Bathurst Caribou Range Plan

Supporting Report:

Land Use Scenarios and Economic Considerations

January 2018

Acknowledgements

The Bathurst Caribou Range Plan (BCRP) Project Team is grateful to community members and members of the Working Group who provided generous contributions of time, knowledge, insight, guidance, and encouragement. The Project Team is led by Karin Clark (Government of the Northwest Territories) and includes Dan Ohlson (Compass Resource Management), Shawn Francis (FSR Consulting), John Nishi (EcoBorealis Consulting) and Natasha Thorpe (Trailmark Systems/Thorpe Consulting Services).

The Government of Northwest Territories Department of Environment and Natural Resources is serving as overall sponsor of the BCRP. Polar Knowledge Canada is also providing generous funding support to the planning process.

Disclaimer

This is a technical supporting document to the Bathurst Caribou Range Plan (BCRP). It describes the methods used and technical information considered or created while developing the BCRP. The audience for this report is intended to be technical specialists—a plain language summary has not been produced as key information is included in the Plan.

This report does not represent the results of community engagement nor Government policy direction. Separate supporting documents have been created for caribou range assessment technical information and traditional knowledge.

This document should be cited as follows:

> **Bathurst Caribou Range Plan, Supporting Report: Land Use Scenarios and Economic Considerations. Yellowknife, NT. January 2018.**

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

<blank page>

1 Introduction

This report is a technical supporting document for the Bathurst Caribou Range Plan (BCRP; the range plan). It describes the major land uses (mineral exploration and development, transportation and hydroelectric generation and transmission) in the Bathurst range and their economic considerations. Both the current and potential future situations are examined. While it is recognized that other important land uses, such as tourism and recreation, also occur in the Bathurst range, these three land uses account for the majority of human-caused habitat disturbance outside of communities. Two companion background documents describe the scientific information (Caribou Range Assessment and Technical Information Report) and the traditional knowledge (Traditional Knowledge of Caribou and Caribou People Report) used and considered by the range plan. The Traditional Knowledge Report provides information on human settlements and traditional economy values.

Current mineral exploration and development activities, and transportation and hydroelectric generation and transmission infrastructure, were summarized from available literature and mapping. With the assistance of a Mineral Task Group, the BCRP Working Group defined three future development scenarios to explore plausible patterns and amounts of development footprint within the Bathurst range. The purpose of the scenarios was not to attempt to predict the future but to examine potential levels of range disturbance resulting from different levels of land use activity that could then be examined as part of the structured decision-making evaluation framework.

2 Approach

The purpose of the BCRP is to recommend measures to reduce caribou habitat disturbance. Understanding the amount and location of disturbance is therefore important. To provide a baseline estimate of current human development footprint in the Bathurst range, a human development map was created from a variety of information sources, including the GNWT Cumulative Impact Monitoring Program (CIMP) human disturbance database, the National Road Network, and mineral industry-provided information used to support project assessment and permitting activities. Please see Appendix A of the Caribou Range Assessment and Technical Information Report for a detailed description of human development footprint mapping methods. The land use and footprint mapping information was also used as the basis for creating the future development scenarios.

2.1 Land Use and Disturbance Concepts

Human land use can result in disturbance[1] to caribou. Human disturbance effects can be considered as either **direct** or **indirect**. Some land use features, such as roads, settlements or mine sites, have a direct

[1] Disturbance is a temporary or permanent change in environmental conditions that might influence wildlife abundance and distribution. It is comprised of two aspects: direct disturbance is physical change (e.g. trees cut down or burned) whereas indirect disturbance is a change to non-physical aspects of the environment (e.g. noise, smell, light, etc.)

physical footprint that results in habitat loss or alteration. An area of indirect disturbance may exist around these physical footprints, where noise, dust, smells or other factors influence caribou's use of habitat. This area is known as the zone of influence (ZOI). Based on both traditional knowledge and scientific observation, caribou may avoid these ZOI areas, use them less frequently, or exhibit altered behavior or have a higher mortality risk from harvest or predation within them.

The ZOI concept can also be understood through the following community perspective:

> *The concepts inǫ̀ dè ɔǫ̀goèhshì (the caribou have thrown that land away) is translatable to the zone of influence. The forage conditions surrounding the mines are of poor quality and caribou chose to avoid the area and instead walk in a different direction, towards areas with no noise and better feeding grounds. The TK study for the Diavik Lichen and Soil Sampling Program (TRTI 2013) concluded that the lichen and vegetation, thus forage areas, were of poor quality for a radius of up to 15 kilometres around the mine site of Diavik. Extending from 15 to 30 kilometres, the quality of forage improved, but some locations were still impacted by mining activities. The amount of caribou activity, such as walking and feeding, increased with further distance away from the mine site. The increase in caribou activity correlates with improved caribou forage further away from the mine.* -- Dedats'eetsa: Tłı̨chǫ Research and Training Institute. May 4 2016: 63

In GIS mapping, ZOI is estimated as a buffer of a defined distance around the development features (Figure 1). The ZOI extent around different human development features was estimated based on literature reviews and values used in recent environmental assessments. ZOI extents assigned to each human feature type and supporting literature sources are provided in Appendix B of the Caribou Range Assessment and Technical Information Report.

Figure 1 illustrates concepts for the direct footprint of physical features and its associated ZOI. In this example the Snap Lake diamond mine is shown; the property is currently under care and maintenance, and is considered to have a 5 km ZOI surrounding the mine site. Its associated winter road is assigned a 1 km ZOI on either side of the road (2 km total width), which would only be active during the January-April haul period when the road is in use.

Based on the human development mapping and its associated ZOI extents, the amount of direct and indirect disturbance within the Bathurst range can be calculated using GIS. How human disturbance may affect caribou, and the potential effects of different levels of human disturbance on caribou populations, is explored in both the Caribou Range Assessment and Technical Information Report and the Traditional Knowledge of Caribou and Caribou People Report.

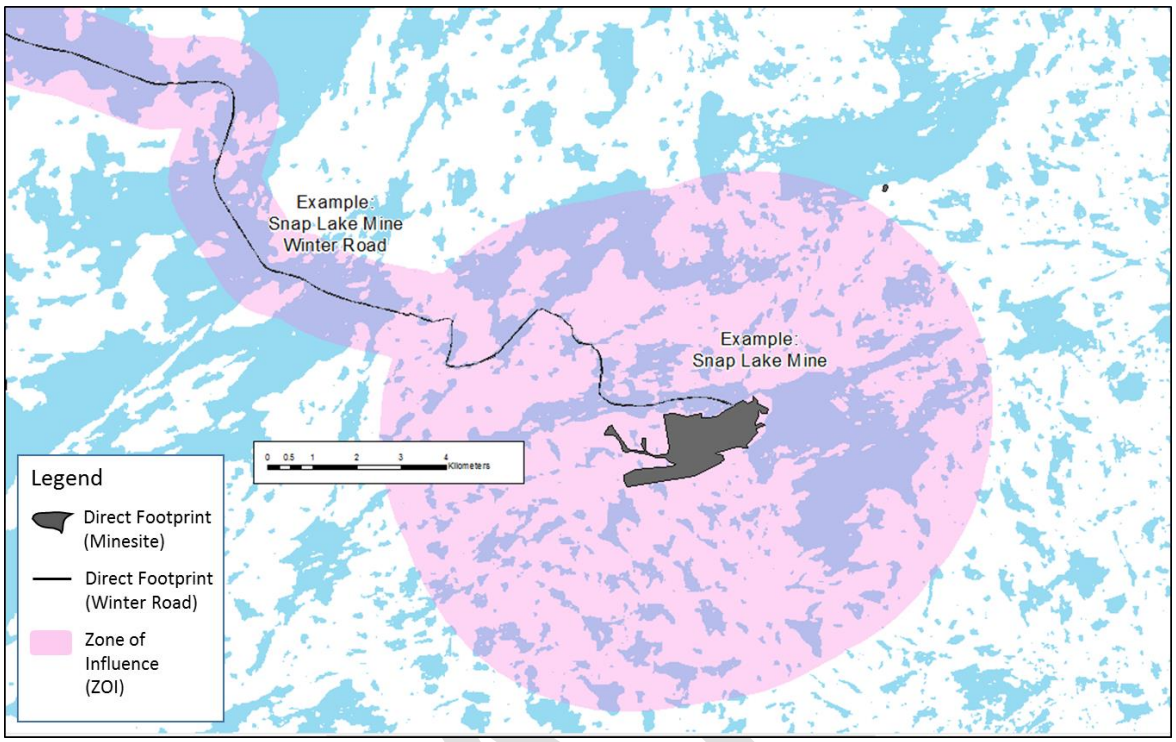


FIGURE 1: HUMAN DISTURBANCE CONCEPTS—DIRECT FOOTPRINT AND ITS SURROUNDING ZONE OF INFLUENCE (ZOI).

3 Current Situation

3.1 Major Land Uses in the Bathurst Range

3.1.1 Mineral Exploration and Development

Over the past century, the Bathurst range has experienced a high level of mineral exploration activity and multiple producing mines. During much of this period, exploration efforts were largely focused on gold, resulting in the construction of several producing gold mines. These included the Giant and Con mines near Yellowknife, the Tundra and Colomac mines in other parts of the Bathurst range in Northwest Territories, and the Lupin mine in Nunavut, near Contwoyto Lake (Figure 2). Silke (2009) provides a detailed operational history of mines in the Northwest Territories.

However, in 1993, diamonds were discovered in the Lac des Gras region of the Slave Geological Province in the central Bathurst range, leading to a dramatic increase in the level of mineral exploration in the central NWT and the Kitikmeot region of Nunavut. A prolonged mineral commodity cycle in the 2000s also led to increased interest in gold and base metal exploration. During this period from the mid-1990s to late-2000s, active mineral claims covered most of the central and northern portion of the Bathurst

herd range (Figure 3). This large increase in exploration activity was the original source of the cumulative effects concerns for Bathurst caribou as voiced by community members, regulators and scientists.

