Section E

Environmental Impact Assessment Summary

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E. ENVIRONMENTAL ASSESSMENT

This section of the Benga Mining Limited (Benga) Grassy Mountain Coal Project (the Project) Application constitutes the Environmental Impact Assessment (EIA) for the Project. The full environmental baseline and impacts reports with supporting raw data for each Project discipline are contained in Consultant Reports (CR #1 to CR #12). This section includes Benga's evaluation and summary of pertinent information from each of the Consultant Reports along with commitments to monitoring and mitigation measures relating to the environmental resources associated with the Project.

The EIA methodology used in this assessment is provided in Section D (EIA Methodology) of the application. With this application, Benga is proposing the Project which will involve a surface steelmaking coal mine, a coal handling and preparation plant (CHPP) with associated infrastructure, an overland conveyor system, which will parallel an existing high grade access corridor and connect to a rail load-out facility, and a new section of rail track (Figure A.1.0-2).

In November 2015, Benga applied for a provincial coal mine permit and a provincial coal processing plant approval as per the Alberta Coal Conservation Act which is administered by the Alberta Energy Regulator (AER). Benga also applied for a *Canadian Environmental Assessment Act* approval which is administered by the Canadian Environmental Assessment Agency (CEAA) in November 2015.

Benga is currently filing the following applications:

- Pursuant to Section 66 under the *Environmental Protection and Enhancement Act* (EPEA) an application for an operating approval to construct, operate, and reclaim the Project (Appendix 1B).
- An application for approval for a new coal processing plant under the CCA, (Part 5 Operation and Abandonment of Coal Processing Plants, Section 23(1)(a) (Appendix 1C).
- An application for approval for Mine Licences under the CCA (Part 4 Development, Operation and Abandonment of Mines, Section 11(b)) to construct, operate, and reclaim the associated open mine pit, a north rock disposal area, central rock disposal area, and south rock disposal area (Appendix 1C).
- A *Water Act* (WA) application for approval to capture, collect, treat and manage surface runoff and groundwater as part of the water management program including development of an end pit lake (Appendix 1D).
- A WA application to transfer surface water licences required for the Project and to divert surface and groundwater for use in the Project (Appendix 1E).

- A *Public Lands Act* (PLA) application to obtain a MSL (and applicable LOCs) to use crown lands within the Project's mine permit boundary (Appendix 1F).

These applications are being supported and accompanied by an Environmental Impact Assessment (EIA) report, which is being provided to both the AER and the CEAA. This assessment follows the Terms of Reference (ToR) established for the Project issued by the AER on March 19, 2015 (Appendix 1A) and the *Guidelines for the Preparation of an Environmental Impact Statement* issued by CEAA on May 14, 2015 (Appendix 2A). In addition to these guidance documents, the *Guide to Preparing Environmental Impact Assessment Reports in Alberta* (Government of Alberta 2013a) and the *Draft Technical Guidance for Assessing Cumulative Environmental Effects* under the *Canadian Environmental Assessment Act, 2012* (CEAA 2014) were also referred to. Information requirements for both agencies are provided in the application, with agency specific concordance tables provided in Appendix 1A and Appendix 2A.

The scope of the Project for the EIA includes all phases (construction, operation, decommissioning and reclamation) of the coal mine, coal processing plant and associated facilities and infrastructure required to carry out these activities. Specifically, the scope of the Project includes:

- construction of predevelopment activities (*i.e.*, timber clearing, soil salvage, site drainage and blasting);
- construction, operation and reclamation of mine pit and dump areas;
- construction, operation and reclamation of coal handling and preparation plant facility (CHPP) including all coal cleaning waste disposal areas;
- construction, operation and reclamation of mine access road, coal conveyor, loadout and associated infrastructure areas; and
- construction, operation and reclamation of water management facilities that include domestic sewage treatment, dewatering wells, settling ponds, ditches and mined out areas.

A full description of the scope of the Project is included in Sections A (Introduction) and C (Project Description) of the Application.

The intent of the Project is to develop a world class steelmaking coal mine supplying North Asia (*e.g.*, Japan, South Korea) and South America markets and to help develop a substantial long term positive effect on the local Crowsnest Pass economy in addition to providing a number of benefits to the province of Alberta, including diversifying the resource revenue base and providing significant economic stimulus in southern Alberta. The mine is designed to produce 4.5 million CMT at full production.

