikely to have an effect on ecological receptors after mitigation and management measures are implemented (Section 6.4.2.3). Metals occur naturally in environmental media (e.g., water, soil, and vegetation) due to local physical and geological processes, and their concentrations could potentially change due to Project activities due to deposition of dust containing metals or due to effluent discharge containing metals.

Contaminants measured during field studies of the atmospheric environment (Volume 4), freshwater environment (Volume 6), marine environment (Volume 7), terrestrial environment (Volume 5), and human environment (Volume 8) under baseline conditions are listed in Table 6.4-7.

The screening process for COPCs is shown as a flowchart in Figure 6.4-11. When considering each environmental medium or biota (i.e., air, water, or country foods) that could affect human health, COPC concentrations predicted by modelling were screened against two assessment criteria, applicable guidelines and baseline concentrations. Modeled concentrations were first screened against applicable guidelines.

First, where territory-specific guidelines were available, modeled concentrations were screened against Nunavut Guidelines:

- Nunavut's Ambient Air Quality Standards (Government of Nunavut 2011).

Where Nunavut Guidelines were unavailable, CCME Guidelines were used in the screening process. The CCME has established the following environmental quality guidelines for different media:

- Canadian Ambient Air Quality Standards for $PM_{2.5}$ (CCME 2012)
- Water Quality Guidelines for the Protection of Aquatic Life - Freshwater and Marine (CCME 2013c); and
- Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural (CCME 2013b).

Finally, if neither Nunavut-specific nor CCME guidelines were available, guidelines from other jurisdictions were incorporated into the screening procedure:

- British Columbia's Air Quality Objectives (BC MOE 2013a);
- Ontario's Ambient Air Quality Criteria (Ontario MOE 2012); and
- Effects screening levels (ESL) lists used in the review of air permitting data by Texas Commission on Environmental Quality (Texas CEQ 2013).

Hazard quotients (HQs) were calculated by dividing the predicted concentration of a metal by the guideline limit in each relevant media. COPCs with a HQ less than 1.0 were screened out of the HHRA, since these metals would not be expected to cause adverse effects in ecological receptors due to exposure in the environmental media. Metals without a guideline were carried through to the second step of screening since the goal was to identify any COPCs that have a significant change in concentration in any environmental media as a result of Project activities.

Metals with a HQ greater than 1.0 relative to the guideline limit and metals with no guidelines were retained for a second screening step. In the second screening step, the predicted metal concentrations were compared to the 95th percentile of the baseline concentrations. This baseline concentration was selected because, considering spatial variability, field sampling variability, variability in laboratory methods, and conservatism within the modelling, any contaminant concentration less than the 95th percentile baseline concentration is unlikely to be sufficiently distinguishable from background levels to be considered a Project-related effect. This step was done to ensure that all COPCs identified and carried through the HHRA process were only those COPCs with concentrations that were predicted to increase due to Project-related activities and it eliminates COPCs which already exceeded guidelines during baseline studies (which is not a Project-related effect). If a predicted metal concentration was greater than the 95th percentile concentration (i.e., HQ greater than 1.0), then the metal would be identified as a COPC and would be carried forward in the HHRA for further evaluation.

At the end of the screening process for each environmental medium, any metals that had either:

a) HQ greater than 1.0 relative to guideline **and** a HQ greater than 1.0 relative to baseline concentrations, or

b) no guideline **and** a HQ greater than 1.0 relative to baseline concentrations

were retained as COPCs in the HHRA to be assessed for their potential to cause health effects in environmental and human receptors.

6.4.2.9.2 Screening of Contaminants of Potential Concern in Air

The purpose of the air quality effects assessment was to evaluate the potential for Project activities to affect human health through the inhalation of air contaminants. The Project has the potential to release COPCs via airborne emissions, including: fugitive dust, PM_{10} with bound metals, and CACs (CO, NO_2, SO_2, TSP, $PM_{2.5}$, and PM_{10}). These contaminants were evaluated in the HHRA.

The rationale for this evaluation was that people use the area near the Project for hunting, trapping, berry picking, and recreation, and could inhale potential contaminants in the air that may be emitted from the Project. Off-duty workers residing in the worker camps could also be exposed to air contaminants from Project sources.

Modelled concentrations of contaminants were screened at two locations, George Property and Goose Property camps, because off-duty workers reside in the camps and contaminant concentrations are expected to be highest near Project infrastructure and activities. Therefore, any potential exposures at the camps will be higher than exposures for land users located at a distance further away from the Project, resulting in a conservative assessment for potential risk to other land users. The atmospheric environment, which included air quality, was also evaluated in DEIS Volume 4, Chapter 1.

Criteria Air Contaminants

Nunavut has established Ambient Air Quality Standards (AAQSs; Government of Nunavut 2011) which were used to screen the criteria air contaminants. For certain air contaminants there are no Nunavut standards, thus those criteria air contaminants were compared against the CCME Ambient Air Quality Standards (CCME 2012) or the BC MOE Air Quality Objectives (BC MOE 2013a).

Predicted concentrations for SO_2, NO_2, CO, non-fugitive dust (24-hour and annual averaged TSP, PM_{10}, $PM_{2.5}$), fugitive dust (annual TSP and 24-hour and annual $PM_{2.5}$), and total dust (annual TSP and 24-hour and annual $PM_{2.5}$) were below guideline limits and were therefore screened out as COPCs (Table 6.4-14).

Table 6.4-14. Summary of Baseline and Model Predictions of Criteria Air Pollutants at Goose and George Camps

Criteria Air Pollutant		Averaging Period	Nunavut Ambient Air Quality Standards[1] (µg/m^3)	CCME - Canadian Ambient Air Quality Standards[2] (µg/m^3)	BC Air Quality Objective[3] (µg/m^3)	Goose Camp							George Camp						
						Predicted Air Concentration (µg/m^3)	Predicted > Guideline?	Hazard Quotient Relative to Guideline	Baseline Concentration (µg/m^3)	Predicted > Baseline?	Hazard Quotient Relative to Baseline	Selected as a COPC?	Predicted Air Concentration (µg/m^3)	Predicted > Guideline?	Hazard Quotient Relative to Guideline	Baseline Concentration (µg/m^3)	Predicted > Baseline?	Hazard Quotient Relative to Baseline	Selected as a COPC?
SO_2		1-hour	450	-	450	32.4	No	0.0720	16.25[4]	Yes	2.00	No	5.26	No	0.0117	3.75[4]	Yes	1.40	No
		24-hour	150	-	160	9.29	No	0.0619	3.25[4]	Yes	2.86	No	1.95	No	0.0130	0.75[4]	Yes	2.60	No
		Annual	30	-	25	1.56	No	0.0520	1.3[4]	Yes	1.20	No	0.350	No	0.0117	0.3[4]	Yes	1.17	No
NO_2		1-hour	400	-	400	148	No	0.371	7.5[4]	Yes	19.8	No	90.4	No	0.226	13.75[4]	Yes	6.57	No
		24-hour	200	-	200	86.3	No	0.432	1.5[4]	Yes	57.6	No	52.8	No	0.264	2.75[4]	Yes	19.2	No
		Annual	60	-	60	23.5	No	0.391	0.6[4]	Yes	39.1	No	6.54	No	0.109	1.1[4]	Yes	5.95	No
CO		1-hour	-	-	14,300	1390	No	0.0972	1250[5]	Yes	1.11	No	1340	Yes	0.0937	1250[5]	Yes	1.07	No
		8-hour	-	-	5,500	939	No	0.171	142.9[5]	Yes	6.57	No	933	Yes	0.170	142.9[5]	Yes	6.53	No
Non-fugitive	TSP	24-hour	120	-	120	13.0	No	0.108	7[5]	Yes	1.86	No	10.7	No	0.0889	7[5]	Yes	1.52	No
		Annual	60	-	60	2.19	No	0.0365	1.4[5]	Yes	1.56	No	1.72	No	0.0287	1.4[5]	Yes	1.23	No
	PM_{10}	24-hour	-	-	50	9.71	No	0.194	3.8[6]	Yes	2.56	No	5.66	Yes	0.113	3.8[6]	Yes	1.49	No
	$PM_{2.5}$	24-hour	30	27	25	6.46	No	0.215	3.8[7]	Yes	1.70	No	5.09	No	0.170	3.8[7]	Yes	1.34	No
		Annual	-	8.8	8	1.27	No	0.144	0.76[7]	Yes	1.67	No	0.960	No	0.109	0.76[7]	Yes	1.26	No
Fugitive	TSP	24-hour	120	-	120	490	Yes	4.09	7[5]	Yes	70.1	**Yes**	137	No	1.15	7[5]	Yes	19.6	**Yes**
		Annual	60	-	60	58.2	No	0.970	1.4[5]	Yes	41.6	No	11.7	No	0.195	1.4[5]	Yes	8.35	No
	PM_{10}	24-hour	-	-	50	123	No	2.45	3.8[6]	Yes	32.3	**Yes**	37.2	Yes	0.745	3.8[6]	Yes	9.80	No
	$PM_{2.5}$	24-hour	30	27	25	11.8	No	0.395	3.8[7]	Yes	3.12	No	7.14	No	0.238	3.8[7]	Yes	1.88	No
		Annual	-	8.8	8	2.40	No	0.273	0.76[7]	Yes	3.16	No	1.11	No	0.126	0.76[7]	Yes	1.46	No
Total (fugitive + non-fugitive)	TSP	24-hour	120	-	120	493	Yes	4.11	7[5]	Yes	70.4	**Yes**	139	No	1.16	7[5]	Yes	19.9	**Yes**
		Annual	60	-	60	59.0	No	0.984	1.4[5]	Yes	42.2	No	12.0	No	0.200	1.4[5]	Yes	8.56	No
	PM_{10}	24-hour	-	-	50	125	No	2.51	3.8[6]	Yes	33.0	**Yes**	38.9	Yes	0.779	3.8[6]	Yes	10.2	No
	$PM_{2.5}$	24-hour	30	27	25	13.7	No	0.455	3.8[7]	Yes	3.59	No	8.43	No	0.281	3.8[7]	Yes	2.22	No
		Annual	-	8.8	8	2.91	No	0.331	0.76[7]	Yes	3.83	No	1.32	No	0.150	0.76[7]	Yes	1.74	No

Notes:

COPC = contaminant of potential concern

CO = carbon monoxide

NO_2 = nitrogen dioxide

SO_2 = sulphur dioxide

TSP = total suspended particles

$PM_{2.5}$ = particulate matter up to and including 2.5 µm in size

PM_{10} = particulate matter up to and including 10 µm in size

[1] *Government of Nunavut (2011).*

[2] *CCME (2012).*

[3] *BC MOE (2013a). Level A, Maximum Acceptable Level, or National Maximum Desirable Level.*

[4] *Baseline concentrations of NO_2 and SO_2 are the maximum 30-day averaging concentrations measured by passive air sampling stations in 2012, which are compared most appropriately to annual guidelines. US EPA conversion factors were used to convert the 30-day average into 1-hour and annual averaging periods.*

[5] *CO and TSP baseline concentrations are the annual averages used for the Bathurst Inlet and Road Project (BIPR; located northwest of the study area), which is representative of background levels typical in Nunavut. US EPA conversion factors were used to convert into 1-hour, 8-hour , and 24-hour averaging periods.*

[6] *PM_{10} baseline concentration is the highest concentration measured at Mary River over a 24-hour averaging period, which is representative of background PM_{10} levels typical in Nunavut.*

[7] *$PM_{2.5}$ baseline concentration is the highest concentration measured at Mary River over a 24-hour averaging period, which is representative of background $PM_{2.5}$ levels typical in Nunavut. US EPA conversion factors were used to convert into annual averaging periods.*

Concentration used for calculating chronic exposure is the predicted maximum concentration for 24-hour averaging.