The diamond discoveries resulted in construction of four new diamond mines: Ekati, Diavik and Snap Lake (all in Northwest Territories), and the Jericho mine in Nunavut (Figure 2). A fifth diamond mine, Gahcho Kué, also in Northwest Territories, opened in fall 2016. All of these new mines are located within either the summer or calving and post-calving range of the Bathurst herd. The Jericho diamond mine in Nunavut operated briefly and is currently abandoned, while the Snap Lake mine was put under care and maintenance in late-2015. Several advanced exploration properties resulted from this period including Back River, Hackett River, High Lake and Izok Lake in Nunavut, and Courageous Lake, Indin Lake and Kennady Lake in Northwest Territories[2] (Figure 2).

In recent years, the level of mineral exploration has declined dramatically and active mineral claims and leases now occupy only approximately 5% of the Bathurst range planning area, with most occurring in the central Northwest Territories around the three producing diamond mines near Lac de Gras (Figure 3), and specific geological tracts in Nunavut. Given this low level of exploration, and the length of time needed to bring a mineral property into production, the potential to replace the existing producing diamond mines with new mines in the near future is uncertain.

[2] Some of these mineral deposits were known for decades but received renewed interest during the extended 2000s commodity mineral cycle.

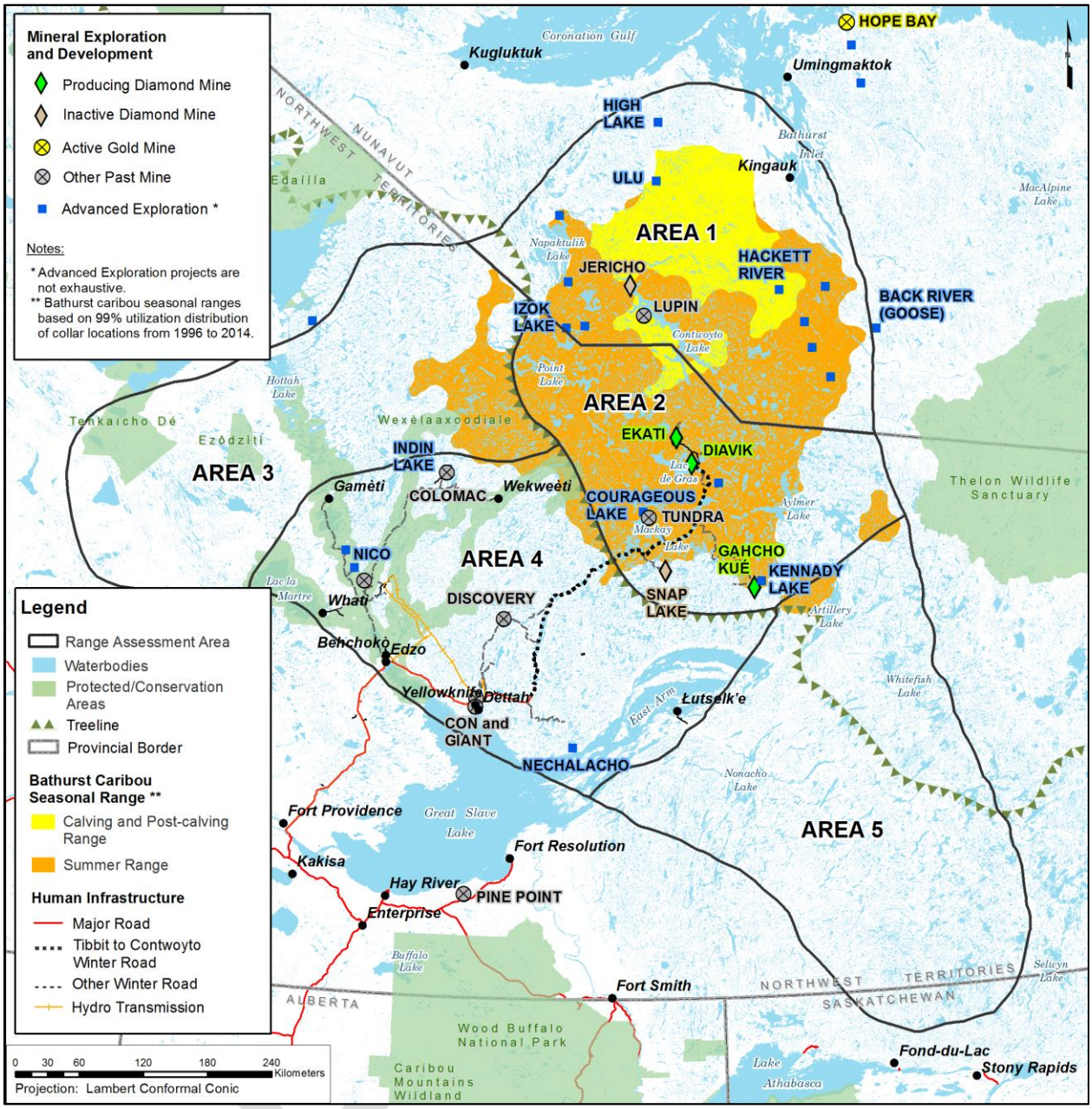


FIGURE 2: PAST MINES, NEW MINES CURRENTLY OPERATING OR UNDER CARE AND MAINTENANCE, AND OTHER ADVANCED EXPLORATION PROJECTS IN THE BATHURST RANGE.

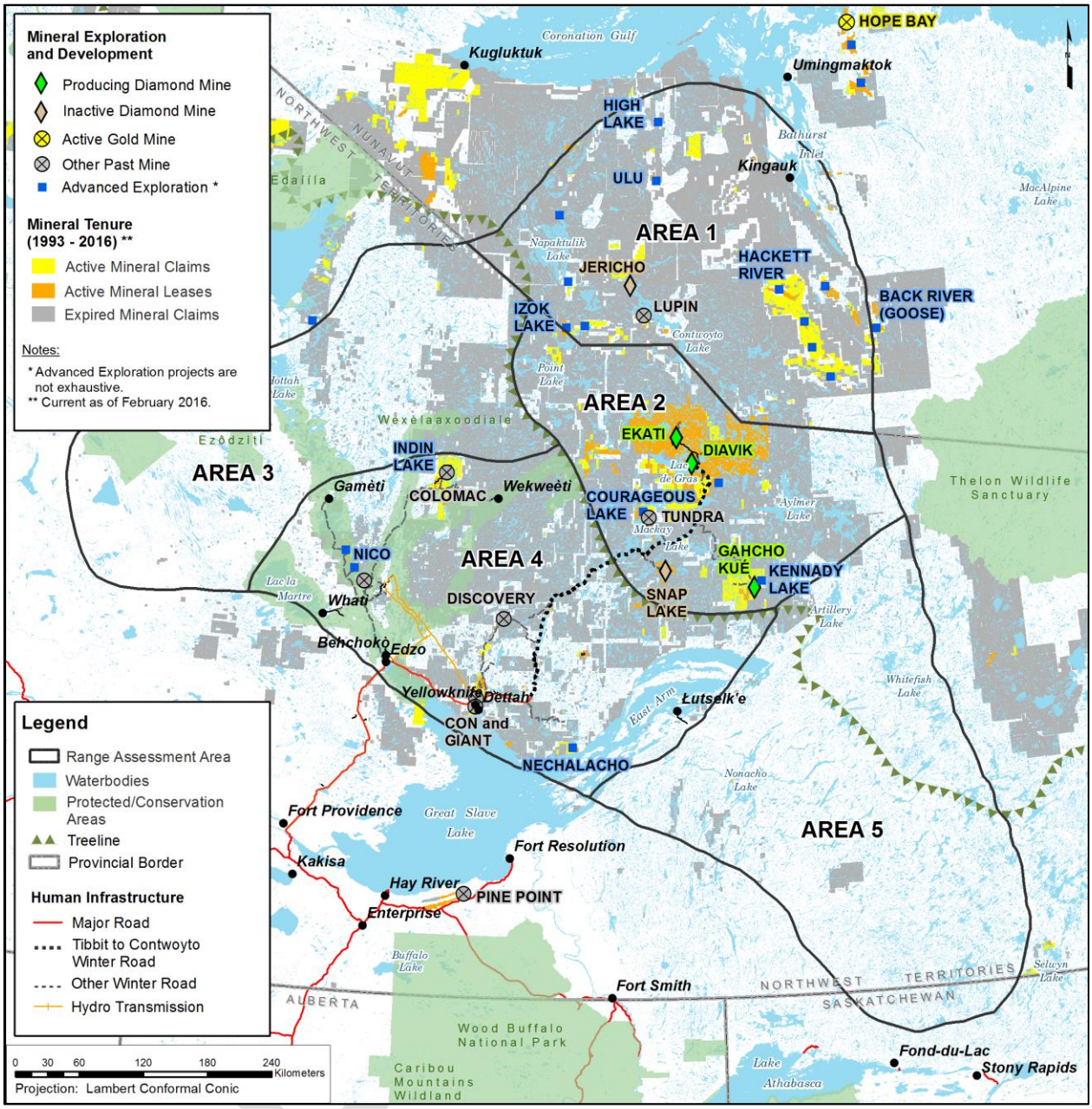


FIGURE 3: HISTORICAL AND CURRENT MINERAL TENURE ON THE BATHURST RANGE (SOURCE: GOVERNMENT OF NORTHWEST TERRITORIES, DEPARTMENT OF INDUSTRY, TOURISM AND INVESTMENT, AND NATURAL RESOURES CANADA).

The Mineral Exploration and Development Cycle

Mineral exploration and development can be considered a long-term cycle spanning roughly 25-55 years comprised of five different phases: 1) early exploration, 2) discovery, 3) development/construction, 4) production, and 5) reclamation (Figure 4). A sustained level of mineral exploration is required to develop a mine, as fewer than 1 in 1,000 exploration projects generally result in a producing mine, and the average time to develop a mine is 10 to 15 years from discovery to production. Each stage of the mineral exploration and development cycle requires different types of jobs and has varying levels of economic contributions.