The area proposed for disturbance totals approximately 1,520.7 ha. This includes all infrastructure, pits, rights-of-way and environmental management systems as summarized in Table E.1:

Table E.1 Summary of Spatial Extent of the Primary Project Components

Project Component	Component Area (ha)	Percentage of Development (%)
Coal Handling Processing Plant and Infrastructure	94.1	6.2
Coal Load-Out and Railway Loop	33.1	2.2
Construction Camp	1.9	0.1
Haul Road	0.3	<0.1
Powerline, Access and Conveyor RoW	15.2	1.0
Reclamation Material Storage	37.9	2.5
Surface Water Management Ponds and Ditches	74.6	4.9
Ultimate Rock Disposal Extent	589.9	38.8
Ultimate Pit Extent	632.4	41.6
Proposed Water Pipeline/Service Road Right of Way	1.5	0.1
Proposed Golf Course Development [1]	38.1	2.5
Proposed Helipad Access [1]	1.6	0.1
Total Mining Activities Reclamation Area	**1,481.0**	**97.4**
Total Non-Mining (Incidental) Area [1]	**39.7**	**2.6**
TOTALS[2]	**1,520.7**	**100**

[1] Benga Reclamation Responsibility include "incidental physical activities" identified by CEAA

[2] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

The Project EIA considers the following assessment scenarios:

- baseline case, which includes existing environmental conditions and existing projects or "approved" activities;
- application case, which includes the baseline case plus the Project; and
- planned development case (cumulative effects), which includes the "application case" combined with past studies, existing and anticipated future environmental conditions, existing projects or activities, plus other "planned" projects or activities.

For the purposes of defining assessment scenarios, "approved" means approved by any federal, provincial or municipal regulatory authority, and "planned" means any project or activity that has been publicly disclosed prior to the issuance of the Project's Terms of Reference or up to six months prior to the submission of the Project application and the EIA report, whichever is most recent.

In the Alberta EPEA, environmental effects must include an evaluation of the environmental, social, economic and cultural consequences of a project. Positive and negative impacts are to be assessed with an indication of plans the proponent will implement to manage negative impacts.

In the *CEA Act, 2012*, an environmental effect refers to any change that a project may cause in the environment. This includes the effect of any such change on health and socio-economic conditions, physical and cultural heritage, current use of lands and resources for traditional purposes by Aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. In contrast to the EPEA, only negative effects are analysed as per the *CEA Act, 2012*.

The Project EIA has addressed potential effects by identifying Valued Components (VCs). VCs are those environmental attributes associated with Project development, which have been identified to be of concern either by directly-affected stakeholders, government agencies or the professional community. They can be referred to as key indicators or parameters in the ToR. VCs consider both biophysical (*i.e.,* ecosystem) and socio-economic attributes because of the broad-based definition of environmental effect, as outlined in federal and provincial legislation.

E.1 AIR QUALITY & CLIMATE

E.1.1 Introduction and Terms of Reference

Benga Mining Limited (Benga) conducted an Air Quality & Climate Assessment for the proposed Project. The following section is a summary of the Air Quality & Climate Assessment that was prepared by Millennium EMS Solutions Ltd. The full report is included in Consultant Report #1a (CR #1a). Although CR #1a includes the rail loadout facility, an assessment of the rail loadout facility only (CR #1b) was also completed as it is the closest Project activity to the community and has been a key topic of discussion throughout the stakeholder engagement program.

The AER final Terms of Reference (ToR) and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to air quality have been addressed in this report:

3.2.5 Air Emissions Management

[A] Discuss the selection criteria used, options considered, and rationale for selecting control technologies to minimize air emission and for air quality management.

[B] Provide emission profiles (type, rate and source) for the Project's operating emissions including point and non-point sources and fugitive emissions (including mine faces), and for construction emissions. Consider both normal and upset conditions. Discuss:

a. annual and total greenhouse gas emissions for all stages of the Project. Identify the primary sources and provide examples of calculations;

b. the Project's contribution to total provincial and national greenhouse gas emissions on an annual basis;

c. the Proponent's overall greenhouse gas management plans;

d. odorous or visible emissions from the proposed facilities;

e. the Proponent's plans to manage emissions from the mining fleet;

f. the amount and nature of Criteria Air Contaminant emissions; and

g. the amount and nature of acidifying emissions, probable deposition patterns and rates.