Bold and grey shading indicates concentrations above guideline and baseline concentrations and both hazard quotients larger than one. Therefore retained as a COPC for the assessment.

Predicted 24-hour average concentrations of fugitive TSP and total TSP exceeded the guideline concentrations at both George and Goose Camps, as did the 24-average concentration of fugitive and total PM_{10} at Goose Camp only (Table 6.4-14). These guideline exceedances resulted in HQ's greater than 1.0, and these COPCs were then compared to baseline concentrations in the second step in the screening process for COPCs.

Baseline concentrations of TSP were unavailable for the Project site thus the annual average concentrations from the nearby BIPR project (Rescan 2013o) were adopted. Baseline concentrations for PM_{10} were also unavailable for the Project site and instead the maximum concentrations during 24-hour averaging at the nearby Mary River Project (RWDI 2012) were adopted (3.8 $\mu g/m^3$).

Screening found that the predicted concentration of fugitive TSP and total TSP and at Goose and George camps, and for fugitive and total PM_{10} at Goose Camp, were greater than baseline concentrations. Fugitive TSP is the predominant contributor to total TSP (i.e, makes up 99% of the total TSP concentration). Similarly, fugitive PM_{10} is the predominant contributor to total PM_{10} (i.e., makes up 95 to 98% of the total PM_{10}. Therefore, only total TSP and PM_{10} were selected as COPCs and were scoped into the HHRA. These COPCs will require additional consideration to determine the level of risk to human health posed by exposure to these CACs.

Metals on PM_{10}

Neither Nunavut nor the CCME have standards or guidelines for the allowable limits of metals in PM_{10}. Therefore, predicted metal concentrations in PM_{10} were compared to chronic inhalation (24-hour) health-based guidelines for humans from the Texas Commission on Environmental Quality Effects Screening Levels (Texas CEQ 2013) and the Ontario Ministry of Environment Ambient Air Quality Criteria (Ontario MOE 2012).

All predicted concentrations of metals bound to PM_{10} with applicable guidelines (Ontario MOE 2012; Texas CEQ 2013) were below guidelines and therefore had a hazard quotient relative to guideline of below 1.0 (Table 6.4-15). Predicted PM_{10} metal concentrations for those parameters without guidelines were compared to baseline concentrations. For those without guidelines, predicted metal concentrations did not exceed baseline concentrations resulting in hazard quotients below 1.0. Therefore, none of the metals on PM_{10} were screened in as COPCs in the risk assessment.

6.4.2.9.3 Screening of Contaminants of Potential Concern in Drinking Water

The purpose of the drinking water effects assessment was to evaluate the potential for Project activities to affect human health via the ingestion of water. Water resources in Nunavut are managed by Aboriginal Affairs and Northern Development Canada (AANDC 2013). Nunavut does not have legislation for drinking water and utilizes Health Canada's Drinking Water Quality Guidelines (Health Canada 2012b), which have been used in this HHRA as the first step in screening for COPCs in drinking water.

Health Canada recommends that surface water should always be treated before using it for drinking (Health Canada 2007). Workers living in the George and Goose camps will receive drinking water from George and Goose lakes that will be monitored and treated as required to meet established drinking water guidelines and criteria for contaminants and bacteriological quality. All water treatment systems will obtain appropriate approval from the responsible authorities, and the type of treatment and the capacity of the facility will be able to achieve water quality standards as stated in the permit. After treatment, potable water will be distributed to the main facilities and the camps.

Drinking water quality was only assessed for Goose and George Lakes since they are the only known and identified potential sources of drinking water. In addition, these lakes are in close proximity to Project

infrastructure, so any changes in water quality would be greater at these sites than in lakes located at a greater distances away from dust sources. If no significant changes in drinking water quality are noted in Goose or George lakes, then it is unlikely that Project-related changes in water quality would occur in waterbodies further away.

Freshwater quality baseline parameters were obtained from samples collected from George (n = 15) and Goose (n = 26) lakes in 1993, 1997, 2011, 2012, and 2013. The predicted metal concentrations in the lakes due to atmospheric deposition were compared to the Canadian Drinking Water Quality Guidelines (Health Canada 2012b) and the 95th percentile of baseline concentrations for each parameter and HQs were calculated. Results of these comparisons and HQ calculations can be seen in Table 6.4-16.

As seen in Table 6.4-16, all predicted metal concentrations were below the guidelines and below the 95th percentile of baseline concentrations, thus all the HQs were below 1.0. Therefore, no COPCs were identified in drinking water.

6.4.2.9.4 Screening of Contaminants of Potential Concern in Country Foods

The purpose of the country foods effects assessment was to evaluate the potential for Project activities to affect human health from the consumption of country foods.

Because country foods take up contaminants from environmental media (i.e., freshwater and marine water, soil, and vegetation), the quality of the foods is directly related to the quality of the environmental media. To determine the potential effects to country foods, predicted changes to the environmental media were screened against relevant guidelines and baseline concentrations for each of the environmental media, using the methodology explained in Section 6.4.2.7.1 to identify COPCs. If the predicted concentrations of metals in each of the environmental media were either below guidelines or below baseline levels, then there would be no predicted decreases in the quality of country foods.

Screening of Freshwater Quality

The water quality in freshwater streams was not expected to change significantly compared to baseline as a result of Project activities (Section 6.4.2.6.2), and therefore no metals were identified as COPCs in streams.

To screen for COPCs in freshwater that could affect the quality of country foods, the mean predicted lake water concentrations were compared to the CCME Water Quality Guidelines and the 95th percentile of the baseline lake metal concentrations. The predicted water COPC concentration for cadmium exceeded the guideline limit and the hazard quotient was determined to be 1.04. The 95th percentile of baseline concentrations are higher than predicted concentrations, therefore cadmium was not selected as a COPC. None of the predicted concentrations of other metals in freshwater lakes exceeded guideline limits and the hazard quotients were below 1.0 (Table 6.4-17). None of the predicted water COPC concentrations exceeded the 95th percentile of the baseline lake concentrations, and all of the calculated HQs (for baseline) were less than one (Table 6.4-17).

Overall, no COPCs that could change the quality of country foods relative to baseline levels were identified in freshwater.

Table 6.4-15. Screening of Model Predictions of Metals in PM_{10}

Metals	Texas CEQ ESL[1] ($\mu g/m^3$)	Ontario AAQC[2] ($\mu g/m^3$)	George Camp							Goose Camp						
			Predicted Metal Concentration in PM_{10} ($\mu g/m^3$)	Predicted > Guideline?	Hazard Quotient Relative to Guideline	Baseline Metal Concentration in PM_{10}[3] ($\mu g/m^3$)	Predicted > Baseline?	Hazard Quotient Relative to Baseline	Selected as a COPC?	Predicted Metal Concentration in PM_{10} ($\mu g/m^3$)	Predicted > Guideline?	Hazard Quotient Relative to Guideline	Baseline Metal Concentration in PM_{10}[3] ($\mu g/m^3$)	Predicted > Baseline?	Hazard Quotient Relative to Baseline	Selected as a COPC?
Aluminum	5	-	0.00142	No	0.000284	0.00775	No	0.184	No	0.0102	No	0.00204	0.00441	Yes	2.31	No
Antimony	0.5	-	0.00000000400	No	0.00000000800	0.0000058	No	0.000688	No	0.0000000274	No	0.0000000548	0.0000158	No	0.00173	No
Arsenic	0.067	-	0.00000396	No	0.0000591	0.0000597	No	0.0663	No	0.0000227	No	0.000339	0.0000158	Yes	1.43	No
Barium	0.5	-	0.00000633	No	0.0000127	0.000137	No	0.0462	No	0.0000458	No	0.0000916	0.000216	No	0.212	No
Beryillum	0.002	-	0.00000000174	No	0.000000868	0.0000294	No	0.0000591	No	0.0000000123	No	0.00000616	0.0000786	No	0.000157	No
Bismuth	5	-	0.0000000107	No	0.00000000213	0.0000294	No	0.000363	No	0.0000000712	No	0.0000000142	0.0000786	No	0.000906	No
Boron	5	-	0.000000524	No	0.000000105	0.000581	No	0.000902	No	0.000003717	No	0.000000743	0.00158	No	0.00235	No
Cadmium	0.01	-	0.00000000381	No	0.000000381	0.0000232	No	0.000164	No	0.0000000273	No	0.00000273	0.00000786	No	0.00347	No
Calcium	-	-	0.000479	-	-	0.0294	No	0.0163	No	0.00352	-	-	0.0204	No	0.173	No
Chromium	0.041	0.00035	0.00000451	No	0.0129	0.0000482	No	0.0934	No	0.0000319	No	0.0912	0.0000786	No	0.406	No
Cobalt	0.02	-	0.00000105	No	0.0000524	0.0000228	No	0.0459	No	0.00000751	No	0.000376	0.0000158	No	0.474	No
Copper	1	-	0.00000312	No	0.00000312	0.00146	No	0.00214	No	0.0000223	No	0.0000223	0.00381	No	0.00587	No
Iron	5	-	0.00371	No	0.000743	0.0114	No	0.326	No	**0.0263**	No	0.00525	0.00907	Yes	2.90	No
Lead	-	-	0.000000308	-	-	0.0000692	No	0.00445	No	0.00000214	-	-	0.0000661	No	0.0323	No
Lithium	-	-	0.000000151	-	-	0.000294	No	0.000516	No	0.00000107	-	-	0.000898	No	0.00119	No
Magnesium	-	-	0.000779	-	-	0.0291	No	0.0268	No	0.00557	-	-	0.0158	No	0.351	No
Manganese	0.2	0.2	0.0000232	No	0.000116	0.000546	No	0.0425	No	0.000167	No	0.000837	0.000367	No	0.456	No
Mercury	0.025	-	0.000000000191	No	0.00000000764	0.00000294	No	0.0000650	No	0.00000000122	No	0.0000000487	0.00000786	No	0.000155	No
Molybdenum	3	-	0.0000000732	No	0.0000000244	0.00000294	No	0.0249	No	0.000000514	No	0.000000171	0.0000259	No	0.0198	No
Nickel	0.059	0.1	0.00000249	No	0.0000422	0.0000557	No	0.0447	No	0.0000176	No	0.000299	0.000113	No	0.156	No
Phosphorus	-	-	0.00000000366	-	-	0.140	No	0.0000000261	No	0.0000000259	-	-	0.0564	No	0.000000458	No
Potassium	2	-	0.000372	No	0.000186	0.227	No	0.00164	No	0.00267	No	0.00133	0.283	No	0.00942	No
Selenium	0.2	-	0.0000000102	No	0.0000000512	0.0000581	No	0.000176	No	0.0000000700	No	0.000000350	0.000158	No	0.000442	No
Silver	0.01	-	0.00000000527	No	0.000000527	0.000000703	No	0.00750	No	0.0000000339	No	0.00000339	0.00000158	No	0.0214	No
Sodium	-	-	0.0000514	-	-	0.117	No	0.000441	No	0.00037	-	-	0.283	No	0.00132	No
Strontium	2	-	0.00000138	No	0.000000689	0.0000923	No	0.0149	No	0.0000100	No	0.00000498	0.0000812	No	0.123	No
Thallium	0.1	-	0.0000000105	No	0.000000105	0.00000581	No	0.00180	No	0.0000000746	No	0.000000746	0.0000158	No	0.00471	No
Tin	0.1	-	0.00000000273	No	0.0000000273	0.00000760	No	0.000359	No	0.0000000182	No	0.000000182	0.0000158	No	0.00115	No
Titanium	5	-	0.0000788	No	0.0000158	0.000581	No	0.136	No	0.00057	No	0.000115	0.00158	No	0.363	No
Uranium	0.2	0.15	0.0000000615	No	0.000000410	0.000000581	No	0.106	No	0.000000432	No	0.00000288	0.00000158	No	0.273	No
Vanadium	0.05	-	0.00000347	No	0.0000693	0.0000581	No	0.0596	No	0.0000252	No	0.000504	0.000158	No	0.159	No
Zinc	2	-	0.00000311	No	0.00000156	0.00100	No	0.00311	No	0.0000222	No	0.0000111	0.00215	No	0.0103	No