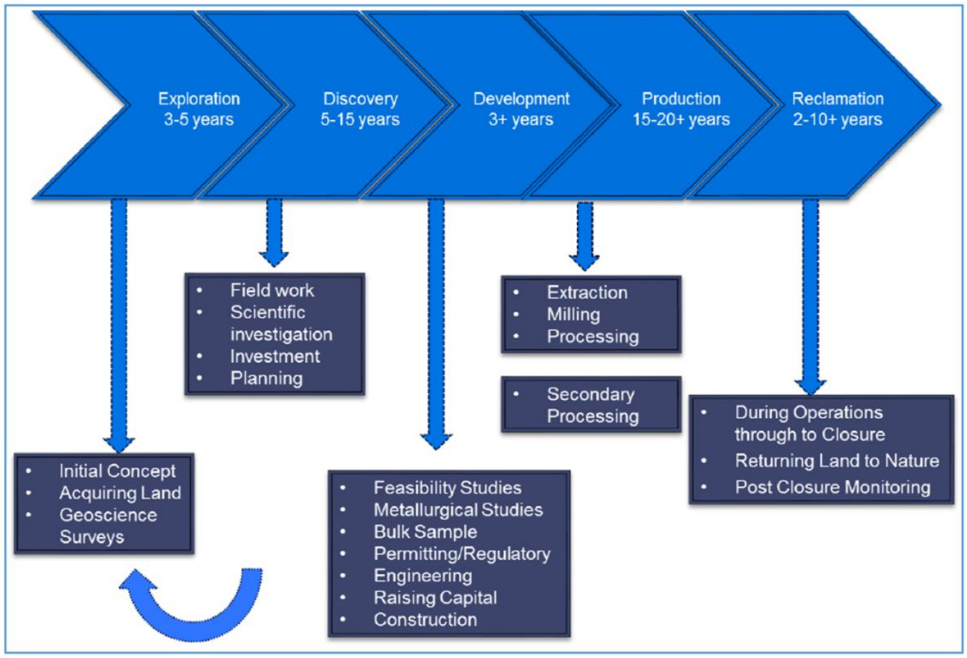


FIGURE 4: THE MINERAL EXPLORATION AND DEVELOPMENT LIFE-CYCLE (SOURCE: GOVERNMENT OF NORTHWEST TERRITORIES, DEPARTMENT OF INDUSTRY, TOURISM AND INVESTMENT).

Economic Contributions

Mineral exploration and development have been important components of the NWT economy and have contributed a major legacy of infrastructure, including highways, rail lines and hydroelectric facilities. With the addition of the new major diamond mines, the direct economic benefits of mining account for over one quarter of the NWT's Gross Domestic Product. Indirect benefits are also significant, through spending on transportation, construction, real estate and supporting activities such as monitoring, assessment and project planning. Mining is the largest private sector employer in the territory. Since 1998, the diamond mines alone have generated nearly $10 billion in NWT business contracts (over $4 billion of which were spent with Aboriginal-owned businesses) and have created over 20,000 total person years of employment (nearly half of which were Aboriginal employees) (NWT Industry, Tourism and Investment 2012).

3.1.2 Transportation

While there are few major roads in the Bathurst range, it is considered to be the most accessible barren-ground caribou range in Northwest Territories. Almost all roads and trails are located in the west central part of the winter range (RAA4), around the City of Yellowknife and the Tłı̨chǫ communities of Whatì, Wekweètì, Gamètì and Behchokǫ̀-Edzo, and the YKDFN community of Dettah (Figure 5).

The only major all-season road in the range, Highway 3, runs along the north shore of Great Slave Lake, connecting the City of Yellowknife and surrounding area to the highway system of southern Canada. Winter roads, operating seasonally between January and early April, are the most important transportation features. Winter roads connect the Tłı̨chǫ communities of Whatì, Gamètì and Wekweètì to Highway 3, and a number of other winter roads are used periodically to transport materials and fuel to mineral exploration sites. The most important winter road is the Tibbitt to Contwoyto Lake route which connects the three operating diamond mines near Lac de Gras to the public highway system (Figure 5). The Tibbit to Contwoyto winter road was originally constructed in 1982 to service the Lupin minesite near the Nunavut-NWT border. From its start at the end of Highway 4 (Ingraham Trail) to the Lupin mine, the Tibbit to Contwoyto Lake winter road spans approximately 600 km, although in recent years the road has only been constructed as far as the Ekati minesite (a distance of approximately 450 km). Approximately 87% of the road is routed over frozen lakes. In high traffic years, as many as 11,000 freight trucks travel the winter road at a rate of 12 to 15 trucks per hour, 24 hours per day. Three seasonal maintenance camps are located along the route.

The Tibbit to Contwoyto Lake winter road will likely continue to be constructed and used annually as long as the operating mines require resupply. GNWT is currently considering a 160 km all-season overland road (the Slave Geological Province all-season access road) to replace the southern section of the Tibbit to Contwoyto road, in order to extend the length of winter road operations. An all-season road from Highway 3, to the southwest of Behchokǫ̀, to Whatì is also being planned[3]. In Nunavut, an all-season road is being considered from Grays Bay to the central Kitikmeot region (the Grays Bay – Izok Lake corridor) and previously, an all-season road has been proposed between Bathurst Inlet and Contwoyto Lake (the BIPAR road corridor). Other project specific winter roads may also be built, as required.

3.1.3 Hydro Development and Transmission

Two major hydroelectric development and transmission systems are located along the western periphery of the Bathurst range (Figure 5). The Bluefish and Snare hydro systems supply power to the City of Yellowknife and other North Slave communities. Together they consist of five hydro generators and approximately 150 km of transmission lines. The Taltson hydroelectric facility, near Fort Smith, is not within the planning area but uses Nechalacho Lake, to the southeast of Łutsel K'e, as a reservoir, resulting in fluctuating water levels.

[3] As of December 2016, the Behchokǫ̀ to Whatì all-season road was undergoing environmental assessment.

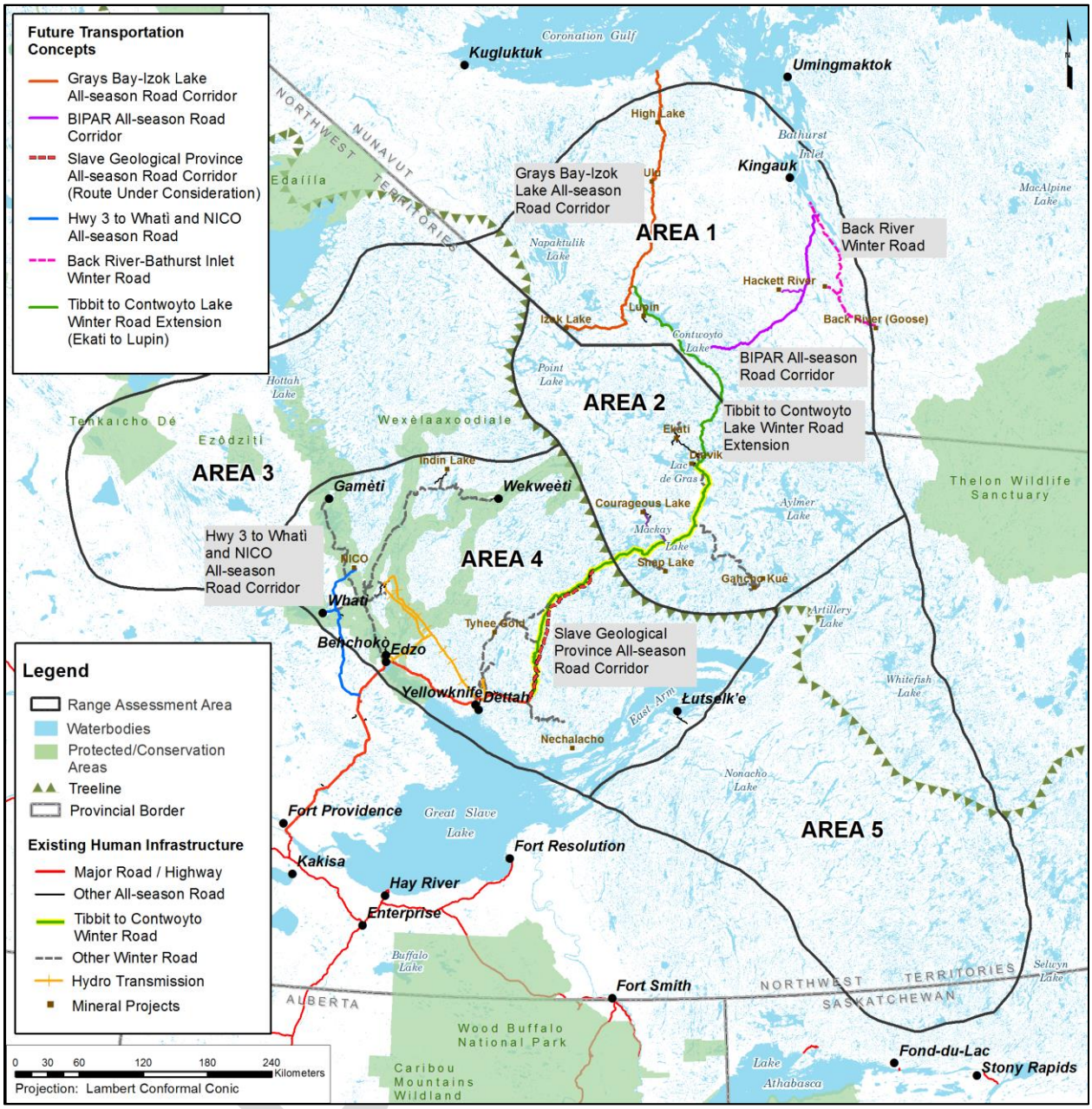


FIGURE 5: MAJOR TRANSPORTATION AND HYDRO FACLITIES AND TRANSMISSION LINES IN THE BATHURST RANGE.

3.2 Current Human Disturbance

Figure 6 shows the location of current direct human footprint and its associated ZOI resulting from land use. For a detailed description of the current human disturbance within the Bathurst range, see Section 3.5 of the Caribou Range Assessment and Technical Information Report.