4.1 Air Quality, Climate and Noise

4.1.1 Baseline Information

[A] Discuss the baseline climatic and air quality conditions including:

a. the type and frequency of meteorological conditions that may result in poor air quality; and

b. appropriate ambient air quality parameters.

4.1.2 Impact Assessment

[A] Identify components of the Project that will affect air quality, and:

a. describe the potential for reduced air quality (including odours and visibility) resulting from the Project and discuss any implications of the expected air quality for environmental protection and public health;

b. estimate ground-level concentrations of appropriate air quality parameters;

c. discuss any expected changes to particulate deposition, nitrogen deposition or acidic deposition patterns;

d. identify areas that are predicted to exceed Potential Acid Input (PAI) critical loading criteria;

e. discuss interactive effects that may occur resulting from co-exposure of a receptor to all emissions; and

f. describe air quality impacts resulting from the Project, and their implications for other environmental resources, including habitat diversity and quantity, soil resources, vegetation resources, and water quality.

[B] Identify stages or elements of the Project that are sensitive to changes or variability in climate parameters, including frequency and severity of extreme weather events. Discuss what impacts the change to climate parameters may have on elements of the Project that are sensitive to climate parameters.

For the CEAA Guidelines the following excerpts are specific to the air quality assessment, with the associated concordance table in (Appendix 2):

6.1.1. Atmospheric Environment

- *ambient air quality in the project areas and, for the mine site, the results of a baseline survey of ambient air quality, including the following contaminants: total suspended particulates, fine particulates (PM2.5), particulate matters up to 10 micrometers in size (PM-10), sulfur oxide (SOx), volatile organic compounds (VOCs), and nitrogen oxide (NOx);*

- *historical records of monthly and total precipitation (rain and snow) and temperatures, including means, maximums, and minimums.*

6.2.1. Changes to the Atmospheric Environment

- *changes in air quality;*

The Regional Study Area (RSA) and Local Study Area (LSA) for the Project are shown on CR #1a, Figure 2.3-1. The sizes and locations of the study areas were based on several factors and meet the requirements of AEP model guideline (AESRD 2013b). In particular, the RSA (30 km x 35 km) encompassed all project sources and concentrations from these sources reduced to 10% or less of maximum values at the RSA boundary. All identified, regional sources within the RSA were included in the assessment. The LSA was defined as the region immediately surrounding the Project development and was 12 km by 15 km. An ambient background was added to all model predictions

for Baseline and Application/PDC cases to account for the effects of distant and natural sources not within the RSA.

For the Project, the main emission sources are combustion emissions from the mine fleet and fugitive dust emissions from mining operations. Therefore, the following chemicals of potential concern were identified: sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), ozone (O_3), Volatile Organic Carbons (VOC), Polycyclic Aromatic Hydrocarbons (PAH), particulate matter with a mean aerodynamic diameter of 2.5 µm or smaller ($PM_{2.5}$), particulate matter with a mean aerodynamic diameter of 10 µm or smaller (PM_{10}), particulate matter with a mean aerodynamic diameter of about 30 µm or smaller (TSP), and greenhouse gases (GHGs).

The Project is also a source of trace quantities of metals, contributes to deposition of emitted chemicals, and contributes to local odour and trace levels of regional ozone formation.

An overview of Project emissions is presented in CR #1a, Section 4, with emissions basis and regional emissions presented in CR #1a, Appendix A. The air quality modelling approach, including CALMET and CALPUFF modelling parameterization, used for the Project is described in CR #1a, Appendix B. Regional air quality and meteorological observations are presented in CR #1a, Appendix C. The dispersion model was applied to the three assessment scenarios, including Baseline Case, Application Case, and Planned Development Case, and followed the Alberta *Air Quality Model Guideline* (AESRD 2013b). Predictions were made at specific locations using discrete, community and health receptors. Receptor locations are presented in CR #1a, Table 2.5-3 and Figure 2.3-1. Maximum points of impingement concentration in the RSA and LSA were based on modelling within the grid of receptors.

E.1.2 Baseline Conditions

E.1.2.1 Key Meteorological Parameters

Meteorological observations in the RSA are presented in CR #1a, Appendix C. These observations are summarized here to provide context for dispersion modelling results that form the basis of the assessment.

Winds play an important role in determining air quality. Winds used in dispersion modelling are predominately from the west and northwest at the Project site. In addition, Benga conducted field measurements of winds at two locations near the Project during the summer and fall of 2014. The wind roses from the two on-site locations demonstrate that wind directions are determined by the terrain in the vicinity of the measurements.