Notes:

[1] *Texas Commission on Environmental Quality (Texas CEQ 2013). Guidelines are for chronic (24-hour) exposure.*

[2] *Ontario Ministry of the Environment (Ontario MOE 2012). Guidelines are for chronic (24-hour) exposure.*

[3] *See Appendix V8-6J and text in Section 6.4.2.6.1 for method used to calculate metals bound to PM_{10}.*

PM_{10} = particulate matter up to and including 10 µm in size

Table 6.4-16. Screening of Predicted Metal Concentrations in Lakes Used as Drinking Water Sources

	Goose Lake								George Lake							
Metals	Predicted Mean Concentration (mg/L)	Drinking Water Guidelines[1] (mg/L)	Predicted > Guideline?	Hazard Quotient for Guideline	95th Percentile of Baseline Water Concentration[2] (mg/L)	Predicted > Baseline 95th Percentile?	Hazard Quotient for Baseline	Retained as a COPC?	Predicted Mean Concentration (mg/L)	Drinking Water Guidelines[1] (mg/L)	Predicted > Guideline?	Hazard Quotient for Guideline	95th Percentile of Baseline Water Concentration[2] (mg/L)	Predicted > Baseline 95th Percentile?	Hazard Quotient for Baseline	Retained as a COPC?
Aluminum	0.0354	0.1	No	0.354	0.0694	No	0.510	No	0.0583	0.1	No	0.583	0.207	No	0.282	No
Antimony	<0.002	0.006	-	-	<0.002	No	-	No	<0.002	0.006	No	-	<0.002	No	-	No
Arsenic	0.000232	0.010	No	0.0232	0.000319	No	0.729	No	0.000351	0.010	No	0.0351	0.000603	No	0.582	No
Barium	0.00731	1	No	0.00731	0.0137	No	0.534	No	0.00302	1	No	0.00302	0.00563	No	0.536	No
Beryllium	<0.0002	-	-	-	<0.0002	No	-	No	<0.0002	-	-	-	<0.0002	No	-	No
Bismuth	<0.002	-	-	-	<0.002	No	-	No	0.000993	-	-	-	0.00230	No	0.432	No
Boron	0.00661	5	No	0.00132	0.0151	No	0.437	No	0.0164	5	No	0.00329	0.0328	No	0.501	No
Cadmium	0.00000952	0.005	No	0.00190	0.0000273	No	0.349	No	0.0000122	0.005	No	0.00244	0.0000300	No	0.406	No
Calcium	3.50	-	-	-	6.50	No	0.539	No	5.61	-	-	-	11.6	No	0.485	No
Chromium	0.000285	0.05	No	0.00570	0.000730	No	0.390	No	0.000681	0.05	No	0.0136	0.00163	No	0.419	No
Cobalt	0.000146	-	-	-	0.000295	No	0.494	No	0.000593	-	-	-	0.00136	No	0.435	No
Copper	0.00192	1	No	0.00192	0.00375	No	0.512	No	0.00191	1	No	0.00191	0.00275	No	0.696	No
Iron	0.0677	0.3	No	0.226	0.0703	No	0.963	No	0.0907	0.3	No	0.302	0.337	No	0.269	No
Lead	0.000124	0.010	No	0.0124	0.000421	No	0.294	No	0.000415	0.010	No	0.0415	0.00129	No	0.320	No
Lithium	<0.005	-	-	-	<0.005	No	-	No	<0.005	-	-	-	<0.005	No	-	No
Magnesium	1.62	-	-	-	2.91	No	0.557	No	2.16	-	-	-	3.84	No	0.561	No
Manganese	0.00376	0.05	No	0.0751	0.00876	No	0.429	No	0.0103	0.05	No	0.205	0.0314	No	0.327	No
Mercruy	<0.00005	0.001	No	-	<0.00005	No	-	No	<0.00005	0.001	No	-	<0.00005	No	-	No
Molybdenum	<0.0004	-	-	-	<0.0004	No	-	No	0.000149	-	-	-	0.000260	No	0.574	No
Nickel	0.00448	-	-	-	0.00792	No	0.566	No	0.00435	-	-	-	0.00811	No	0.537	No
Phosphorus	<0.3	-	-	-	<0.3	No	-	No	<0.3	-	-	-	<0.3	No	-	No
Potassium	0.419	-	-	-	0.685	No	0.612	No	0.460	-	-	-	0.760	No	0.606	No
Selenium	0.0000805	0.01	No	0.00805	0.000213	No	0.378	No	0.000149	0.01	No	0.0149	0.000310	No	0.482	No
Silver	<0.00001	-	-	-	<0.00001	No	-	No	0.00000709	-	-	-	0.0000125	No	0.567	No
Sodium	0.777	-	-	-	1.28	No	0.607	No	0.962	-	-	-	1.67	No	0.576	No
Strontium	0.0194	-	-	-	0.0363	No	0.536	No	0.0205	-	-	-	0.0420	No	0.489	No
Thallium	<0.003	-	-	-	<0.003	No	-	No	<0.003	-	-	-	<0.003	No	-	No
Tin	<0.002	-	-	-	<0.002	No	-	No	0.00100	-	-	-	0.00241	No	0.415	No
Titanium	<0.01	-	-	-	<0.01	No	-	No	<0.01	-	-	-	<0.01	No	-	No
TSS	<4	-	-	-	<4	No	-	No	2.34	-	-	-	3.65	No	0.642	No
Uranium	0.00000508	0.02	No	0.000254	0.0000110	No	0.462	No	<0.00001	0.02	No	-	<0.00001	No	-	No
Vanadium	<0.001	-	-	-	<0.001	No	-	No	0.000279	-	-	-	0.000538	No	0.518	No
Zinc	0.00222	5	No	0.000444	0.00485	No	0.458	No	0.00804	5	No	0.00161	0.0224	No	0.360	No

Notes:

[1] *Health Canada (2012b). Maximum acceptable concentrations and other values.*

[2] *Baseline lake data collected in 1993, 1997, 2011, 2012, 2013.*

(-) = no value

< indicates the value or mean was below the method detection limit for that parameter.

Table 6.4-17. Surface Water Screening for Contaminants of Potential Concern for Lake Sites within the Country Foods Local Study Area

Metals	CCME Freshwater Guidelines [1] (mg/L)	95th Percentile of Baseline Lake Surface Water Concentrations [2] (mg/L)	Predicted Mean Lake Surface Water Concentration (mg/L)	Predicted > Guideline?	Hazard Quotient for Guideline	Predicted > Baseline 95th Percentile	Hazard Quotient for Baseline	Retained as a COPC?
Aluminum	0.1	0.0647	0.0269	No	0.269	No	0.416	No
Antimony	-	<0.00010	<0.00010	-	-	No	-	No
Arsenic	0.005	0.000837	0.000315	No	0.0629	No	0.376	No
Barium	-	0.0136	0.0056	-	-	No	0.413	No
Beryllium	-	0.000100	0.0000866	-	-	No	0.866	No
Bismuth	-	<0.00050	<0.00050	-	-	No	-	No
Boron	1.5	0.00971	0.00730	No	0.0049	No	0.751	No
Cadmium	0.00000827	0.0000307	0.00000863	Yes	1.04	No	0.281	No
Calcium	-	17.5	3.90	-	-	No	0.223	No
Chromium	0.0089	0.000440	0.000320	No	0.0360	No	0.728	No
Cobalt	-	0.00448	0.000435	-	-	No	0.097	No
Copper	0.002	0.00384	0.00197	No	0.984	No	0.513	No
Iron	0.3	0.199	0.0804	No	0.268	No	0.403	No
Lead	0.001	0.000735	0.000290	No	0.290	No	0.394	No
Lithium	-	<0.0050	<0.0050	-	-	No	-	No
Magnesium	-	4.40	1.83158	-	-	No	0.416	No
Manganese	-	0.0296	0.00847	-	-	No	0.286	No
Mercury	0.000026	<0.000010	<0.000010	No	-	No	-	No
Molybdenum	0.073	0.0000553	0.0000540	No	0.000740	No	0.978	No
Nickel	0.0280	0.0260	0.00488	No	0.174	No	0.188	No
Potassium	-	0.853	0.452	-	-	No	0.531	No
Selenium	0.001	<0.0002	<0.0002	No	-	No	-	No
Silicone	-	1.89	n/d	-	-	No	-	No
Silver	0.0001	<0.000010	<0.000010	No	-	No	-	No
Sodium	-	1.75	0.86	-	-	No	0.492	No
Strontium	-	0.0458	0.0185	-	-	No	0.403	No
Thallium	0.0008	<0.00010	<0.00010	No	-	No	-	No
Tin	-	<0.00010	<0.00010	-	-	No	-	No
Titanium	-	<0.010	<0.010	-	-	No	-	No
Uranium	0.2	0.0000270	0.00000828	No	0.0000414	No	0.307	No
Vanadium	-	0.000383	0.000237	-	-	No	0.620	No
Zinc	0.03	0.00747	0.00280	No	0.0935	No	0.375	No

Notes:

CCME = Canadian Council of Ministers of the Environment

[1] CCME (2013e). Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

[2] 95th percentile of lake water samples collected between 2010 and 2012.

(-) = no value

< indicates the values or mean was below the method detection limit for that parameter.

Screening of Marine Water Quality

Concentrations of metals in the MLA marine water and sediment are not expected to change from baseline concentrations. Air emissions from vehicles, ships, and camp incinerator within the MLA are much lower than the air emissions within the George and Goose Property Areas. Therefore, no air quality modelling was conducted for the MLA. As a result, the mean predicted marine water and sediment concentrations within the MLA are assumed to be similar to the mean baseline concentrations. As a result, no COPCs were identified in marine water or sediments.

Screening of Soil Quality

Predicted soil metal concentrations as a result of dust deposition during Year 3 (Goose Property Area) and Year 7 (for George Property Area) of the Operational phase of the Project were first screened against CCME Agricultural Soil Quality Guidelines (CCME 2013c). None of the predicted metal concentrations were greater than the CCME Guidelines. All of the HQs calculated relative to the guidelines were less than 1.0. Results of these comparisons and HQ calculations can be seen in Table 6.4-18 for sites within the George and Goose Property Areas, the MLA, and areas outside of the air quality modelling domain. Predicted soil metal concentrations without guidelines were subsequently screened against the 95th percentile of baseline concentrations (from samples collected in 2012). None of the predicted mean soil metal concentration exceeded the 95th percentile of baseline concentrations and all hazard quotients were below 1.0. As a result, no COPCs that could change the quality of country foods relative to baseline were identified in soil.

Screening of Vegetation Quality

Vegetation baseline concentrations (from samples collected in 2012) for total metals were compared to mean predicted concentrations, since guidelines are not available for vegetation quality. Results of this comparison can be seen in Table 6.4-19 for lichens and sedge and Table 6.4-20 for berries. None of the mean predicted metal concentrations were greater than the 95th percentile of baseline concentrations. As a result, no COPCs that could change the quality of country foods relative to baseline were identified in vegetation.

Results of Screening of Contaminants of Potential Concern for Country Foods

Overall, no COPCs were identified in any of the environmental media that were screened and incremental changes in environmental media quality due to Project activities were small. Since no COPCs were identified in any environmental media as a result of Project activities, no COPCs were identified that could affect the quality of country foods relative to baseline.