Using available mapping, the BCRP Working Group determined that less than 0.05% (179.5 km^2) of the Bathurst annual range is currently affected by direct development footprint. Some of the disturbance is seasonal. For example, the Tibbit to Contwoyto Lake winter road is only operational between January and early-April of each year, and crosses frozen waterbodies for much of its length. Settlements (e.g., City of Yellowknife) and active mine sites (e.g., Ekati, Diavik and Gacho Kué) are the largest sources of direct footprint, followed by linear features such as all-season and winter roads, trails and electrical transmission corridors.

While the direct footprint of human land use in the Bathurst herd range may be very small, in some areas the total human ZOI is substantial. Using the ZOI assumptions described in Appendix B of the Caribou Range Assessment and Technical Information Report, the BCRP Working Group estimated that approximately 5.6% (21,898 km^2) of the Bathurst range is currently affected by direct and indirect human disturbance (direct footprint with associated ZOI). The highest levels of human disturbance occur in the Northwest Territories, in RAA4 (central winter range), where all of the permanent settlements and all-season highways are located, and RAA2 (central tundra) where the current operating diamond mines are located (Figure 6). Although linear features have a relatively small direct footprint, they are a major contributor to total human ZOI on the Bathurst annual range, and facilitate access for humans into previously difficult to travel areas.

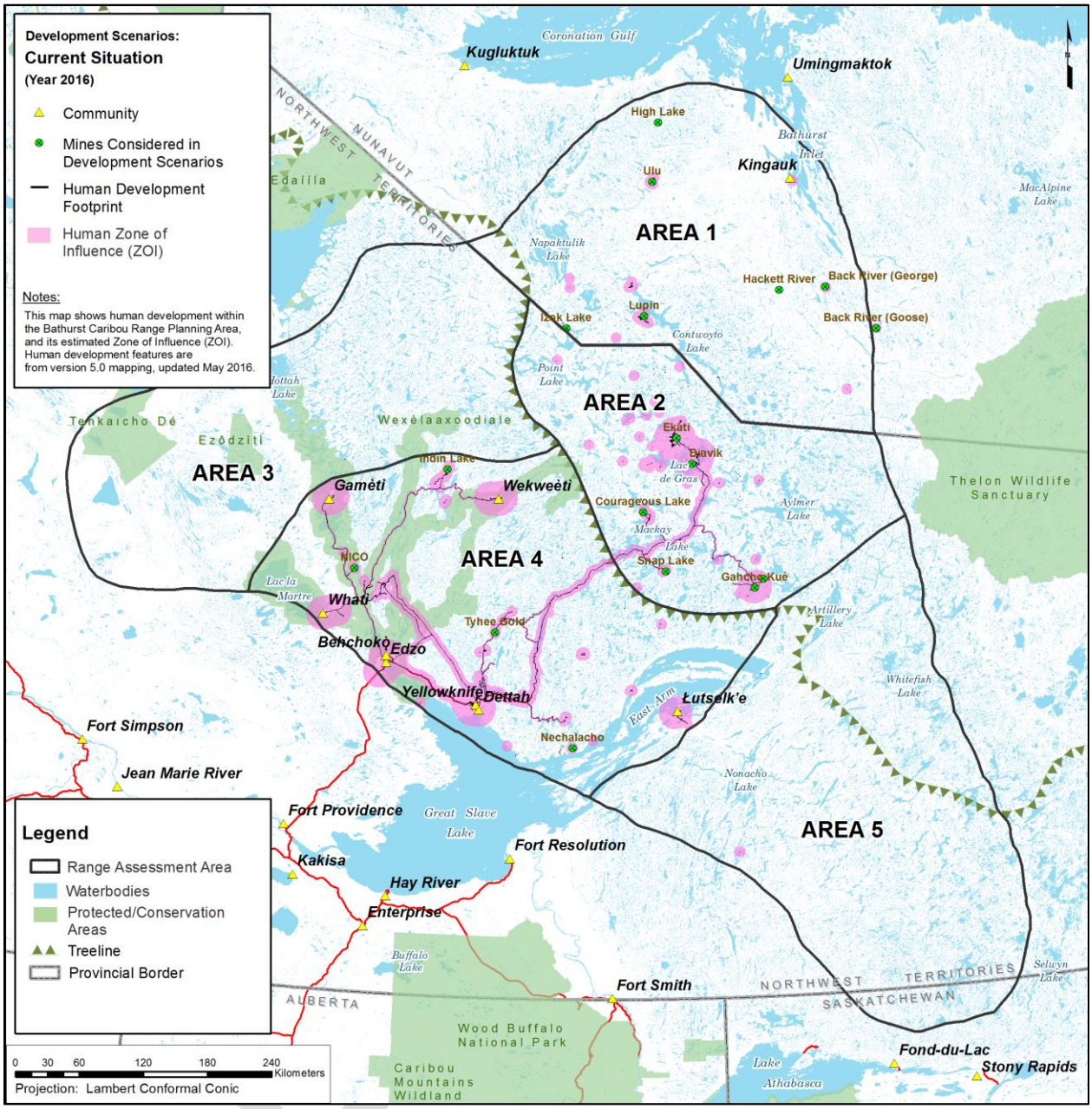


FIGURE 6: CURRENT DIRECT AND INDIRECT HUMAN DISTURBANCE IN THE BATHURST RANGE.

4 Future Situation

4.1 Future Development Scenarios

Future development (land use) scenarios provide insight into the amount of human-caused change that may occur in different parts of the range in the future. The scenarios were created using information based on known or reasonably foreseeable future mineral development and transportation projects that may occur in the next 24 years (2016 to 2040)[4]. Early-stage mineral exploration (mineral staking and grass-roots exploration activities) was not addressed in the future development scenarios, but may be examined in the future. The BCRP considered three potential scenarios:

- CASE 1: Declining development;
- CASE 2: Continuing development; and
- CASE 3: Increasing development.

Table 1 summarizes the major assumptions for each scenario. For each case, a detailed timeline of construction, operations and reclamation was created for each project considered in the scenario (Figure 7). CASE 1 represents a situation of declining development, where the existing operating diamond mines and Tibbit to Contwoyto Lake winter road cease operations by 2040, and no new mines are brought to production. CASE 2 projects a similar level of development into the future as current, where the existing diamond mines are replaced by new mineral development projects in the coming decades, and the southern part of the Tibbit to Contwoyto Lake winter road is replaced by a new all-season road into the central Slave Geological Province. CASE 3 represents an increasing level of development with new all-season road infrastructure in Nunavut and several new mines being developed, both in Nunavut and Northwest Territories.

[4] The BCRP Working Group worked closely with the Mineral Task Group to develop assumptions and project parameters for the three development scenarios.

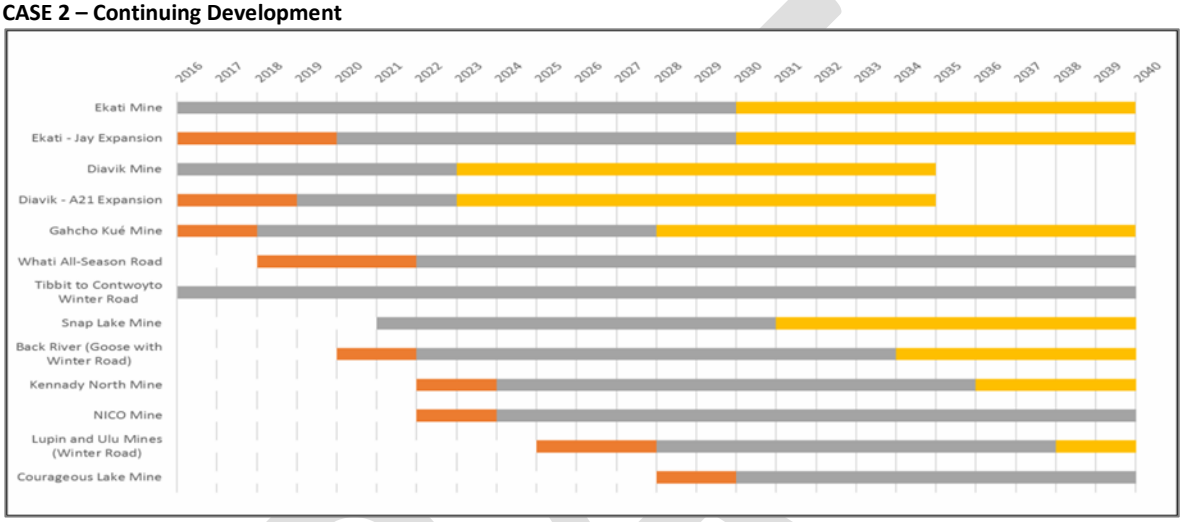
TABLE 1: OVERVIEW OF BATHURST RANGE PLAN FUTURE DEVELOPMENT SCENARIOS.