Atmospheric stability controls dispersion of plumes. Stable atmospheres, most common at night and in winter, limit dispersion and enhance the channelling effects of terrain on the low-level emissions associated with the Project. Unstable conditions result in greater mixing. Pasquill-Gifford (PG) stability classes A (very unstable) to E (very stable). Unstable conditions occur most often in spring and summer, and during midday.

Mixing heights determine the extent to which emitted plumes are mixed in the vertical. Seasonal mixing heights are derived from CALMET model output data Median mixing heights range from near 500 to 800 m during winter, to around 1,500 and 2,000 m during spring and summer afternoons respectively. Mixing heights show substantial diurnal variation in spring and summer, with the largest values in the afternoon due to thermal effects, and values near 200 m at night due to mechanical turbulence. These median mixing heights were assumed to be representative of the study area. Mixing heights are less important for near-surface emissions from the Project than they would be for tall stack sources.

E.1.2.2 Background Concentrations

According to guidance (ESRD 2013b), appropriate contaminant concentrations due to natural sources, and unidentified, possibly distant sources are to be used as background, and added to predicted values from the facility and nearby sources.

For this assessment NO_x, SO_2 and CO from the Lethbridge air quality monitoring station between 2010 and 2014 were used to estimate the background concentrations. Measurements from Nelson Kutenai were used for $PM_{2.5}$ and PM_{10}, as this was the closest station with a similar rural setting and thus representative. Table E.1.2-1 presents background values for criteria air contaminants.

For the modelling of acid deposition, total potential acid input (PAI) was calculated from measurements at the Kananaskis Village station, as this is closest station which was representative of the Project setting. Calculated deposition rates are presented in Table E.1.2-2.

Background concentrations for the speciated VOCs and PAHs were obtained from measurement made elsewhere in the province, using data from Alberta Health and Wellness (2003), Alberta Environment (2004a), *Canadian Environmental Protection Act* (2000, 2001), and the Fort Air Partnership (FAP 2004).

Averaged 24-hour maximum measurements from the Genesee and Powers stations in west-central Alberta were used as metal background concentration values for both the 1-hour and 24-hour averaging periods. Annual concentrations were derived from these values using the power law as recommended by OMOE (2005).

VOC, PAH and metal backgrounds are presented in CR #1a, Table 4.5-1 to 4.5-3.

Table E.1.2-1 Ambient Background Concentrations of Criteria Air Contaminants

Compounds	Hourly (µg/m³)	8-Hour (µg/m³)	24-Hour (µg/m³)	Monthly (µg/m³)	Annual (µg/m³)	Data Source
SO_2	2.6	-	2.1	1.0	0.9	Lethbridge, 2010-2014[(a)]
NO_x	32	-	-	-	17	Lethbridge, 2010-2014[(a)]
NO_2	24	-	-	-	11	Lethbridge, 2010-2014[(a)]
CO	344	301	-	-	-	Lethbridge, 2010-2014[(a]
$PM_{2.5}$	8.0	-	6.8	-	4.0	Nelson Kutenai, 2009-2013[(b)]
PM_{10}	-	-	21	-	13	Nelson Kutenai, 2009-2013[(b)]
TSP	-	-	42	-	26	2x PM_{10} Background Values

[(a)] CASA 2014
[(b)] NAPS 2014
- No AAAQO for this averaging period, therefore background concentration not required.

Table E.1.2-2 Average Potential Acid Input Estimates

Location	Measurement Type	Nitrate	Sulphate	PAI	Cations	Total PAI
		Dry Deposition [keq/ha/yr]	Dry Deposition [keq/ha/yr]	Wet Deposition [keq/ha/yr]	Dry Deposition [keq/ha/yr]	Deposition [keq/ha/yr]
Kananaskis Village	Passive	0.015	0.048	0.079	0.044	0.100

[(a)] Data Source: CASA (2014).

E.1.2.3 Baseline Concentrations

For this assessment, all objectives and guidelines are taken to apply at and outside the mine permit boundary (MPB) and at any special receptor locations inside the MPB. The MPB is chosen as the defining location because access within the MPB must be controlled for safety reasons. Therefore, the public will not be allowed inside this area.