6.4.2.10 Risk Assessment for Human Health due to Air Contaminants

6.4.2.10.1 Identification of Contaminants of Potential Concern in Air

For parameters with predicted maximum concentrations that were above standards and objectives, these exceedances were found to be well within the air quality modelling domains Any potential effects to air quality would therefore be limited to within the boundaries of the LSA.

Predicted 24-hour average concentrations of fugitive and total TSP exceeded baseline and guideline concentrations at George and Goose Camps, as did the 24-average concentration of fugitive and total PM_{10} at Goose Camp (Section 6.4.2.7.2). The guideline screening relied on chronic and acute air quality objectives and standards (Government of Nunavut 2011; CCME 2012; BC MOE 2013a). These exceedances resulted in HQs greater than 1.0, and these COPCs were retained in the HHRA for further analysis to determine if effects to human health are likely to occur.

Table 6.4-18. Soil Screening for Contaminants of Potential Concern for Sites within the Country Foods Local Study Area

Metals	Predicted Mean Soil Concentration (mg/kg)	CCME Soil Guidelines[1] (mg/kg)	Predicted Concentration > Guideline?	Hazard Quotient Relative to Guideline	95th Percentile of Baseline Soil Concentration[2] (mg/kg)	Predicted Concentration > Baseline 95th Percentile?	Hazard Quotient Relative to Baseline	Retained as a COPC?
Aluminum	5,603	-	-	-	10,225	No	0.548	No
Antimony	0.0717	20	No	0.00358	0.173	No	0.415	No
Arsenic	9.06	12	No	0.755	34.2	No	0.265	No
Barium	40.3	750	No	0.0537	112	No	0.360	No
Beryllium	0.216	4	No	0.0540	0.540	No	0.400	No
Bismuth	<0.20	-	-	-	<0.20	No	-	No
Cadmium	0.112	1.4	No	0.0802	0.402	No	0.279	No
Calcium	2,182	-	-	-	4,755	No	0.459	No
Chromium	15.8	64	No	0.247	33.8	No	0.467	No
Cobalt	7.28	40	No	0.182	16.1	No	0.452	No
Copper	20.7	63	No	0.329	72.1	No	0.288	No
Iron	10,116	-	-	-	16,650	No	0.608	No
Lead	2.62	70	No	0.0374	5.13	No	0.510	No
Lithium	8.35	-	-	-	20.8	No	0.401	No
Magnesium	2,961	-	-	-	6,258	No	0.473	No
Manganese	93.4	-	-	-	280	No	0.333	No
Mercury	0.0343	6.6	No	0.00520	0.121	No	0.285	No
Molybdenum	0.367	5	No	-	0.803	No	-	No
Nickel	20.5	50	No	0.409	54.6	No	0.375	No
Phosphorus	495	-	-	-	968	No	0.511	No
Potassium	556	-	-	-	780	No	0.712	No
Selenium	0.189	1	No	-	0.590	No	-	No
Silver	<0.10	20	No	-	<0.10	No	-	No
Sodium	71.7	-	-	-	130	No	-	No
Strontium	12.8	-	-	-	32.9	No	0.389	No
Thallium	0.0385	1	No	0.0385	0.0945	No	0.407	No
Tin	<2.0	5	No	-	<2.0	No	-	No
Titanium	238	-	-	-	402	No	0.591	No
Uranium	0.675	23	No	0.0293	2.05	No	0.330	No
Vanadium	20.1	130	No	0.155	38.4	No	0.524	No
Zinc	19.0	200	No	0.0950	40.6	No	0.468	No

Notes:

CCME = Canadian Council of Ministers of the Environment

[1] CCME (2013c). Soil Quality Guidelines for the Protection of Environmental and Human Health - Agricultural.

[2] 95th percentile of soil metal concentrations for data collected in 2012.

(-) = no value, < indicates the value or mean was below the method detection limit for that parameter.

Table 6.4-19. Vegetation Screening for Contaminants of Potential Concern for Sites within the Human Health Risk Assessment Local Study Area

Metals	Predicted Mean Concentration (mg/kg)	95th Percentile of Baseline Concentration[1] (mg/kg)	Predicted > Baseline 95th Percentile?	Hazard Quotient	Retained as a COPC?
Aluminum	337	726	No	0.464	No
Antimony	< 0.050	< 0.050	No	-	No
Arsenic	0.285	0.602	No	0.474	No
Barium	14.5	24.8	No	0.585	No
Beryllium	< 0.50	< 0.50	No	-	No
Bismuth	< 0.150	< 0.150	No	-	No
Cadmium	0.0254	0.0698	No	0.363	No
Calcium	1117	1742	No	0.641	No
Chromium	< 0.50	< 0.50	No	-	No
Cobalt	1.72	6.04	No	0.285	No
Copper	2.51	6.77	No	0.371	No
Iron	324	687	No	0.472	No
Lead	0.730	1.58	No	0.462	No
Lithium	< 0.50	< 0.50	No	-	No
Magnesium	384	528	No	0.727	No
Manganese	54.4	102	No	0.533	No
Mercury	0.0498	0.124	No	0.403	No
Molybdenum	< 0.050	< 0.050	No	-	No
Nickel	4.94	19.2	No	0.257	No
Phosphorus	325	423	No	0.769	No
Potassium	914	1,141	No	0.801	No
Selenium	< 1.0	< 1.0	No	-	No
Silver	< 0.050	< 0.050	No	-	No
Sodium	< 100	< 100	No	-	No
Strontium	4.54	8.76	No	0.518	No
Thallium	< 0.050	< 0.050	No	-	No
Tin	< 0.250	< 0.250	No	-	No
Titanium	9.7	18.3	No	0.528	No
Uranium	0.0321	0.0782	No	0.410	No
Vanadium	0.837	0.968	No	0.865	No
Zinc	15.1	21.5	No	0.700	No

Notes:
[1] 95th percentile baseline concentrations of vegetation samples collected in 2012.
(-) = no value
< indicates the value or mean was below the method detection limit for that parameter.

Table 6.4-20. Berries Screening for Contaminants of Potential Concern for Sites within the Country Foods Local Study Area

Metals	Predicted Mean Concentration (mg/kg)	95th Percentile of Baseline Concentration[1] (mg/kg)	Predicted > Baseline 95th Percentile?	Hazard Quotient	Retained as a COPC?
Aluminum	6.30	9.00	No	0.700	No
Antimony	< 0.010	< 0.010	No	-	No
Arsenic	< 0.010	< 0.010	No	-	No
Barium	3.42	6.02	No	0.568	No
Beryllium	< 0.10	< 0.10	No	-	No
Bismuth	< 0.030	< 0.030	No	-	No
Cadmium	0.0165	0.0354	No	0.468	No
Calcium	284	521	No	0.546	No
Chromium	< 0.10	< 0.10	No	-	No
Cobalt	< 0.020	< 0.020	No	-	No
Copper	1.05	1.60	No	0.657	No
Iron	3.73	6.35	No	0.587	No
Lead	< 0.020	< 0.020	No	-	No
Lithium	< 0.10	< 0.10	No	-	No
Magnesium	129	201	No	0.645	No
Manganese	28.6	63.5	No	0.451	No
Mercury	< 0.0010	< 0.0010	No	-	No
Molybdenum	0.0166	0.0200	No	0.829	No
Nickel	0.424	0.845	No	0.502	No
Phosphorus	250	360	No	0.693	No
Potassium	1,377	2,255	No	0.611	No
Selenium	< 0.20	< 0.20	No	-	No
Silver	< 0.010	< 0.010	No	-	No
Sodium	< 200	< 200	No	-	No
Strontium	0.742	1.80	No	0.413	No
Thallium	< 0.010	< 0.010	No	-	No
Tin	0.00600	0.299	No	0.0201	No
Titanium	< 1.0	< 1.0	No	-	No
Uranium	< 0.0020	< 0.0020	No	-	No
Vanadium	< 0.10	< 0.10	No	-	No
Zinc	5.41	15.9	No	0.340	No

Notes:
[1] 95th percentile baseline concentrations of berry samples collected in 2012.
(-) = no value
< indicates the value or mean was below the method detection limit for that parameter.

6.4.2.10.2 Potential Effects in Human Receptors from Contaminants of Potential Concern in Air

The CACs that were screened into the HHRA included PM_{10} and TSP; all other CACs or air contaminants considered were below air quality objectives and standards. PM_{10} and TSP are considered to be threshold contaminants (i.e., COPCs that begin to have health effects above a certain threshold but are not carcinogenic).

The potential human health effects resulting from poor air quality involve the body's respiratory and cardiovascular systems, and may range from subtle biological and physical changes to difficulty breathing, wheezing, coughing, and aggravation of existing respiratory and cardiac conditions. Individual reactions depend on the type of air contaminant, the degree of exposure, the individual's health status, and genetics. These effects can result in increased medication use, increased doctor and emergency room visits, a higher number of hospital admissions, and even premature death (Health Canada 2004b). Although everyone is at risk from the health effects of air contaminants, certain individuals are more susceptible (Health Canada 2004b). Sensitive individuals who are more susceptible to respiratory contaminants may feel the effects more acutely, or at lower levels than the average person in the population. Typically children, the elderly, and people with cardio-respiratory health problems (e.g., asthma or chronic bronchitis) are the most susceptible (Health Canada 2009).

PM_{10} can be generated from burning of fossil fuels for heating, transportation, and the generation of electricity, motor vehicles travelling on unpaved site roads during the ice-free season, moving and crushing of rock and ore, and construction and blasting activities. PM_{10} is produced primarily by mechanical processes (e.g., construction activities, blasting, road dust re-suspension, and wind). Epidemiological and toxicological studies have shown combustion-derived particles (e.g., from incinerators and diesel engines) are more toxic than non-combustion derived particles (e.g., road dust or fugitive dust). However, PM_{10} can travel into and lodge themselves deep in the lungs posing a health risk, particularly in susceptible and sensitive subpopulations. Exposure can result in: coughing; breathing difficulties; reduced lung function; increased use of asthma medication; irritation of the eyes and nose; lung inflammation and increasing response to an inhaled allergen; acute respiratory illnesses in children; and lung cancer.

TSP consists of larger airborne particles that have a diameter up to 100 µm. Commonly referred to as dust or dirt, these particles can be released to the air from natural sources as well as human activities (e.g., motor vehicles travelling on unpaved site roads). When these larger particles are inhaled, over 99% of them are either exhaled or trapped in the upper areas of the respiratory system and expelled. However, they can cause irritation of the bronchial system and lungs.

The potential health effects listed above do not represent an exhaustive list, but the most common direct health effects are listed to provide rationale for their inclusion in the health effects assessment. Indirect effects from air contaminants generally include restricted activity days, lost school days, lost work days, unscheduled hospital admissions, and an increase in mortality.

6.4.2.10.3 Human Receptor Characteristics and Conversion Factors

Human Receptor Characteristics

A variety of age groups are often considered due to differences in sensitivity to air contaminants. When evaluating the risks to human health from exposure to contaminants, human receptor selection generally depends on the type of contaminant evaluated. For instance, the receptor selected for threshold contaminants is either the group that has the greatest exposure per unit body weight per day, which are typically children, or individuals who are particularly sensitive to potential adverse effects (e.g., elderly).

However, the Project is in a remote location, and children and the elderly are highly unlikely to be in the vicinity of sources of PM_{10} or TSP from the Project (i.e., within the LSA, close to the camps). Public access to the Project sites will be controlled. Other potential human receptors in the region (e.g., tourists and hunters) are more likely to be further away from Project-related air COPC sources (see Figures 6.4-13 and 6.4-14) and these people will only experience background air quality, or transiently exposures to COPCs while passing through areas close to Project infrastructure. Air quality is assumed to reach background concentrations outside of the air quality LSA (Volume 4, Chapter 1).