Scenario Assumptions	CASE 1: Declining Development	CASE 2: Continuing Development	CASE 3: Increasing Development
General Assumptions	CASE 1 assumes the existing producing mines are closed at the end of their projected life-span and no new mines are built, leading to the discontinuation of the Tibbit to Contwoyto Lake Winter Road. Mineral exploration declines or remains similar to current, with no other changes in transportation ore electrical utility infrastructure.	CASE 2 assumes that only a few of the existing advanced mineral exploration projects will become producing mines in the coming 24 years, mineral exploration will remain similar to current, and there will be limited change in current transportation and electrical utility infrastructure.	CASE 3 assumes that many of the existing advanced mineral exploration projects will become producing mines in the coming 24 years, the level of mineral exploration may increase, and the amount of transportation infrastructure will increase, but electrical generation will remain similar to current.
Advanced Mineral Exploration*	• Current mineral exploration projects.	• Current mineral exploration projects are maintained except those that advance to producing mines. • 3 new Advanced Exploration projects	• Current mineral exploration projects are maintained except those that advance to producing mines. • 7 new Advanced Exploration projects (CASE 2 plus 4 new)
Mineral Development	3 active mines: • 3 producing diamond mines (Ekati, Diavik and Gahcho Kué) • 1 diamond mine under care and maintenance (Snap Lake). The 3 producing diamond mines become past mines as they reach closure in 10-20 years future.	6 active mines: • Back River Project (Goose) • Snap Lake (re-opens) • Kennady North • Lupin-Ulu • NICO • Courageous Lake The 3 producing diamond mines become past mines as they reach closure in 10-20 years future.	12 active mines (CASE 2 plus the following 6): • Izok Lake • High Lake • Hackett River • Indin Lake • Nechalacho • Tyhee Gold
Transportation	Current all-season and winter road transportation network. After the Ekati, Diavik and Gacho Kué mine sites are closed, the Tibbit to Contwoyto Winter Road is no longer used.	Current road network maintained except construction of new all-season roads: • Hwy #3 to Whatì (replace existing winter road); • NICO to Whatì; • Tibbitt to Lockhart Lake (replaces approximately 150km southern section of existing winter road) Construction of Back River Project winter road to Bathurst Inlet and Marine Laydown facility proceeds.	Future low scenario plus new Nunavut minesite access roads: • IZOK road and port • BIPAR road and port (Phase I) • Back River utilizes BIPAR road and port
Electrical Generation and Transmission	Current facilities and transmission: • Snare; • Bluefish; and • Taltson	No change; current situation is maintained.	No change; current situation is maintained.
Settlements	Current situation	No change; current situation is maintained.	No change; current situation is maintained.

*Early-stage mineral exploration (staking and grass-roots exploration) is not currently addressed in the BCRP Development Scenarios.

CASE 1 – Declining Development

CASE 2 – Continuing Development

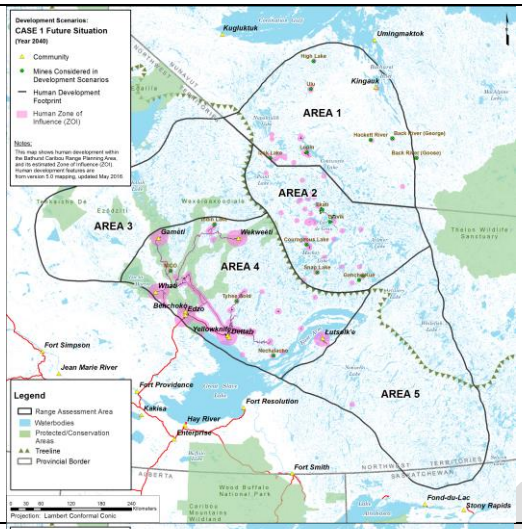


CASE 3 – Increasing Development

FIGURE 7: DETAILED TIMELINES FOR PROJECTS CONSIDERED IN BCRP FUTURE DEVELOPMENT SCENARIOS.

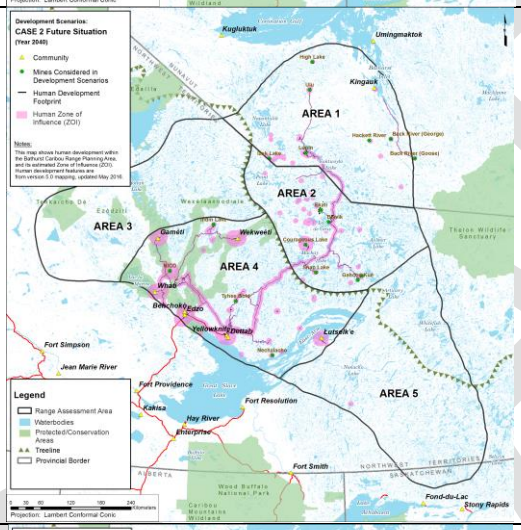
4.2 Disturbance Resulting from Future Development Scenarios

Figure 8 shows the mapped results of each scenario at year 2040. In all cases, there is very limited new land use activity projected for RAA3 (NWT Northwest Winter Range) and RAA5 (NWT Southeast Winter Range. Most of the projected changes in total human disturbance resulting from the three development scenarios occur in RAA1 (Nunavut), RAA2 (NWT Central Tundra), and RAA4 (NWT Central Winter Range). For a detailed description of the potential future human disturbance within the Bathurst range under these future development scenarios, see Section 3.5 of the Caribou Range Assessment and Technical Information Report.



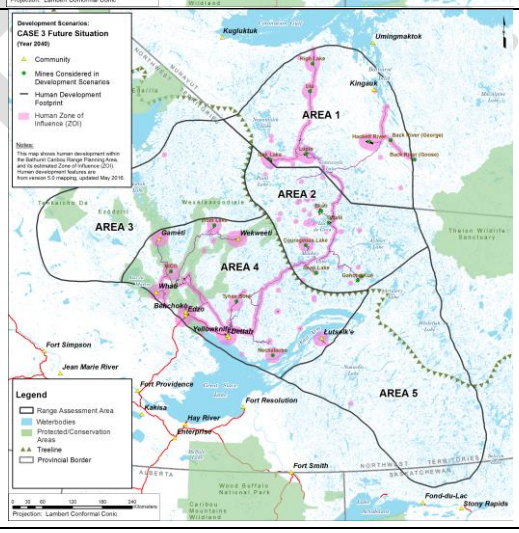
CASE 1:
Declining Development

Year 2040



CASE 2:
Continuing Development

Year 2040



CASE 3:
Increasing Development

Year 2040

FIGURE 8: POTENTIAL FUTURE HUMAN DISTURBANCE IN THE BATHURST RANGE: CASE 1 (DECLINING DEVELOPMENT), CASE 2 (CONTINUING DEVELOPMENT), AND CASE 3 (INCREASING DEVELOPMENT). ALL MAPS SHOW RESULTS AT YEAR 2040.

4.3 Economic Assessment of Future Development Scenarios

An economic assessment of the three Future Development Scenarios was conducted to understand the relative economic outputs associated with each. This first-order assessment is based primarily on the use of published economic multipliers for Northwest Territories (NWT Bureau of Statistics 2012)[5]. Using input of the Mineral Task Group, three economic indicators were calculated for each scenario: Gross Domestic Product (GDP), Employment and Labour Income. The three indicators were each calculated for the general project phases of construction, operations and reclamation.[6] Values were calculated in annual time steps based on the detailed project timelines shown in Figure 7.

The intent of economic evaluation within the BCRP range planning exercise is not to make precise predictions about future economic outputs resulting from potential mineral development and transportation projects. Instead, its purpose is to understand the relative changes that may occur as a means to explore the potential economic consequences of different caribou habitat management strategies that could alter, defer or limit future levels of future land use activity. See Appendix A for a detailed description of economic evaluation assumptions and methods.

The potential economic implications of the three development scenarios, reported by range assessment area, are as follows:

[5] Similar economic multipliers have not yet been gathered for Nunavut.

[6] Note: The multipliers used to date are based on most recent mineral economic development activity in the NWT, and thus are skewed toward the economics of diamond mining. Research is underway to develop economic multipliers that better reflect the full spectrum of commodities.

RAA1 - Nunavut

Figure 9 and Figure 10 show the projected change in GDP ($M/year) and employment (PY/year) resulting from development Case 1, 2 and 3 for RAA1:

- **Case 1**: There is no projected development, therefore no GDP or employment.
- **Case 2**: The Back River (Goose) project begins in 2021 causing a short term increase in construction related employment up to over 700 PY/Yr and increase in GDP to over 90 $M/Yr. The Lupin and Ulu projects begin in 2026 causing a decade-long rise in GDP to nearly 200 $M/Yr. Long-term employment opportunities increase up to nearly 700 PY/Yr for 3 years, then drop to around 300 PY/Yr by 2029 and again down to 150 PY/Yr by 2040.
- **Case 3**: In addition to Case 2:
  - The Back River (George) project begins in 2029 causing an increase in in construction related employment up to nearly 1,300 PY/Yr and increase in GDP to over 300 $M/Yr.
  - The Izok Lake and High Lake projects begin in 2033 causing a short term increase in construction related employment up to a peak of nearly 5,700 PY/Yr and increase in GDP to nearly 950 $M/Yr.
  - The Hackett River project begins in 2037 causing a second short term increase in construction related employment up to a peak of over 4,000 PY/Yr and increase in GDP to a peak of over 1,300 $M/Yr.
  - Izok and High Lake mines shift to reclamation phase in 2040 causing a drop in employment and GDP.
  - Long term non-construction employment hovers around 1,500 PY/Yr from 2033 onward.

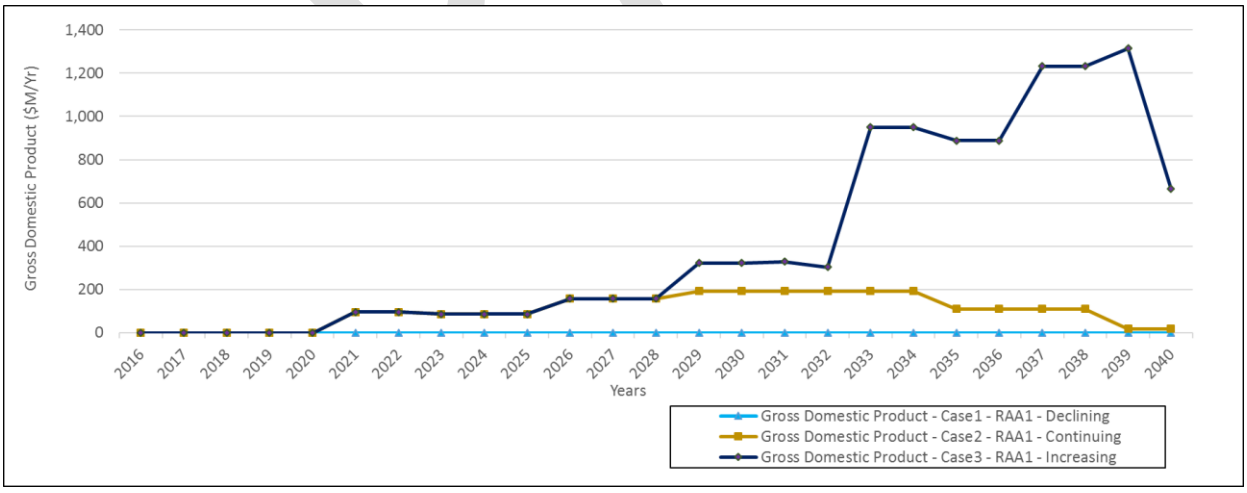


FIGURE 9: RAA1 (NUNAVUT) - PROJECTION OF POTENTIAL CHANGE IN GROSS DOMESTIC PRODUCT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