E.1.2.3.1 Sulphur Dioxide

The CALPUFF model was used to estimate the concentration of SO_2 that would occur for the three assessment scenarios (CR #1a, Table 5.1-1; CR #1b, Table 6.0-1). No exceedances of the SO_2 AAAQO were predicted at any location for any averaging period.

E.1.2.3.2 Nitrogen Oxides

The CALPUFF model was used to estimate the concentration of NO_2 that would occur for the three assessment scenarios. Using the ozone limiting method to convert NO_x to NO_2, the model resulted in no predicted exceedances of the AAAQOs of NO_2 at any averaging period for the Baseline Case (CR #1a, Table 5.2-2; CR #1b, Table 6.0-1).

E.1.2.3.3 Carbon Monoxide

The CALPUFF model was used to estimate the concentration of CO. The results indicate that there are no exceedances of the AAAQOs at the MPOI or any of the receptors for the Baseline Case or averaging period (CR #1a, Table 5.3-1; CR #1b, Table 6.0-1). Predicted concentrations at Health Receptors were well below AAAQOs.

E.1.2.3.4 $PM_{2.5}$

The CALPUFF model was used to estimate the concentration of ground-level $PM_{2.5}$ (CR #1a, Table 5.4-1; CR #1b, Table 6.0-1) for each of the three assessment scenarios. The secondary production of nitrates and sulphates within the dispersion model was included in the predicted results along with direct emissions. $PM_{2.5}$ concentrations were not depleted by deposition.

There are no predicted exceedances of the AAAQG, AAAQO or the CAAQS at the RSA-MPOI, LSA-MPOI, or at any health receptors.

E.1.2.3.5 PM_{10}

The CALPUFF model was used to estimate the concentration of ground-level PM_{10} (CR #1a, Table 5.5-1; CR #1b, Table 6.0-1) for each of the three assessment scenarios. Predicted concentrations were not depleted by deposition.

For the Baseline case, the predicted maximum daily concentrations at the RSA-MPOI and special receptors were higher than the B.C. AAQO of 50 $\mu g/m^3$ (there is no Alberta objective for PM_{10}) and occurred at Blairmore as a result of emissions from the community and Highway 3. Exceedances were also predicted at some health receptors in the Baseline.

E.1.2.3.6 Total Suspended Particulate

The CALPUFF model was used to estimate the concentration of ground-level total suspended particulate (TSP) (CR #1a, Table 5.6-1; CR #1b, Table 6.0-1) for each of the three assessment scenarios. Predicted concentrations were not depleted by deposition.

For the Baseline case, the predicted maximum daily and annual concentrations at the RSA-MPOI and special receptors were higher than the AAAQOs and occurred at Blairmore as a result of emissions from the community and Highway 3. Exceedances were also predicted for daily concentrations at some health receptors in the Baseline. There is a higher level of uncertainty and conservatism in regional community and highway emission estimates, particularly for fugitive dust sources that contribute to TSP.

E.1.2.3.7 TSP Deposition

TSP deposition was estimated using CALPUFF. Predictions are presented in CR #1a, Table 5.7-1 and compared to AEP dustfall guidelines.

The maximum 30-day TSP deposition for the Baseline Case occurred in Blairmore as a result of emissions from the community and highway. The maximum prediction (RSA-MPOI) is slightly higher (54 *vs.* 53 kg/ha) than the AEP dustfall guidelines for residential and recreational areas.

E.1.2.3.8 Nitrogen Deposition Leading to Eutrophication

Deposition of nitrogen can lead to eutrophication in water bodies or changes in growth rates of terrestrial vegetation, and its calculation includes both wet (removal in precipitation) and dry (direct contact with surface features) processes. In the current approach, nitrate particulate was determined to be deposited by both wet and dry processes and was directly calculated by the dispersion model. NO_2 was assumed to be deposited by dry processes only, based on annual average predicted concentrations. A background deposition value, estimated based on the closest precipitation station at Kananaskis, was also included.

The results of CALPUFF modelling are listed in CR #1a, Table 5.8-1, indicating that the regional maximum predicted nitrogen deposition was 6.5 kg/ha/yr for the Baseline Case.

E.1.2.3.9 Potential Acid Input

Deposition includes both wet and dry processes and can result in the long-term accumulation of atmospheric emissions (primarily, NO_x and SO_2) in aquatic and terrestrial ecosystems. The PAI background was 0.10 keq/ha/yr, estimated from the closest precipitation station in Kananaskis. The results of CALPUFF modelling are shown in CR #1a, Table 5.9-1.