Consequently, health effects from the exposure to air contaminants will be assessed for individuals that are present near the Project sites regularly during the Construction and Operational phases, who are adults with sensitivity to air contaminants similar to an average, normal population. Therefore, the primary potential receptor considered in the assessment are off-duty workers residing on-site.

Conversion Factors

To estimate the fraction of time exposed, it was assumed that off-duty workers occupy the Project operation camp areas for 24 hours a day with worker shifts lasting 12 hours a day. The off-duty workers were assumed to be exposed to the emission for six months per year (182 days) due to shift rotations with two weeks on and two weeks off. This exposure duration is considered a conservative estimate since actual exposure times may be lower due to vacation or other leave from work. It was assumed that people will be exposed to Project related emissions for 10 years during the Operational phase.

The modelling tools and inputs described in Rescan (2013i) allowed TSP and PM_{10} to be predicted from model simulations. The air quality model predicted 24-hour and annual average TSP and 24-hour averaged PM_{10} concentrations from Project-related emissions during operation. The parameters used to calculate human exposure to air contaminants were:

- *IR* = inhalation rate (assumed to be 16.6 m^3/day for adults; Health Canada 2009);
- *BW* = body weight (70 kg; Richardson 1997);
- *D1* = fraction of hours per day spent at site (exposure time; unitless; assumed to be 12 hours per 24 hours);
- *D2* = fraction of days per week spent at site (exposure frequency; unitless; assumed to be seven days per week); and
- *D3* = fraction of weeks per year spent at site (exposure frequency; unitless; assumed to be 183 days per year, based on two weeks on/two weeks off rotation).

6.4.2.10.4 Air Quality Exposure Assessment, Toxicity Assessment, and Risk Characterization

The air quality exposure assessment evaluated the potential human health effects from the inhalation of TSP and PM_{10} by calculating estimated daily exposures from inhalation (EDEI). Inhalation HQs were then calculated by dividing the EDEI by applicable tolerable daily intakes (TDIs).

For the exposure assessment of CACs that exceeded guidelines in the initial screening, the predicted maximum concentration for the 24-hour averaging period was used to calculate the chronic exposure dose due to inhalation of the COPC. The 24-hour, rather than annual, averaging period was used to represent the concentration to which human receptors would be exposed to on a daily basis during their rotation at the site (for workers). The exposure doses for the receptors at the George and Goose Camps are estimated using the following equation (Health Canada 2009):

$$EDEI = \frac{C_{air} \times RAF_{inh} \times IR \times D1 \times D2 \times D3}{BW}$$

where:

EDEI = estimated daily exposure from inhalation of (non-carcinogenic) COPC in air (mg/kg BW/day)
C_{air} = maximum concentration of COPC in air (mg/m^3)
RAF_{inh} = inhalation relative absorption factor (unitless, assumed to be 1)
IR = inhalation rate (assumed to be 16.6 m^3/day for adults; Health Canada 2009)
BW = body weight (70 kg)
D1 = fraction of hours per day spent at site (exposure time; unitless; assumed to be 12 hours over 24 hours)
D2 = fraction of days per week spent at site (exposure frequency; unitless; assumed to be seven days per week)
D3 = fraction of weeks per year spent at site (exposure frequency; unitless; assumed to be 183 days per year based on two weeks on/two weeks off rotation)

The EDEI is the average daily dose from the inhalation route that a human receives due to frequenting the site (Health Canada 2009).

Table 6.4-21 presents the COPCs that were selected for further evaluation and the calculated exposure dose of air contaminants (EDEI) for off-duty workers.

Table 6.4-21. Risk Characterization for Contaminants of Potential Concern in Air that Exceeded Guidelines at George and Goose Camps

		George Camp	Goose Camp	
Parameter	**Unit**	**Total TSP, 24-hour**	**Total TSP, 24-hour**	**Total PM_{10}, 24-hour**
C_{air}	mg/m^3	0.139	0.493	0.125
RAF_{inh}	unitless	1	1	1
IR	m^3/day	16.6	16.6	16.6
D1	unitless	0.5	0.5	0.5
D2	unitless	1	1	1
D3	unitless	0.5	0.5	0.5
BW	kg	70	70	70
EDEI	mg/kg BW/day	0.00827	0.0293	0.00745
NAAQO[1]	mg/m^3	0.12	0.12	0.05
TDI Inhalation[2]	mg/kg BW/day	0.0285	0.0285	0.0119
Risk Characterization	Hazard Quotient	0.291	1.03	0.628

Notes:
C_{air} = maximum air concentration of COPC at receptor including background (mg/m^3)
RAF_{inh} = inhalation relative absorption factor (unitless, assumed to be 1)
IR = receptor inhalation rate (assumed to be 16.6 m3/day for adults; Health Canada 2009)
D1 = fraction of hours per day spent at site (exposure time; unitless; assumed to be 12 hours over 24 hours)
D2 = fraction of days per week spent at site (exposure frequency; unitless; assumed to be 7 days per week)
D3 = fraction of weeks per year spent at site (exposure frequency; unitless; assumed to be 183 days per year based on two week on/two week off rotation)
BW = body weight (70 kg)
EDEI = estimated daily exposure from inhalation of (non-carcinogenic) COPC in air (mg/kg BW/day), calculated as EDEI = (C_{air} × RAF_{inh} × R × D1 × D2 × D3)/BW
[1] National Ambient Air Quality Objectives (Maximum Desirable, mg/m^3)
[2] TDI Inhalation = tolerable daily intake (mg/kg BW/day); calculated as TDI = NAAQO × IR × RAFinh/BW
Hazard quotient calculated as HQ = EDEI/TDI
Grey shading indicates a hazard quotient greater than one.

As determined during screening of potential contaminants (Section 6.4.2.7.2), only total TSP (24-hour average) at George Camp and total TSP (24-hour average) and total PM_{10} (24-hour average) at Goose Camp exceeded guidelines and were evaluated further. Calculation of the EDEI based on maximum 24-hour averaged concentrations of TSP and PM_{10} are shown in Table 6.4-21.

Toxicity assessment involves the classification of the potential effects of substances and the estimation of the amount of a substance that can be received by an organism without adverse health effects. An appropriate toxicity benchmark or TRV was determined for each COPC based on its reported mode of action. For threshold substances (i.e., generally not a carcinogen), adverse effects are expected to only occur above a certain dose rate. The guidelines for TSP and PM_{10} were reviewed and the national ambient maximum desirable air quality objectives (NAAQO) were used as a toxicity reference value (TRV) for inhalation risks.

An inhalation tolerable daily intake (TDI) was derived based on the TRV and by including the average inhalation rate and body weight for an adult (RAIS 2013):

$$TDI = \frac{TRV \times IR \times RAF_{inh}}{BW}$$

where:

TDI = tolerable daily intake through inhalation (mg/kg BW/day)
TRV = toxicity reference value (mg/m^3)
IR = inhalation rate (assumed to be 16.6 m^3/h for adults; Health Canada 2009)
RAF_{inh} = inhalation relative absorption factor (unitless, assumed to be 1)
BW = body weight (70 kg)

Table 6.4-21 shows the calculation results. The TDI was used for comparison with the predicted maximum EDEI for each COPC and is expressed as an HQ, using the following equation (Health Canada 2009):

$$HQ = \frac{EDEI}{TDI}$$

where:

HQ = hazard quotient
EDEI = estimated daily exposure from inhalation of COPC in air (mg/kg BW/day)
TDI = tolerable daily intake through inhalation (mg/kg BW/day)

The HQs for TSP and PM_{10} at the George and Goose Camps are presented in Table 6.4-21. A HQ is the ratio between the exposure likely to be incurred by the person and the amount of exposure that is considered to be safe. At the George Camp, the HQ for TSP (24-hour averaging) was below 1.0, indicating negligible potential for health risk to adults from inhalation of TSP.

At Goose Camp, the HQ for PM_{10} (24-hour averaged) was calculated to be 0.63. A HQ smaller than 1.0 indicates that there is negligible potential for risk to human health from inhalation of PM_{10} in a normal adult population.

However, at Goose Camp the HQ for total TSP (24-hour averaging) was 1.03. An HQ value greater than 1.0 does not necessarily indicate that a health risk exists, but indicates that predicted exposure is greater than the established safe exposure limit and that there is potential for elevated risk to be present. A HQ of 1.0 was used as the threshold, because CACs are not expected to be present in environmental media other than air (e.g., country food or water) that are taken up by human

receptors. The HQ for total TSP was only slightly above 1.0 which indicates a relatively low potential for risk from TSP inhalation. Given that most human health effects related to particulates are experienced from inhalation of the portion of fine particulates (i.e., $PM_{2.5}$ and PM_{10}) and given that $PM_{2.5}$ did not exceed guidelines and PM_{10} had a HQ related to a derived TDI of less than 1.0, it is unlikely that members of the normal (i.e., not sensitive receptors), adult population expected to be present at Goose Camp will experience health effects from TSP.

6.4.2.11 Risk Assessment for Human Health Due to Drinking Water

6.4.2.11.1 Identification of Contaminants of Potential Concern in Drinking Water

All predicted metal concentrations in Goose and George lakes were below the guidelines and below the 95th percentile of baseline concentrations, and the HQs were below 1.0 (Section 6.4.2.7.3). Thus no COPCs were identified in drinking water due to Project activities.

6.4.2.12 Risk Assessment for Human Health Due to Country Foods Contaminants

6.4.2.12.1 Identification of Contaminants of Potential Concern in Country Foods

All predicted metal concentrations in fresh and marine water, soil, and vegetation were below applicable guideline limits or the 95th Arctic Char percentile of baseline concentrations (Section 6.4.2.7.4), thus all the HQs were below 1.0. No COPCs were identified that could affect the quality of country foods relative to baseline conditions. No adverse effects from Project activities and components anticipated to affect human health from the consumption of country foods (Volume 8, Chapter 5).

6.4.2.13 Uncertainties in the Human Health Risk Assessment

The process of evaluating human health risks from exposure to environmental media involves multiple steps, each containing inherent uncertainties that ultimately affect the final risk estimates. These uncertainties exist in numerous areas, including the collection of samples, laboratory analysis, estimation of potential exposures, and derivation of toxicity reference values, potentially resulting in either an over- or under-estimation of risk. However, for the HHRA, where uncertainties existed, a conservative approach was taken where possible to overestimate, rather than underestimate, potential risks.

Baseline data for NO_2 and SO_2 was limited to samples collected in 2012. Site-specific baseline data for CO, TSP, PM_{10}, and $PM_{2.5}$ was not collected and, instead, measured concentrations from other locations in Nunavut were used as baseline levels for the George and Goose Camps (Section 6.1.1 and Volume 4, Chapter 1). The model predictions of COPC concentrations used in the calculations and presented in the air quality sections were the maximum concentrations predicted, thus likely overestimate exposure and risk. Human receptor exposures were further overestimated by assuming that workers will be working at the camps for 10 years and during this time the highest emissions will occur continuously.

Baseline sampling did not include the concentration of metals in air bound to PM_{10} and this was calculated based on the proportion of metals in dustfall, which has several assumptions involved (Section 6.4.2.6.1). Furthermore, predicted concentrations of metals bound to PM_{10} were also calculated based on the proportion of metals in Back River rocks, again with several assumptions. These assumptions have the potential to increase the uncertainty in the assessment.

To generate the air quality model, several assumptions had to be made regarding input parameters (i.e., specific equipment that will be used and associated specifications).The conservatism is a result of the assumptions used in the exposure assessment models (Volume 4, Chapter 1 and Appendix V4-1B).

Additionally, exposure modelling is performed for outdoor receptors, but off-duty workers are likely to spend most of their time indoors. It is likely, but not certain, that the quality of the indoor air environment will be higher than the quality of the outdoor environment.