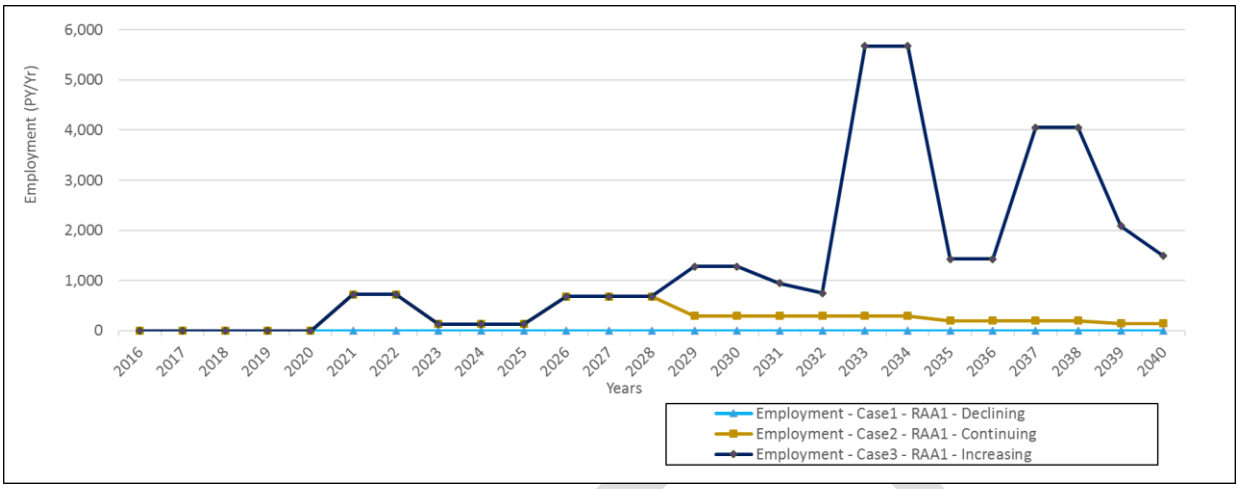


FIGURE 10: RAA1 (NUNAVUT) - PROJECTION OF POTENTIAL CHANGE IN EMPLOYMENT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

RAA2 – NWT Central Tundra

Figure 11 and Figure 12 show the projected change in GDP ($M/year) and employment (PY/year) resulting from development Case 1, 2 and 3 for RAA2:

- **Case 1**: There is no projected new development. The current GDP of over 970 $M/Yr decreases over time to near zero as the current active mines reach reclamation and then closure. Similarly, the current active employment of 3000 PY/Yr decreases over time to very low levels.
- **Case 2** and **Case 3** are the same. In addition to Case 1:
  - The Snap Lake mine resumes operations by 2023 and along with the new Kennady North mine there is an increase in GDP to nearly 1,300 $M/Yr in 2023. GDP then drops with the closure of Diavik, before another increase to nearly 1,100 $M/Yr in 2030 with the construction of the Courageous Lake mine. Long-term GDP drops to 400 $M/Yr and then below 300 $M/Yr as the larger existing mines close.
  - The Snap Lake mine resumes operations by 2023 and along with the new Kennady North mine there is an increase in employment to over 3,500 PY/Yr in 2023. Employment then drops with the closure of Diavik, before another short-term increase to nearly 4,000 PY/Yr in 2030 with the construction of the Courageous Lake mine. Long-term employment drops to around 700 PY/Yr as the larger existing mines close.

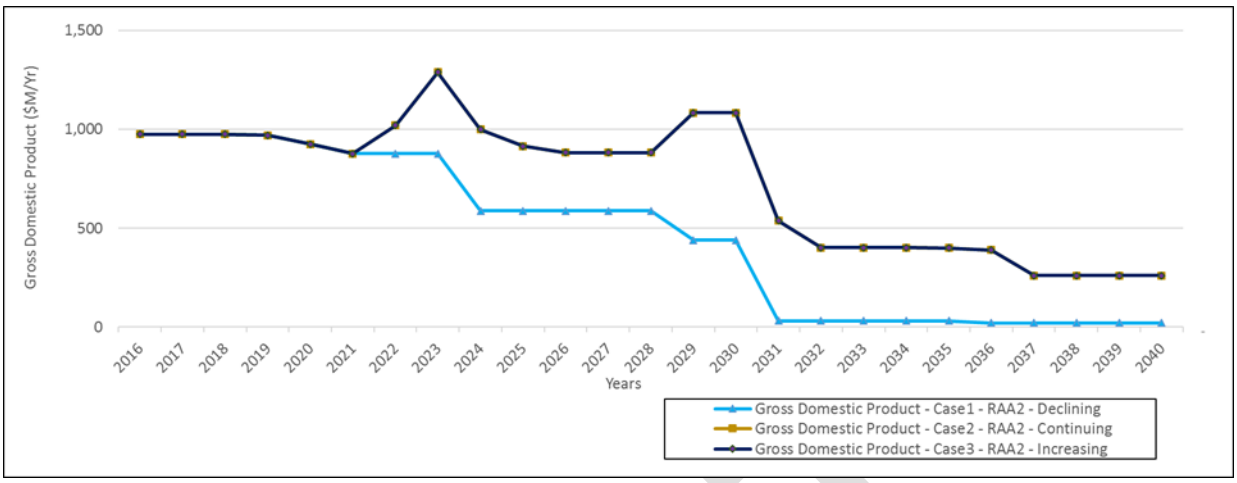


FIGURE 11: RAA2 (NWT CENTRAL TUNDRA) - PROJECTION OF POTENTIAL CHANGE IN GROSS DOMESTIC PRODUCT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

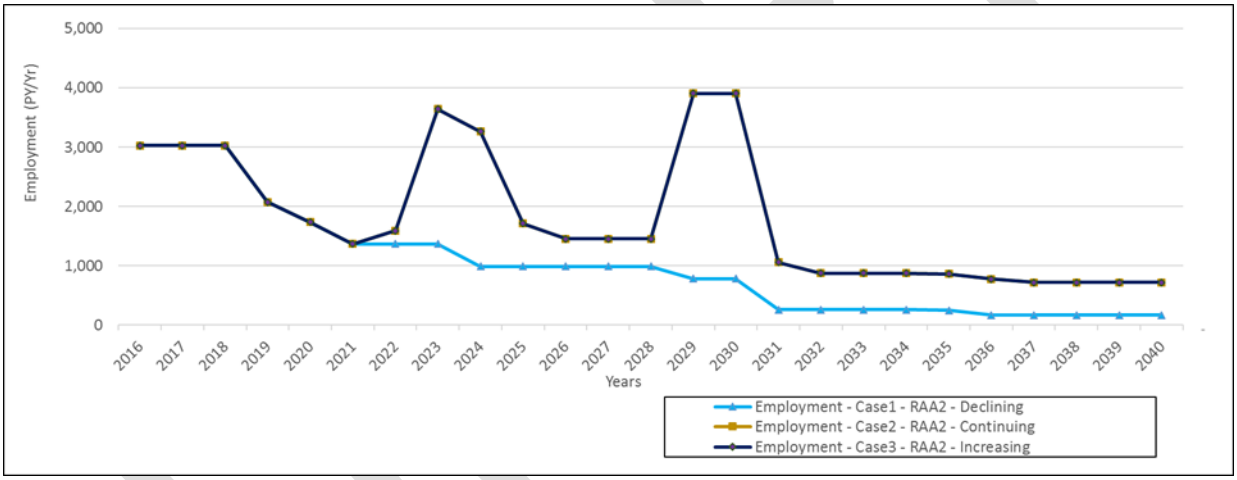


FIGURE 12: RAA2 (NWT CENTRAL TUNDRA) - PROJECTION OF POTENTIAL CHANGE IN EMPLOYMENT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

RAA4 – NWT Central Winter Range

Figure 13 and Figure 14 show the projected change in GDP ($M/year) and employment (PY/year) resulting from development Case 1, 2 and 3 for RAA4:

- **Case 1**: There is an increase in GDP (up to over 20 $M/Yr) and employment (up to nearly 180 PY/Yr) during the three-year construction of the Whati road.
- **Case 2**: In addition to Case 1, the NICO project begins in 2023:
  - There is a two-year increase in construction related employment up to over 640 PY/Yr.

Long-term employment opportunities drop to around 80 PY/Yr.

- There is a two-year increase in construction related GDP to over 80 $M/Yr. Long-term GDP drops to around 40 $M/Yr.

- **Case 3**: In addition to Case 2:
  - The Nechlacho, Indin Lake and Tyhee projects all begin by 2029.
  - There is an increase in construction related employment up to over 3,400 PY/Yr for two years. Long-term employment opportunities drop to around 740 PY/Yr.
  - There is an increase in long-term GDP to around 470 $M/Yr.