The maximum predicted PAI value in the RSA is approximately 0.11 keq/ha/yr in the Baseline Case, associated with communities and the highway. The spatial distribution of PAI across the study areas is shown in CR #1a, Figure 5.9-1.

E.1.2.3.10 Other Trace Compounds

Trace emissions of some VOCs and PAHs will be produced by incomplete combustion from Project sources. CR #1a, Appendix A provides a more detailed discussion of emission sources and estimates, both for the Project and regionally.

There is limited availability of local ambient measurements for some VOC and PAH concentrations, so measurements from outside the RSA were used (sources of background concentrations are presented in CR #1a, Appendix C). For all species, this resulted in very conservative predictions as the modelling predictions (for all cases) were often much smaller than the background values. Background concentrations were added to predictions for the Baseline case.

Ground-level concentration predictions of VOC and PAH compounds at MPOI, community, and receptor locations near the Project, for compounds which are subject to AAAQOs, are presented in CR #1a, Tables 5.10-1 to 5.10-6. Effects from a longer list of compounds are presented in the odour assessment (CR #1a, Section 5.12) and the human health risk assessment (CR #12). Model predictions for all chemicals were below AAAQOs in all emission scenarios.

Metals are emitted in trace amounts by diesel engines and dust resuspension. In addition, there is limited availability of background ambient measurements for metals so measurements from outside the RSA were used. Ambient measurements (summarized in CR #1a, Appendix C) tend to be available from areas with higher levels of industrialization than the Project area, so the background concentrations introduce additional conservatism to the predictions. Ambient measurements were added to predictions for all assessment cases. Baseline metal concentrations are presented in CR #1a, Tables 5.11-1 to 5.11-5. No exceedances of the AAAQO were predicted for any metal, for any averaging period.

A summary of the chemicals included in the odour assessment is presented in CR #1a, Table 5.12-1. The odour threshold was exceeded for NO_2. CR #1a, Table 5.12-2 compares the predicted 3-minute concentrations to the odour threshold. The RSA-MPOI in the Baseline is associated with community and highway emissions. Odour potential, from the aggregate exposure of multiple odorous compounds, is not expected at any health receptors in the Baseline Case.

E.1.2.3.11 Ozone

Surface O_3 can be formed through photochemical production from emissions of anthropogenic NO_x, anthropogenic VOC, and biogenic VOC compounds. The potential is greatest during summer periods characterized by high ambient temperatures (*i.e.*, above 20°C) and stagnant weather conditions (*i.e.*, low wind speeds).

Observations of O_3 at three air monitoring stations near the study area – Lethbridge, Castlegar, and Nelson - have been summarized in CR #1a, Appendix C (Section C.3.4) for 2009-2014. The 1-hr maximum observation at Castlegar was substantially higher than at other stations, but lower percentile values were substantially lower and for these percentiles and averaging times, Lethbridge values were consistently higher. The 4th highest 8-h average values at all three stations were lower than the CAAQS of 63 ppb (124 µg/m³).

E.1.3 Potential Impacts

E.1.3.1 Project Emissions

E.1.3.1.1 Combustion

The Project includes a mine fleet consisting of dozers, loaders, graders, backhoes, drills, shovels, haul trucks, and support equipment. Blasting emission and those of the loadout locomotives are also included; ANFO used in blasting is a major source of SO_2, NO_x, and CO emissions. Blasting was conservatively modelled each day; instead of on the 120 days per year, that blasting is expected in Year 14, to ensure worst-case meteorological conditions could occur simultaneously with blasting. Emission rates of CACs associated with these combustion sources are summarized in CR #1a, Table 4.2-3.

Emissions of VOCs and PAHs from diesel combustion were calculated using emission factors taken from as AP-42. Combustion $PM_{2.5}$ sources were modelled separately from fugitive sources. Emissions of VOCs and PAHs were scaled from combustion $PM_{2.5}$ emission predictions, based on the multiplier of each species.

Metal emission factors for diesel combustion were based on Health Effects Institute (HEI) (2006). When HEI factors were not available, only the emissions from other sources were considered. Metal content in soil and overburden was measured for the Project. Predictions for metals were scaled from combustion $PM_{2.5}$ and fugitive TSP predictions separately and then summed together.