Freshwater and sediment were collected inside the LSA during baseline studies from several years (1993, 1997, 2011, 2012, and 2013, n = 239 for water and n = 188 for sediments) and used to establish baseline concentrations and model total (baseline plus Project contribution) predicted concentrations. Soil samples (n = 28) were collected inside the LSA in 2012. Vegetation samples co-located with soil samples inside the LSA (berry n = 15, lichen n = 18, and sedge n = 3) were collected in 2012. These datasets are considered large enough to provide a good indication of the COPC concentrations in these environmental media in the LSA and provide adequate statistical estimates for screening purposes.

Laboratory non-detects of metal concentrations in all environmental media add uncertainty as the non-detects were set to half their detection limit for calculation purposes (means and 95th percentiles) and screening of COPCs. This approach assumes that on average all values between the detection limit and zero could be present, and that the average value of non-detects could be as high as half the detection limit. Generally, replacement of non-detects with values half of their detection limit is a conservative estimate and recommended when there is a likelihood that the COPC is actually present (actual concentration is larger than zero), but does not over-estimate the concentration (actual concentration is smaller than the detection limit) and therefore does not over-estimate potential risk (US EPA 1991).

Biotransfer factors were used to model Project-related plant COPC concentrations. Modelling of plant COPC concentrations has a higher level of uncertainty than measuring concentrations. Biotransfer factors were calculated on a site-specific basis from baseline concentrations in co-collected soil and plant baseline samples. This method assumes that the plant obtained the COPCs entirely from the soil that was analyzed and excludes uptake from other sources. This approach is conservative as it would over-estimate the soil-to-plant BTF (since some of the uptake could come from other sources, such as deposition of dust on surfaces). Where concentrations were below method detection limits, BTFs could not be calculated reliably and were substituted with non-site specific literature-based BTFs. This added uncertainty to the modelling of plant COPC concentrations.

6.4.2.14 Conclusions of Human Health Risk Assessment for Contaminants

Predicted 24-hour average concentrations of total TSP was identified as a COPC at the proposed George and Goose Camps, as was the 24-average concentration of total PM_{10} at Goose Camp (Section 6.4.2.7.2). These COPCs could potentially be inhaled by off-duty workers at the camps.

Additional, more refined assessment of these COPCs found that total TSP at George Camp, and total PM_{10} at Goose Camp were unlikely to lead to human health effects through the inhalation of these COPCs (Section 8.4.2.8.4). However, the risk characterization HQ for total TSP at Goose Camp was 1.03, which is only slightly above the threshold HQ of 1.0. This indicates that total TSP poses a low risk to humans at the camp, and the potential health effects may include irritation of the bronchial system and lungs.

No COPCs were identified that would change the quality of either drinking water (Section 6.4.2.7.3) or country foods (Section 6.4.2.7.4) relative to baseline conditions. The potential for effects to human health is expected to be similar to baseline conditions and is not projected to change significantly due to Project-related activities. Any incremental change in environmental quality related to Project components or activities that could affect drinking water or country foods quality within the LSA is expected to remain within the range of baseline natural variability.

6.4.3 Risk Assessment for Noise

6.4.3.1 Noise Assessment Methodology

The Noise and Vibration Modelling Report (Rescan 2013m, Appendix V4-2B) was prepared by Environmental Resources Management (ERM) and provides details of the modelling undertaken to assess the environmental impact of noise and vibration associated with the proposed gold mining, and construction and operational activities at the Project (Rescan 2013m).

Noise and vibration is an important environmental factor because a change may adversely affect wildlife, workers, and local residents. Noise is defined as any undesirable sound that can irritate people, disturb rest or sleep, result in loss of hearing, or otherwise affect the quality of life of affected individuals (PWC Consulting 2002). Noise can result in psychological and physiological effects (e.g., stress), mental health effects, and effects on residential behavior (WHO 1999).

In addition, noise may adversely affect wildlife causing them to avoid important habitats and/or take time away from their key behaviours such as feeding, breeding or watching for predators, which can ultimately lead to reduced reproduction and increased mortality. Direct effects of high noise levels and shock waves on fish include mortality or internal injury (e.g., hearing, bleeding, and ruptured swim bladder). Many of these concerns were raised in the TK reports.

Vibration may be in the form of ground vibration or blasting overpressure (i.e., pressure waves in the atmosphere). These ground-borne or airborne vibrations can cause cosmetic and structural damage to buildings as well as disturbances to local residents, workers and wildlife.

Currently, Health Canada has not established noise guidelines or enforceable noise thresholds or standards (Health Canada 2010e), while Nunavut and the Northwest Territories only have occupational exposure limits for noise (CCOHS 2011). The noise assessment approach advised by Health Canada is to characterize baseline and Project-related noise and determine its potential impact on noise-sensitive receptors (Health Canada 2010e).

Provincial and international guidelines were included as comparative regulatory context for noise since ground-borne noise regulations, guidelines, or criteria at the Territorial and Federal level do not exist. Modelled noise levels at receptor locations can also be compared to the baseline noise levels and provincial and international guidelines adopted by Health Canada (2010e).

6.4.3.2 Spatial Boundaries

The atmospheric environment, which included noise, was evaluated in DEIS Volume 4, Chapter 2 and Rescan (2012g) and Rescan (2013m). Study areas were established based on the "zone of influence" beyond which the residual effects of the Project are expected to diminish to a negligible state. The expected zone of influence was determined using baseline studies, consultation, and expert knowledge.

Based on professional judgement, and other assessments in northern regions such as that for the Snap Lake Project, Project related noise may be audible under calm conditions at a distance of up to 10 km (De Beers Canada Inc. 2002). Therefore, two LSAs were selected for the Project extending 10 km in all directions from infrastructure around the Goose and George Property Areas as seen in Figures 1.4-1 and 2.1-1 in Volume 4, and Rescan (2013m). These two modelling domains were chosen to encompass temporary construction camps and permanent operation camps.

The noise and vibration impacts from the MLA are expected to be less than either the George or Goose Property Areas. If the effects of the highest emissions year at the Goose and George Property Areas are not

predicted to be significant then the potential effects from the entirety of the Project at the MLA should also not be significant. As such, the MLA is not included in the scope of the noise modelling assessment.

6.4.3.3 Temporal Boundaries

The noise assessment considers the Construction and Operational phases of the Project. Modelling years were chosen to be years in which the highest numbers of mobile and fixed equipment units are expected to be in use, as follows:

- Operational phase Year 3 for the Goose Property Area;
- Operational phase Year 7 for the George Property Area.

If the effects of these years are predicted to be not significant then the potential effect for the entirety of the Project should also be not significant.

Noise and vibration levels have also been predicted for two scenarios to represent snap shots of the fixed wing aircraft operations and the helicopter operations using the permanent airstrips at the George and Goose Property Areas.

The noise impact during the decommissioning phase is expected to be less than during the construction and operation phases and therefore this phase is not explicitly included.

6.4.3.4 Mitigation Measures

No additional mitigation measures for noise were considered in the assessment beyond what was outlined in the Noise and Vibration chapter (Volume 4, Chapter 2).

6.4.3.5 Sources of Project-related Noise

There are several Project-related sources of noise arising from the different activities and the types of equipment used as well as numbers of each type of equipment at the Project sites are described in detail in Section 3 of the noise modelling report (Rescan 2013m).

Potential sources of noise that were included in the model were:

- Fixed infrastructure, such as the processing plant and fans;
- Mobile equipment such as dozers, haul trucks, forklift, graders, and fuel trucks;
- Blasting and explosives; and,
- Aircraft and helicopters.

6.4.3.6 Receptor Locations

Receptor locations may be defined as any point occupied by persons or wildlife where extraneous noise and/or vibration are received. The George Camp (400 m NE from the closest mine deposit) and Goose Camp (1,400 m NE from the closest mine deposit) have been identified as being representative of the closest and/or potentially most affected sensitive human receptor locations within 10 km of the infrastructure of the George and Goose Property Areas. These locations have been adopted as the project-specific assessment locations for the sensitive receptors.

This assessment does not include occupational exposure to noise by workers at the Project site; however, off-duty workers who reside in the George and Goose Camps will potentially be impacted by

Project noise. These individuals can be considered temporary residential receptors and noise impacts on them will be assessed. In line with current best practices, the noise assessment for the worker's camps will consider the potential effects on sleep disturbance. Other potential impacts such as interference with speech communication and the potential for noise complaints do not need to be assessed for onsite human receptors.

Receptor locations for environmental receptors (e.g., wildlife) were described in the individual chapters on wildlife (Volume 5, Chapters 5 through 10; Volume 6, Chapters 6 and 7).

6.4.3.7 Receptor-Project Interactions

The Operational phase of the Project will likely create a high level of noise due to blasting, use of helicopters and vehicles, and large construction and mining operation machinery. This creates the potential for human health effects due to noise, such as disturbed rest and sleep, loss of speech comprehension, or loss of hearing in extreme cases. Table 6.4-22 identifies the project activities and potential impacts from noise to the human health VEC for Construction and Operational phases.

Receptor locations for environmental receptors (e.g., wildlife) were described in the individual chapters on wildlife (Volume 5, Chapters 5 through 10; Volume 6, Chapters 6 and 7).

6.4.3.8 Method for Identifying Noise Levels of Concern

Noise is measured in a non-linear scale known as decibels (dB); however, these measurements are filtered or weighted (A-weighted) to account for noise frequencies that are audible to humans and weights lower frequencies as less important than mid- and higher-frequencies (WHO 1999). Measured noise levels that are A-weighted are reported as dBA. Table 6.4-23 presents typical noise levels from familiar sources in terms of dBA, provided by the Alberta Energy Resources Conservation Board Noise Control Directive 038 (ERCB 2007).

Effects to human health for noise-sensitive human receptors were assessed in accordance with current best practices and the following relevant guidance:

- Alberta Noise Directive 038 (ERCB 2007);
- Health Canada (2010e) Useful Information for Environmental Assessment (Section 6: Noise Effects);
- WHO (1999) Guidelines for Community Noise;
- Michaud, Bly and Keith (2008) Using a change in percent highly annoyed with noise as a potential health effect measure for projects under the Canadian Environmental Assessment Act;
- US EPA (1974) Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety;
- Environment Canada (2009)The Environment Code of Practice for Metal Mines;
- International Standards Organization (ISO 2003) ISO 2631/2 Mechanical Vibration and Shock - Evaluation of human exposure to whole-body vibration Part 2;
- German Standard Organization (1970) Vibrations in Building Construction DIN 4150; and
- Swiss Association of Standardization (1978) Effects of Vibration on Construction: SN640 312.