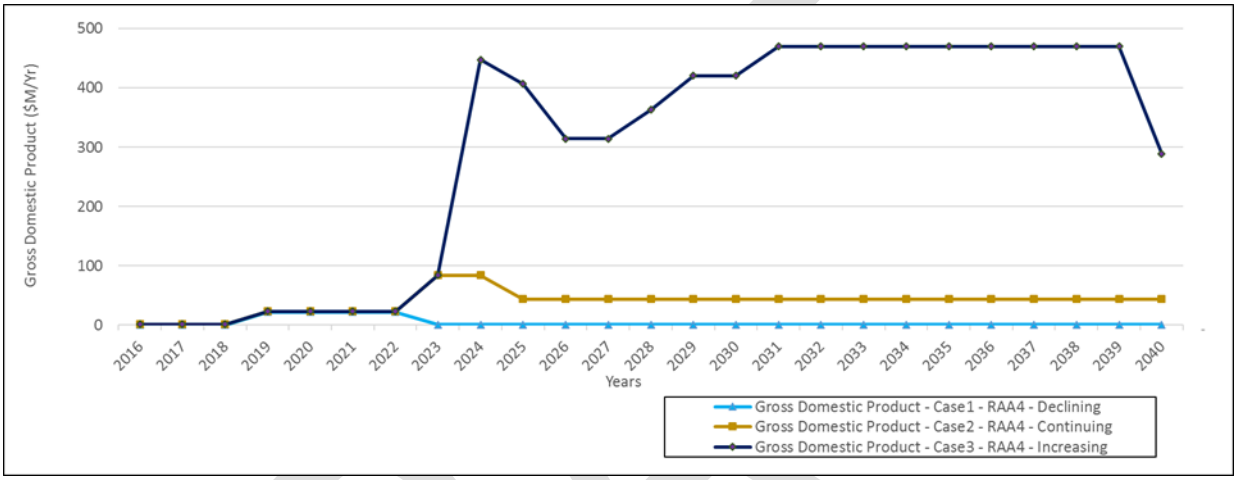


FIGURE 13: RAA4 (NWT CENTRAL WINTER RANGE) - PROJECTION OF POTENTIAL CHANGE IN GROSS DOMESTIC PRODUCT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

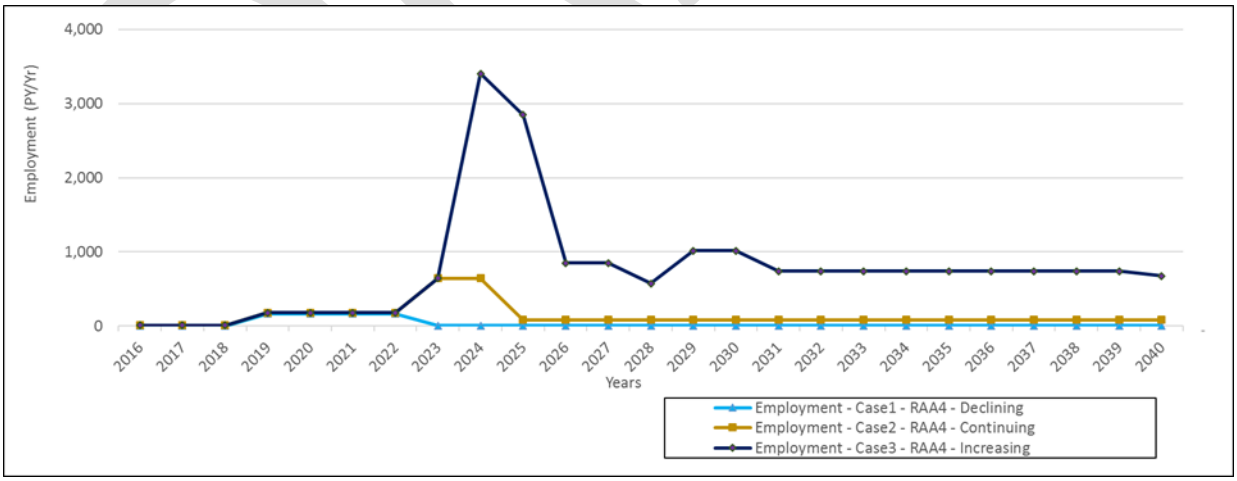


FIGURE 14: RAA4 (NWT CENTRAL WINTER RANGE) - PROJECTION OF POTENTIAL CHANGE IN EMPLOYMENT FOR FUTURE DEVELOPMENT SCENARIO CASES 1, 2 AND 3.

5 Summary

This report describes the major industrial land uses (mineral exploration and development, transportation, and power generation and transmission), their economic considerations and levels of human-caused disturbance within the BCRP planning area. While other important land uses such as tourism and recreation also occur in the Bathurst range, these three land uses account for the majority of human-caused habitat disturbance outside of communities, a situation anticipated to continue into the future. Both the current and potential future situations were considered.

5.1 Current Situation

- Based on available human disturbance mapping and the ZOI assumptions, approximately 5.6% (21,898 km^2) of the Bathurst range planning area is currently affected by direct and indirect human disturbance (direct footprint with associated ZOI).
- The highest level of disturbance is in RAA4 (NWT central winter range), where all of the permanent settlements and all-season highways are located.
- RAA2 (NWT central tundra), with the current operating diamond mines, contains the second highest level of disturbance.
- RAA4 has the highest level of road and trail access.

5.2 Future Situation

- With the assistance of the Mineral Task Group, three future development scenarios were created to explore potential levels of future human disturbance in the BCRP planning area.
- The future development scenarios ranged from declining development (CASE 1) to increasing development (CASE 3).
- In all scenarios, RAA3 and RAA5 were projected to have very low levels of industrial land use.
- RAA1 (Nunavut) has the potential to experience the largest increases in human development and associated disturbance.
- A coarse-level economic assessment of the three future scenarios indicated the potential magnitude of economic impacts generated by new mines and transportation infrastructure for the NWT and Nunavut economies.

6 References

NWT Department of Industry, Tourism and Investment. 2012. Northwest Territories Mineral Development Strategy. Prepared by GNWT and NWT and Nunavut Chamber of Mines. Yellowknife.

NWT Bureau of Statistics. 2012. NWT Economic Multipliers—Overview and Results. Government of Northwest Territories. July 2012. Available online: http://www.statsnwt.ca/economy/multipliers/.

Silke, R. 2009. The operational history of mines in the Northwest Territories, Canada. A historical research project. Prepared for Northwest Territories Geoscience Office. Yellowknife, Northwest Territories. Available online: www.nwtgeoscience.ca.

Tłı̨chǫ Research and Training Institute. 2016a. A Summary Report of Tłı̨chǫ Traditional Knowledge of Ekwò (Barren-ground Caribou) for the Bathurst Caribou Range Plan. Petter Jacobsen May 4, 2016.

Land Use Scenarios and Economic Considerations

APPENDIX A:

Land Use Economic Evaluation Methods

1 Introduction

This document summarizes methods used to estimate the economic outputs of potential future mineral sector and transportation projects within the Bathurst range planning area. At this time, only future potential mineral development and transportation projects have been considered[1]. Potential economic outputs of projects included in the BCRP Future Development Scenarios have been estimated based on known or estimated project parameters.

The goal of economic evaluation within the BCRP range planning exercise is not to make precise predictions about future economic outputs resulting from potential mineral development and transportation projects. Instead, its purpose is to understand the relative changes that may occur as a means to explore the potential economic consequences of different caribou habitat management strategies that could alter, defer or limit future levels of future land use activity.

The methods and results of this evaluation should be interpreted in the following context:

- The methods and results should be interpreted as relative economic outputs or contributions; the methods used are not suitable to forecast detailed absolute values; and
- The methods used result in economic outputs specific to the Bathurst range planning area. They are not intended to provide a detailed economic model for the entire NWT or Nunavut economy, nor do they consider contributions to the national or global economy.

2 Methods

2.1 General Approach

Different economic models and modeling approaches are available to estimate the economic contributions of potential future economic development. Potential economic models include *Statistics Canada's Interprovincial Input-Output Model* and the *Northwest Territories Economic Impact Model*. However, using such detailed economic models can be time intensive and require high levels of expertise. The role of economic modeling within the BCRP is not to make precise estimates of economic contributions resulting from potential future development to the territorial or national economy, but to understand the relative changes that may occur while exploring different caribou habitat management strategies.

Recognizing this situation, the BCRP Working Group aimed to estimate the approximate and relative

[1] In the future, economic outputs associated with mineral development may be considered.

economic outputs associated with a range of potential mineral development and transportation scenarios in the 2016 to 2040 time period. For each mineral development or transportation project included in the BCRP Development Scenarios, published economic multipliers from the NWT Bureau of Statistics (2012) and expert opinion were used to estimate the future economic output of individual projects, based on known or estimated parameters for construction, operations and reclamation costs for each project. Detailed methods are described below.

2.2 Economic Multipliers

The NWT Bureau of Statistics (2012) has published tables of economic multipliers that relate a given amount of economic output within a sector to three different economic indicators: **Gross Domestic Product (GDP), Labour Income,** and **Employment**. As stated by the NWT Bureau of Statistics (2012), such economic multipliers are considered to be intensity ratios, and are intended to be used as follows:

- The intensity ratios are appropriate for very general assessments of economic impacts.
- When estimating economic impacts, it is preferable to use multipliers to make relative, rather than absolute, comparisons. Where multipliers are used to estimate the impacts of a single activity, the results should be treated only as a general estimates, indicating the order of magnitude of the impacts rather than exact levels.

Economic multipliers are therefore well suited as a means to consider the relative changes in economic output that may occur while exploring different caribou habitat management strategies. The following example from NWT Bureau of Statistics (2012) illustrates how economic multipliers can be used to estimate economic output associated with a specified level of spending in the construction industry.

Example: Construction Industry Expansion

Intensity ratios are often used when all that is known about a project is the gross change in economic activity. For example, if there were a $50 million increase expected in the output of the territorial construction industry, then using the construction industry intensity ratios from Table 1, the total direct and indirect economic effects would be as follows:

GDP at Basic Prices ($): [GDP intensity ratio for Const.] x [Gross output]
[0.46] x [$50 million] = $23 million

Labour Income ($): [Labour income intensity ratio for Const.] x [Gross output]
[0.33] x [$50 million] = $16.5 million

Employment (PYs): ([Gross output] / [1 million]) x [Employment intensity ratio for Const.]
[$50 million/1 million] x [3.5] = 175

Therefore, a $50 million expected increase in the output of the construction industry has a potential GDP impact of $23.0 million; labour income impact of $16.5 million; and the potential creation of 175 person-years of employment.

2.3 Applying Economic Multipliers to Mineral Sector Activity

The two main parts of the mining life cycle (Figure 1), exploration and development, provide a useful framework to understand activities considered by the BCRP economic evaluation.