VOC, PAH, and trace metal emissions are presented in CR #1a, Table 4.6-2 to Table 4.6-4. Details of emission factors and calculations are presented in CR #1a, Appendix A, Sections A6 and A7.

E.1.3.1.2 Fugitive

Dust emissions from wheel entrainment is a major source of fugitive emissions. Haul roads will be regularly watered in summer, reducing dust emissions from wheel entrainment by 80%. Winter dust emissions from haul roads were reduced by 90% as the roads will be covered by snow and/or frozen. According to climatological data, periods of snow cover extend from October to April.

It was assumed that, for all other fugitive sources, winter and summer emissions from mine operations are equal. Winter emission reduction effects (snow and freezing ground) were assumed to be insignificant for material excavated from the mine pit.

Fugitive emissions are summarized in CR #1a, Table 4.2-4; detailed emission estimates from fugitive sources are presented in CR #1a, Appendix A. Windblown dust emissions were also considered and are summarized in CR #1a, Table 4.2-7.

E.1.3.1.3 Construction and Reclamation Emissions

Construction emissions were determined by pro-rating the emission rates of CACs from the Project mine and plant operation emissions using the ratio of material moved during the plant construction to the material moved during the peak year of the Project.

The total mass of the material moved during the plant construction is estimated to be 6.0 Mt, which is approximately 5.5% of the total 109 Mt annual waste overburden volume in Year 19 (CR #1a, Section 4.2.4).

Decommissioning/reclamation emission rates for the Project were assumed to be similar to construction emissions.

In Year 19 of the Project, construction emissions are up to 5.5% of peak operations rates. As such, emissions from the construction phase were not assessed as their maximum air quality impacts are expected to be small compared to the impacts from normal operations (Table E.1.3-1).

Table E.1.3-1 Project Construction and Operations Emissions in Year 19 [(a)]

Description	SO_2	NO_x	CO	$PM_{2.5}$	PM_{10}	TSP
Operation Emissions in Year 19 (t)	5.6	929	420	114	1,001	3,866
Construction Emissions (t)[(b)]	0.2	45	2.6	6.3	55	213
Ratio of Construction to Operations [%]	3.6	4.9	0.6	5.5	5.5	5.5

[(a)]Wind driven emissions not included
[(b)]Scaled from maximum daily emissions from mine and plant operation in Year 19 (Table 4.2-5) with 5.5% ratio.

E.1.3.1.4 Upset Emissions

Emission estimates for construction of haul roads and mines are much lower than total emissions for the mines and haul roads during regular operations. Construction activities occur concurrently with mining activities, and operational vehicle activity indicators already include concurrent construction activities. Thus, the emissions calculated for the Project are not additional or incremental to the emissions for construction of haul roads and mines. Rather, the emissions for haul roads and mines construction have already been accounted for in the emissions for the Project.

Apart from the vehicle fleet, and minor emissions associated with space heating, there are no other combustion sources associated with the Project. Therefore, no upset scenarios have been assessed.

E.1.3.2 Regional Emissions

There are few industrial emissions in the RSA. The only major industrial facility is the Devon Canada Coleman sour gas plant which ceased operations permanently in 2012 and as such was not included in modelling. There are four small operating batteries and compressor stations in the RSA; these emissions were accounted for using measured background concentrations.

Highway emissions from combustion and fugitive sources were included. An emission factor model, MOBILE6.2C, was used to calculate vehicle exhaust emissions of SO_2, CO, NO_x, as well as particulate matter emissions from vehicle exhaust, brake wear and tire wear. The emissions for each highway segment were calculated from the annual average daily traffic from 2013 Albert Transportation data. The assumptions of engine emissions for public roads are expected to be conservative, as more fuel efficient vehicles are expected in the future (CR #1a, Table 4.4-2). Details of emission calculations are presented in CR #1a, Appendix A, Section A9.2.

Four communities in the Crowsnest Pass Sub-Division lying within the RSA (Blairmore, Coleman, Bellevue and Frank) were modelled for the Baseline case. CR #1a, Table 4.4-3 lists total exhaust and road dust emissions from the four communities. Emissions from other residences were included via measured background concentrations. Details of emission calculations are presented in CR #1a, Appendix A, Section A9.3.

Fugitive dust emissions from paved roads inside communities were also estimated using AP-42 emission factors (U.S. EPA 2011 – paved roads), based on the approximate mapped road lengths inside the communities.