Table 6.4-22. Human Receptor-Project Interactions Due to Noise and their Rationale for Inclusion in the Human Health Risk Assessment

Project Phase	Interaction Pathway	Project Components and Activities	Potential Effects to VEC/VSEC	Pathway Analysis (Included/Not Included?)	Rationale for Inclusion or Exclusion from the Analysis
Construction	Noise	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas Quarry Development Tailings Management Area/Dam or Dyke Construction at Goose Property Pit Pre-Stripping, Waste Rock Pile Construction, Headframe and Underground Development Winter Road construction and use from Bathurst Inlet to Goose & George properties, and between Goose & George Machinery and Vehicle Emmissions Diesel Power Generation Air Transport of Personnel and Goods Sewage Treatment Plant and discharge Landfill Construction/Solid Waste Management Incinerator Marine Laydown Area: on-land laydown areas/fuel storage Marine Laydown Area: in-water infrastructure Marine Transport of Goods	Construction activities may result in noise levels that have the potential to affect human health through sleep disturbance at camp locations.	not included	Not included, because noise is expected to be less during the construction phase and only worst case scenario (operation phase) is assessed.
		Water Use Machinery and Vehicle Refuelling/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Environmental & Socio-Economic Monitoring Hiring & Managing Labour and Construction Workforce Taxes, Contracts, Purchases	No effects to noise and human health are expected from these project activities.	not included	n/a
Operations	Noise	Camps and Mill Facility (Goose) Open Pits: Drilling, Blasting, Excavation Tailings Storage Waste Rock Piles Road and Airstrip Use & Maintenance Winter Road construction and use from Bathurst Inlet to Goose & George properties, and between Goose & George Diesel Power Generation Air Transport of Personnel and Goods	Operation activities may result in noise levels that have the potential to affect human health through sleep disturbance at camp locations.	included	Noise levels were assessed for worst-case scenarios during operation (Year 3 - Goose Property Area and Year 7 - George Property Area), when the highest number of mobile and fixed equipment units is in operation and has the highest potential to affect human health.
		Underground: Drilling, Blasting, Excavation In-Pit and Surface Water Management Water Use Incinerator Sewage Treatment Plant and discharge Equipment Maintenance/Fuel Storage and Handling Chemical and Hazardous Material Storage and Management Explosives Storage and Handling Machine and Vehicle Emissions Marine Transport of Goods Marine Laydown Area: Fuel Storage and Handling Environmental & Socio-Economic Monitoring Hiring and Managing Operations Work Force Taxes, Contracts, Purchases	No effects to noise and human health are expected from these project activities.	not included	n/a

Note: n/a = not applicable, because no potential impacts were identified

Table 6.4-23. Sound Levels of Familiar Noise Sources

Source	Sound Level (dBA)
Bedroom of a country home	30
Soft whisper at 1.5 m	30
Quiet office or living room	40
Moderate rainfall	50
Inside average urban home	50
Quiet street	50
Normal conversation at 1 m	60
Noisy office	60
Noisy restaurant	70
Highway traffic at 15 m	75
Loud singing at 1 m	75
Tractor at 15 m	78 - 95
Busy traffic intersection	80
Bus or heavy truck at 15 m	88 - 94
Jackhammer	88 - 98
Loud shout	90
Freight train at 15 m	95
Modified motorcycle	95
Jet taking off at 600 m	100
Amplified rock music	110
Jet taking off at 60 m	120
Air-raid siren	130

Notes:
Source: ERCB (2007)
dBA = A-weighted decibels

Baseline data are used to assess the changes in noise levels due to predicted Project activities. Baseline noise levels were monitored at 10 locations around the George and Goose Property Areas during March and June of 2012 (Rescan 2012g); however, only station S10 at the George Camp and S01 at the Goose Camp are applicable to the HHRA (Table 6.4-24). The baseline study collected noise data on the continuous equivalent sound level over a time period of 24 hours (L_{eq}) and the 90th percentile level (L_{90}, which is the A-weighted sound pressure level that is exceeded 90% of the time during the measurement period). Due to the influence of existing anthropogenic noise sources on baseline noise monitoring average rural ambient sound levels for a “quiet, rural area” have been used (Table 6.4-24; ERCB 2007).

The Project location is currently described as pristine wilderness with no noise impact relating to industrial activity. The Construction and Operational phases of the Project will introduce environmental noise sources largely in the form of construction equipment, haul vehicles, blasting, vehicle traffic, and aviation traffic (fixed wing and helicopter).

Table 6.4-24. Baseline Noise Data of 24-Hour Logarithmic Average L_{eq} and L_{90} Noise Levels

Location	Baseline 24-Hour Logarithmic Average L_{eq} (dBA)		Baseline 24-Hour Logarithmic Average L_{90} (dBA)		Baseline Noise Level Used in Assessment (dBA)		
	March	June	March	June	Day (L_d)	Night (L_n)	Day-Night (L_{dn})
George Camp	55	60	37	47			
Goose Camp	62	70	56	52	35	25	35

Notes:
Baseline data was collected in 2012.
L_{eq} = continuous equivalent sound level over a time period
L_{90} = ninetieth percentile level (the A-weighted sound pressure level that is exceeded 90% of the time during the measurement period)
dBA = A-weighted decibel
L_d = day-time sound level
L_n = night-time sound level
L_{dn} = day-night equivalent sound level

The noise assessment (Volume 4, Chapter 2) evaluates the results of the noise modelling study undertaken specifically for the Project (Rescan 2013m) following the assessment methodology established for the Project (Volume 9, Chapter 1 of the DEIS) to determine potential effects of Project noise on human receptors. The assessment methodology is summarized in Volume 4, Chapter 2 and Rescan (2013m). Full details of the assessment of noise from road transportation, industrial sites, blasting, and aircraft noise, and applicable model standards and software used are provided in Rescan (2013m). The type of ground cover (noise absorptive or reflective), typical meteorological conditions at the Project site, topography and obstacles (Project buildings and equipment) were incorporated into the model predictions.

The following assessment scenarios have been developed to quantify potential mining operation and construction noise levels and aviation operation noise levels across the assessment area.

- Scenario 1: representative of mining Operational and Construction phase noise within the George Property Area occurring at Year 3 during the Project life;
- Scenario 2: representative of mining Operational and Construction phase noise within the Goose Property Area occurring at Year 7 during the Project life;
- Scenario 3: representative of combined aviation operations from fixed wing aircraft operations utilising the permanent airstrips at the George and Goose Property Areas;
- Scenario 4**:** representative of helicopter operations between the George and Goose Property Areas; and
- Scenario 5: representative of blasting activities.

Scenarios 1 and 2 offer a representative snap shot of mining and processing operations and construction activities. Scenarios 3, 4, and 5 offer a representative snap shot of aviation operations and blasting impacts at, and between, each of the PDAs.

6.4.3.9 Noise Exposure Assessment

6.4.3.9.1 Environmental Receptors

Noise effects on wildlife receptors were evaluated in the specific wildlife chapters of the DEIS (Volume 5, Chapters 5 through 10; Volume 6, Chapters 6 and 7).

6.4.3.9.2 Human Receptors

The EA approach used to assess the effects from Project-related noise on human health is similar to that described for the Project (Volume 4, Chapter 2). The potential for noise to cause human health effects was assessed to identify the need for monitoring and mitigation, and to develop adaptive mitigation strategies if required. The health effects related to noise were assessed using the results of the noise model presented in Volume 4, Chapter 2, and Rescan (2013m), and comparisons to the appropriate human health noise guidelines and standards.

Health Canada (2010e) recommends evaluating increases in predicted noise levels over baseline conditions for the day-time (L_d) and night-time (L_n) equivalent noise levels, as well as a whole day equivalent noise level descriptor (L_{dn}). Impulsive and tonal characteristics of source noise can increase potential adverse effects and should also be accounted for. People are often exposed to sounds from more than one source and combinations of health effects are common, such as interference with speech in the day and sleep disturbance at night, thus the total adverse health load of noise must be considered over 24-hours (WHO 1999).

6.4.3.10 Potential Effects in Receptors from Noise

6.4.3.10.1 Environmental Receptors

Noise effects on wildlife receptors were evaluated in the specific wildlife chapters of the DEIS (Volume 5, Chapters 5 through 10; Volume 6, Chapters 6 and 7).

6.4.3.10.2 Human Receptors

Noise and vibration is a fairly broad term and it is important to select the correct measureable parameters in order to assess the potential effects of the Project on the receiving environment. A proper assessment of noise impact is important to ensure that decisions regarding noise mitigation requirements are based on the expected significance of the noise impact.

The potential impacts to human health are: sleep disturbance; interference with speech communication; complaints; change in percent highly annoyed (% HA); noise induced rattling; and noise induced hearing loss (WHO 1999; Health Canada 2010e). The potential noise effects covered in this assessment are those recommended by Health Canada (2010e) and are discussed below in more detail. Noise induced hearing loss (NIHL) has been discussed but has not been assessed in this study.

Sleep Disturbance

Uninterrupted sleep is required for normal physiological and mental functioning; however, environmental noise commonly causes sleep disturbance (WHO 1999). The primary effects of sleep disturbance are: difficulty falling asleep; awakenings and alterations of sleep stages or depth; increased blood pressure, heart rate and finger pulse amplitude; vasoconstriction; changes in respiration; cardiac arrhythmia; and increased body movements (WHO 1999). There are also secondary/after-effects of sleep disturbance which occur the following morning or day(s): reduced perceived sleep quality; increased fatigue; depressed mood or well-being; and decreased performance (WHO 1999). A good night's sleep requires indoor night-time equivalent sound levels (L_n, L_{Aeq}, 22:00 to

07:00 hours) of continuous background noise below 30 dBA and individual noise events exceeding 45 dBA (L_{AFmax}) should be not be exceeded more than 10 to 15 times per night (WHO 1999). Sensitivity to noise disturbance varies considerably between individuals, and this guideline is taken to apply to the whole population, so the vast majority of the population would not suffer sleep disturbance above higher levels. It is thus a conservative criterion not generally applicable to HHRA, but does provide a point of reference from which to understand potential noise impacts on humans. Studies around airports have shown that there is little effect on the general population sleeping in their homes from aircraft noise levels below approximately L_{AE} 90 dB (approximately L_{Amax} 80 dB).

As the Project is expected to operate 24-hours a day on two 12-hour shifts, sleep disturbance at the George and Goose Camps may occur throughout the day and night. As a conservative assumption, recommended WHO limits are compared to L_n values.

Sound is attenuated as it is transmitted indoors, and the amount of reduction mostly depends on whether windows are open or not. The US EPA (1974) suggests assuming an outdoor-to-indoor noise reduction of 15 dBA if windows are slightly open and 30 dBA if windows are closed. The actual sound reduction depends on construction materials, geometry, and other factors of the room and building. An attenuation of 30 dBA is typically assumed in cold climates where building shells are more airtight than structures in warmer climates, meaning that the noise attenuation rates are higher.

Interference with Speech Communication

Speech interference is a masking process that renders speech incapable of being understood (WHO 1999). Normal speech has a sound pressure level of approximately 50 dBA, and indoors noise with sound levels of 40 dBA or more interferes with speech comprehension (US EPA 1974). Outdoors, background noise levels should be kept below 55 dBA for continuous noise, and this takes into consideration that 95% of sentence intelligibility is acceptable outside where the separation between speakers is typically larger than indoors and where there are more sound interferences (US EPA 1974).

Complaints

A partial indication of a problem with noise can arise from noise complaints; however, the individual has to be willing and/or able to make a complaint and they require some expectation that the complaint will cause a reduction in noise (Michaud, Bly, and Keith 2008). When the normalized 24-hour A-weighted equivalent sound level (L_{dn}) reaches 62 dBA complaints become widespread and complaints should be expected if the Project L_{dn} is greater than 75 dBA (US EPA 1974).

High Annoyance

The % HA is a reliable and widely accepted indicator of human health effects due to environmental noise and is calculated using the adjusted L_{dn} (or Rating Level) pre- and post-Project (Michaud, Bly, and Keith 2008; Health Canada 2010e). Much of the data available on the health and welfare effects of noise are expressed in terms of % HA, yet this is a description of a subjective human reaction to "noise interference" (US EPA 1974). While the % HA can be statistically quantified, it is not a legal concept and it is the actual interference with activity that is important (US EPA 1974). However, the change in % HA within an average community in reaction to sound levels has been reported as uniform (Michaud, Bly, and Keith 2008). Health Canada (2010e) advises that when there is a change in the % HA at any given receptor greater than 6.5%, then noise mitigation measures should be considered, or if the Project L_{dn} exceeds 75 dBA.

The response to noise is subjective and is affected by many factors such as the: difference between the Specific Sound (sound from the Project) and the Residual Sound (noise in the absence of the Specific

Sound); characteristics of the sound (e.g., if it contains tones, impulses, etc.); absolute level of sound; time of day; local attitudes to the Project; and expectations for quiet.