Mineral Exploration

Mineral Exploration may include all activities prior to mine development (the Exploration and Discovery phases of the mining life cycle, as shown in Figure 1). Specific activities may include mineral claim staking and early investigations, exploration associated with land use permits, and advanced exploration and deposit appraisal.

Mineral Development

Mineral Development refers to the life cycle phases of mine Development (i.e., construction), Production (operations) and Reclamation (Figure 1). Mine development results in the construction of long-term industrial facilities as well as air or ground transportation infrastructure.

At this time, only the mineral development part of the mining life cycle has been considered in the BCRP economic evaluation.

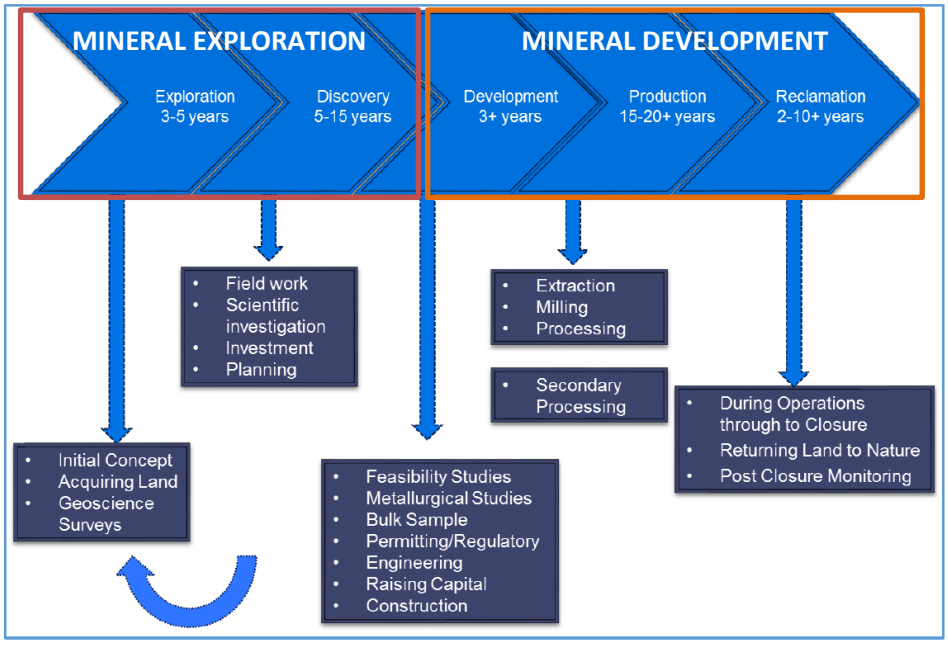


Figure 1. The mineral exploration and development life-cycle (Source: Government of Northwest Territories, Department of Industry, Tourism and Investment).

The BCRP Working Group has used published NWT economic multipliers to estimate economic output associated with mineral development and transportation projects included in the BCRP Future Development Scenarios (see Appendix C). Published economic multipliers relevant to the NWT mineral exploration and development sectors are listed in Table 1[2]. A similar approach was used in a recent socio-economic assessment for the Łue Túé Sųlái Candidate Protected Area in southern NWT (Stantec 2015).

Table 1. NWT economic indicators and multipliers, organized by mineral sector exploration and development activities. Source: NWT Bureau of Statistics (2012).

Mineral Sector Activities	NWT Economic Indicators and Economic Multipliers		
	GDP per dollar of expenditure	Labour Income per dollar of expenditure	Jobs per million dollars of expenditure (PYs)
MINERAL EXPLORATION *			
Support Activities for Mining and Oil and Gas Extraction	0.79	0.57	5.5
MINERAL DEVELOPMENT			
Construction	0.46	0.33	3.5
Diamond Mining	0.71	0.13	1.1
Truck Transportation	0.55	0.44	5.7
Waste Management and Remediation Services	0.82	0.47	6.7

** Note: At this time the BCRP economic evaluation focuses on potential future mineral development and transportation projects.*

2.3.1 Estimating Economic Outputs of Mineral Development and Transportation Projects Considered in the BCRP Development Scenarios

Estimating the potential future economic outputs of mineral development is dependent on the size of the mine, operating costs, and potentially the level of production and/or mineral commodity. BCRP Working Group members held meetings with Government of Northwest Territories and NWT and Nunavut Chamber of Mines representatives between October 2015 and March 2016. During these meetings, and through subsequent research, known or estimated costs were identified for the construction, operations and reclamation phases of mineral development projects considered within the BCRP development scenarios.

Table 2 provides a summary of the known or estimated project costs and calculated economic outputs for three indicators—GDP, labour income and employment—based on NWT published economic multipliers. Results are shown for the construction and operations phases of each mineral development project.

[2] The published NWT economic multipliers are assumed to also be relevant for similar activities in the Nunavut portion of the Bathurst range planning area.

Table 2. Calculated economic outputs (GDP, labour income and employment) resulting from mineral development and transportation projects considered in the Bathurst development scenarios. Economic outputs are based on published NWT economic multipliers (NWT Bureau of Statistics 2012).

SCENARIO	PROJECT	PHASE	CONSTRUCTION								OPERATIONS							
			Total Cost ($M)	Duration (years)	GDP ($M)		Labour Income ($M)		Jobs (PY)		Annual Costs ($M)	Duration (years)	GDP ($M)		Labour Income ($M)		Jobs (PY)	
					Annual	Total	Annual	Total	Annual	Total			Annual	Total	Annual	Total	Annual	Total
CASE 1	Ekati		520	4	60	239	43	172	455	1,820	600	14	426	5,964	78	1,092	660	9,240
	Diavik		386	3	59	178	42	127	450	1,351	423	7	300	2,102	55	385	465	3,257
	Gahcho Kué		1,019	2	234	469	168	336	1,783	3,567	212	12	151	1,806	28	331	233	2,798
CASE 2	Whati Road		190	4	22	87	16	63	166	665	1	18	1	10	0	8	6	103
	Snap Lake		0	0	0	0	0	0	0	0	200	10	142	1,420	26	260	220	2,200
	Back River (Goose)		415	2	95	191	68	137	726	1,453	121	12	86	1,031	16	189	133	1,597
	Kennady North		1,019	2	234	469	168	336	1,783	3,567	212	12	151	1,806	28	331	233	2,798
	NICO		357	2	82	164	59	118	625	1,250	59	16	42	670	8	123	65	1,038
	Tibbit-Lockhart Rd		230	3	35	106	25	76	268	805	2	14	1	15	1	12	11	160
	Lupin and Ulu		470	4	54	216	39	155	411	1,645	150	10	107	1,065	20	195	165	1,650
	Courageous Lake		1,520	2	350	699	251	502	2,660	5,320	300	10	213	2,130	39	390	330	3,300
CASE 3	Nechalacho		1,580	2	363	727	261	521	2,765	5,530	300	15	213	3,195	39	585	330	4,950
	Indin Lake		250	2	58	115	41	83	438	875	150	13	107	1,385	20	254	165	2,145
	Tyhee Gold		250	2	58	115	41	83	438	875	150	10	107	1,065	20	195	165	1,650
	Izok Road		400	4	46	184	33	132	350	1,400	4	8	2	18	2	14	23	182
	Izok Lake		2,000	2	460	920	330	660	3,500	7,000	600	6	426	2,556	78	468	660	3,960
	High Lake		1,000	2	230	460	165	330	1,750	3,500	400	6	284	1,704	52	312	440	2,640
	BIPAR Road		170	3	26	78	19	56	198	595	1	3	1	2	0	1	6	17
	Hackett River		1,500	2	345	690	248	495	2,625	5,250	600	2	426	852	78	156	660	1,320
	TOTALS		12,756	43	2,752	5,868	1,974	4,209	20,937	44,646	3,885	184	2,757	22,832	508	4,208	4,310	35,766

ECONOMIC MULTIPLIERS

Sector	GDP	Labour Income	Jobs (PY)
Construction	0.46	0.33	3.5
Mining	0.71	0.13	1.1
Transportation	0.55	0.44	5.7

TRANSPORTATION CONSTRUCTION COSTS

($ million/km)
2.0

NOTES

1. **Duration of Operations phase is only showing the number of years prior to end of scenario (2040).**
2. **Values in red indicate estimated costs based on similar-sized projects.**

2.3.2 Estimating Economic Outputs of Transportation Projects Considered in the BCRP Development Scenarios

An average of $2 million/km was used to represent construction costs associated with a typical northern all-season road. This value was used based on estimates created for the proposed Whatì all-season road (NWT Department of Transportation estimates a construction cost of approximately $1.6 million/km).

Table 2 shows calculated economic outputs for potential future transportation projects based on average construction costs of $2 million/km and published Transportation economic multipliers.

2.3.3 Estimating Economic Outputs Associated with Mine Reclamation

Information regarding the reclamation costs for existing mines is available (Diavik and Gacho Kué). A coarse level assumption was made to estimate reclamation costs for mines without this type of information (future conceptual projects). Both Diavik and Gacho Kué's reclamation costs are in the range of 20%-35% of annual operating costs. This estimation method assumes that annual operating costs will be proportional to reclamation costs at a level indicated by available information on the Diavik and Gacho Kué mine. So as not to overestimate economic outputs associated with reclamation, a value of 25% annual operating costs was used to estimate reclamation costs for all projects. While this method has a high level of uncertainty, reclamation costs associated with specific mine sites was found to be a relatively minor contribution to the total economic outputs associated with the scenarios, relative to Construction and Operations.

2.3.4 Tracking Economic Contributions of BCRP Development Scenario Projects

A custom-developed spreadsheet was designed to track the economic parameters associated with each mineral development and transportation project included in the BCRP Development Scenarios, for a period 24-years into the future (2016 to 2040). Appendix B of the *Interim Discussion Document (2016)* contains results of the economic assessment by Range Assessment Area.

3 References

NWT Bureau of Statistics. 2012. NWT Economic Multipliers—Overview and Results. Government of Northwest Territories. July 2012. Available online: http://www.statsnwt.ca/economy/multipliers/.

Stantec. 2015. Łue Túé Sųlái Candidate Protected Area Socio-economic Assessment. Final Report. September 30, 2015.