Adjustments to sound levels are suggested to account for more annoying sound characteristics such as the presence of tonal or impulsive noise (US EPA 1974). The penalty for tones and regular impulsive sound is a +5 dBA adjustment to the predicted, calculated, or measured sound pressure level (US EPA 1974). The penalty for highly impulsive noise is a +12 dBA adjustment. The penalties for high-energy impulsive sound (e.g., blasting) and sound with strong low frequency content are variable and calculated according to the American National Standards Institute (ANSI) standard S12.9-2005/Part 4 (ANSI 2005). The penalty for sound with strong low frequency content should only be considered if the C-weighted sound pressure level is more than 10 dB higher than the A-weighted sound pressure level.

Noise Induced Rattling

The American National Standards Institute (ANSI) standard S12.9-2005/Part 4 (ANSI 2005), states that the sum of the sound levels in the 16-, 31.5- and 63-Hz octave bands should be lower than 70 dB to prevent rattles from low-frequency noise and the associated annoyance due to this effect (ANSI 2005).

Noise Induced Hearing Loss (NIHL)

When the human ear is exposed to excessive sound levels over long periods of time, permanent damage may occur (WHO 1999). Hearing impairment is an increase in the threshold of hearing and may be accompanied by tinnitus (ringing in the ears) and primarily occurs in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz (WHO 1999). The human ear is typically affected at the 4,000 Hz frequency first when damaged by noise, thus this frequency is considered the most noise-sensitive and is the frequency most important to be protected (US EPA 1974). Changes of less than 5 dB in hearing level are typically not considered noticeable or significant (US EPA 1974). As exposure time increases, noise-induced hearing impairment occurs at frequencies as low as 2,000 Hz. Hearing impairment is not expected at sound levels less than 70 dBA (energy equivalent sound level), even when exposure is prolonged (WHO 1999). Average sound pressures should never exceed 70 dBA for 24 hours, with peaks of 140 dB for adults and 120 dB for children to avoid hearing loss from noise exposure (WHO 1999). The duration of sound exposure becomes an important risk factor for hearing loss as sound levels increase above 70 dB.

NIHL concerns are normally most efficiently addressed in the Project detailed design phase due to the high variation in actual occupational noise exposures depending on design details. Therefore, assessing the potential for NIHL has not been included in this assessment.

Based on the previous identification of potential effects, five criteria have been chosen to rate potential effects (sleep disturbance, interference with speech communication, complaints, high annoyance, and noise induced rattling). All of these criteria are for off-site human receptors except for sleep disturbance, where onsite mine camps have been assessed with the assumption that windows would be closed. A significant effect is likely to occur if any of the following occur at any receptor outdoors (Table 6.4-25).

Minimial night time blasting, aircraft or road traffic is expected; however, the maximum night-time sound level (L_{AFmax}) has been included as a Project metric since night-shift workers may sleep in the camps during the day.

Table 6.4-25. Project Noise Impact Criteria

Project Metric	Description	Limit
L_d	Day-time noise level for assessing speech interference	55 dBA
L_n	Night-time noise level for assessing sleep disturbance *outside* the Project boundary	45 dBA
	Night-time noise level for assessing sleep disturbance *inside* the Project boundary (i.e., windows closed)	60 dBA
L_{AE}	Noise level for assessing sleep disturbance outside the Project boundary	90 dBA
	Noise level for assessing sleep disturbance inside the Project boundary (i.e., windows closed)	120 dBA
L_{dn}	Assessing the likelihood of complaints	62 dBA
	Legal action / Project noise mitigation required	75 dBA
Δ% HA	Increase in % HA metric before and after Project initiation	6.5%
L_{LF}	Using the sum of low frequency energy content to assess the likelihood of noise induced rattling	70 dBA
	Assessing low frequency noise annoyance: sum of low frequency energy content > 65 dB	65 dB
	C-weighted L_{dn} exceeds A-weighted L_{dn} by 10 dB	10 dB
L_{peak}	Peak sound pressure level for assessing human sensitivity to impulsive blasting noise	120 dB
L_{AFmax}	Sleep disturbance level (internal) not to be exceeded more than 10-15 times per night	45 dBA

Notes:
L_d = day-time (07:00 to 22:00) equivalent sound level
L_n = night-time (22:00 to 07:00) equivalent sound level
L_{AE} = noise event levels
L_{dn} = day-night equivalent sound level
% HA = percent highly annoyed
L_{LF} = low frequency sound level
L_{peak} = peak sound pressure level
L_{AFmax} = maximum night-time sound level
dBA = A-weighted decibel
dB = decibel

6.4.3.11 Significance of the Risk to Receptors from Noise

6.4.3.11.1 Environmental Receptors

Noise effects on wildlife receptors were evaluated in the specific wildlife chapters of the DEIS (Volume 5, Chapters 5 through 10; Volume 6, Chapters 6 and 7).

6.4.3.11.2 Human Receptors

This section presents the findings of the noise and vibration impact assessment with results presented for each of the mining and construction scenarios outlined in Section 6.4.3.6 above. Calculated noise levels for each of the mining, aviation, and blasting scenarios with respect to human receptors are presented in Tables 6.4-26 to 6.4-28.

As there are no known existing human receptors within 10 km of either the George or Goose Property Areas, the impacts of noise on human health focus solely on the Project worker's camps. In line with current best practice, the noise assessment for the George and Goose Camps will consider the potential effects on sleep disturbance.

Table 6.4-26. Noise Modelling Results for the George and Goose Camp Locations for Mining Operations Scenarios 1 and 2

Receptor	Calculated Noise Level L_n[1]	Limiting Criteria L_n[2]	Comply?
George Camp	57	60	Yes
Goose Camp	61		No

Notes:
[1] All noise levels are internal dBA re 2 x 10^{-5} Pa assuming a noise attenuation of 30 dBA.
[2] Night-time noise level for assessing sleep disturbance inside the Project boundary.
L_n = night-time sound level

Table 6.4-27. Noise Modelling Results for the George and Goose Camp Locations for Aviation Noise (Fixed Wing and Helicopter) Scenarios 3 and 4

Receptor	Calculated Noise Level		Limiting Criteria[2] L_{AE}	Comply?
	Fixed Wing L_{AE}	Helicopter L_{AE}		
George Camp	87	70	90	Yes
Goose Camp	86	78		Yes

Notes:
All noise levels are external dBA re 2 × 10^{-5} Pa.
L_{AE} = noise event levels

Table 6.4-28. Noise Modelling Results for the George and Goose Camp Locations for Blasting Noise from Mining Operations Scenario 5

George Property Area	Predicted Noise Level, dB					
Location	LCP North Pit	Locale 1 Pit	Locale 2 Pit N	Locale 2 Pit S		
Charge Weight (kg TNT)	427	320	274	274		
Receptor	dB L_{peak}	dB L_{peak}	dB L_{peak}	dB L_{peak}		
George Camp	96	78	108	110		
Goose Camp	71	72	70	71		
Goose Property Area	**Predicted Noise Level, dB**					
Location	Llama Pit (open) N	Llama Pit (open) S	Umwelt Pit (open) N	Umwelt Pit (open) N	Main Pit (open) West	Main Pit (open) East
Charge Weight (kg TNT)	321	321	296	296	187	187
Receptor	dB L_{peak}	dB L_{peak}	dB L_{peak}	dB L_{peak}	dB L_{peak}	dB L_{peak}
George Camp	72	71	71	71	72	69
Goose Camp	104	106	108	107	85	97

Notes:
dB = decibel
L_{peak} = peak sound pressure level

As seen in Table 6.4-26, the predicted noise levels meet the limiting criteria (60 dBA) at George Camp and exceed the criteria at Goose Camp by 1 dBA. This exceedance is considered to be within a tolerable range and could be easily mitigated through building construction and design.

There will be about eight flights per day at the George and Goose Property Area airstrips in the busiest period of production. For this reason, the assessment of noise impact from aircraft operations is based on noise event levels (L_{AE}) rather than period averaged noise levels (L_n, L_d, etc). Calculated noise levels for each of the aviation scenarios with respect to human receptors are presented in Table 6.4-27.

Table 6.4-27 shows that aviation noise is not predicted to exceed the limiting criteria (90 dBA) at either the George or Goose Camps.

Calculated noise levels from blasting operations with respect to human receptors are presented in Table 6.4-28.

Table 6.4-28 shows that predicted external noise levels from blasting exceed the sleep disturbance limit of 45 dBA at both the George and Goose Camps. Internal noise levels will be reduced by at least 30 dBA which removes the majority of the predicted exceedances, although some still remain. However, this limit needs to be exceeded 10 to 15 times to result in sleep disturbance.

6.4.3.12 Conclusions of Human Health and Environmental Risk Assessment for Noise

The predicted noise levels from mining operations exceeded the limiting criteria at Goose Camp by only 1 dBA. Predicted noise levels from aviation did not exceed the limiting criteria inside either the George or Goose Camps. Predicted external noise levels from blasting exceed the sleep disturbance limiting criteria at both the George and Goose Camps. Noise levels inside buildings will be reduced by at least 30 dBA which removes the majority of the predicted exceedances, although some still remain. However, the limiting criteria need to be exceeded 10 to 15 times to result in sleep disturbance.

The limiting criteria exceedances from predicted noise due to mining operations and blasting are considered to be within a tolerable range and could be easily mitigated through building construction and design.

6.4.4 Conclusions of the Human and Environmental Risk Assessment

6.4.4.1 Conclusions of the Environmental Risk Assessment for Contaminants

No Project-related COPCs, including metals, were identified in the freshwater, marine, or terrestrial environments. Thus, there is negligible potential risk of the Project on health of fish and aquatic habitat, fish communities, wildlife, migratory birds, and raptor VECs.

6.4.4.2 Conclusions of Human Health Risk Assessment for Contaminants

Predicted 24-hour average concentrations of total TSP was identified as a COPC at the proposed George and Goose Camps, as was the 24-average concentration of total PM_{10} at Goose Camp (Section 6.4.2.7.2). These COPCs could potentially be inhaled by off-duty workers at the camps.

Additional, more refined assessment of these COPCs found that total TSP at George Camp, and total PM_{10} at Goose Camp were unlikely to lead to human health effects through the inhalation of these COPCs (Section 8.4.2.8.4). However, the risk characterization HQ for total TSP at Goose Camp was 1.03, which is only slightly above the threshold HQ of 1.0. This indicates that total TSP poses a low risk to humans at the camp, and the potential health effects may include irritation of the bronchial system and lungs.

No COPCs were identified that would change the quality of either drinking water (Section 6.4.2.7.3) or country foods (Section 6.4.2.7.4) relative to baseline conditions. The potential for effects to human health is expected to be similar to baseline conditions and is not projected to change significantly due

to Project-related activities. Any incremental change in environmental quality related to Project components or activities that could affect drinking water or country foods quality within the LSA is expected to remain within the range of baseline natural variability.

6.4.4.3 Conclusions of Human Health and Environmental Risk Assessment for Noise

The predicted noise levels from mining operations exceeded the limiting criteria at Goose Camp by only 1 dBA. Predicted noise levels from aviation did not exceed the limiting criteria inside either the George or Goose Camps. Predicted external noise levels from blasting exceed the sleep disturbance limiting criteria at both the George and Goose Camps. Noise levels inside buildings will be reduced by at least 30 dBA which removes the majority of the predicted exceedances, although some still remain. However, the limiting criteria need to be exceeded 10 to 15 times to result in sleep disturbance.

The limiting criteria exceedances from predicted noise due to mining operations and blasting are considered to be within a tolerable range and could be easily mitigated through building construction and design.

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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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