Project and regional emissions are provided in CR #1, Tables 4.6-1 to 4.6-4)

E.1.3.3 Predicted Concentrations

E.1.3.3.1 Sulphur Dioxide

The CALPUFF model was used to estimate the concentration of SO_2 that would occur for the three assessment scenarios. The results at the RSA-MPOI, MPB maximum, and special receptors maximum are summarized in CR #1a, Table 5.1-1, and results for the rail loadout facility only are summarized in CR #1b, Table 6.0-1. Ambient background concentrations were added to the predictions for Baseline and Application cases. No exceedances of the SO_2 AAAQO were predicted at any location for any averaging period.

The increase in maximum daily, monthly and annual average predictions in RSA-MPOI, MPB maximum, and special receptors between the Baseline and Application Cases was small.

The patterns of SO_2 concentration for the 9th highest hourly, maximum daily, monthly, and annual averages for the Baseline and Application cases are shown on CR #1a, Figures 5.1-1 to 5.1-8. The hourly RSA-MPOI concentration is 32 µg/m^3 for the Application case and is located east of the pit boundary, reflecting emissions from pit operations. Daily, monthly and annual RSA-MPOIs for Baseline and Application cases are located at Blairmore near Highway 3 and are primarily influenced by regional community and highway emissions.

E.1.3.3.2 Nitrogen Dioxide

The CALPUFF model was used to estimate the concentration of NO_2 that would occur for the three assessment scenarios. The model resulted in no predicted exceedances of the AAAQOs of NO_2 for any of the assessment scenarios at any averaging period (CR #1a, Table 5.2-2; CR #1b, Table 6.0-1).

In the Application Case, the hourly RSA-MPOI prediction of 293 µg/m^3 is located east of the Project area, and is influenced by blasting activities, emissions from waste removal and vehicle traffic on the haul road. Blasting, during the hours when it is conducted, is the greatest contributor of NO_2 from the Project. The hourly NO_2 predictions for all receptors show a large relative increase (CR #1a, Table 5.2-2) in the Application Case over the Baseline. However, all predictions with the OLM are well below AAAQOs. The patterns of NO_2 concentration for 9th highest 1-hour and annual average for the Application case are shown on CR #1 Figures 5.2-2 and 5.2-4, respectively.

The annual RSA-MPOI for Application case is also located at Blairmore, near Highway 3, primarily influenced by regional community and highway emissions. The change in annual average predictions at the RSA-MPOI, as well as at special receptors, between the Baseline and Application Cases is negligible.

E.1.3.3.3 Carbon Monoxide

Modelling predictions for CO are presented in CR #1a, Table 5.3-1 and CR #1b, Table 6.0-1, which indicate all predictions for RSA-MPOI, MPB, and special receptors are well below AAAQOs for any of the averaging periods and all emission cases.

The regional patterns of CO concentration for the Application case are presented in CR #1a, Figures 5.3-2 and 5.3-4, respectively. In the Application Case, both hourly and 8-hour MPOIs occur east of the Project, and are primarily influenced by blasting activities.

E.1.3.3.4 $PM_{2.5}$

The predicted $PM_{2.5}$ concentrations are presented in CR #1a, Table 5.4-1 and CR #1b, Table 6.0-1, and are compared to the AAAQO and CAAQS. The maximum daily and annual predicted concentrations for the Application case are shown in CR #1a, Figures 5.4-2 and 5.4-4.

The maximum daily RSA- MPOI prediction for the Baseline case is 24 $\mu g/m^3$, lower than the AAAQO of 30 $\mu g/m^3$. The maximum daily prediction at the RSA- MPOI increases to 50 $\mu g/m^3$ in the Application case with the influence of the Project developments. The 98th percentile daily RSA-MPOI predictions are 32 $\mu g/m^3$ for the Application case and 20 $\mu g/m^3$ for the Baseline case. The maximum annual RSA-MPOI prediction is 12 $\mu g/m^3$ for the Application case and 9.2 $\mu g/m^3$ for the Baseline case.

For the Application case, MPOI locations have shifted from Blairmore to the eastern pit boundary, as a result of dust emissions from the haul road which lies very near the boundary of the pit area. The Application case predictions of $PM_{2.5}$ concentration at receptors R1 and R8 nearest the rail loadout increase by at most 0.7% as a result of the Project. All daily, monthly, and annual predictions for MPB and special receptor locations are less than the AAAQO and CAAQS.

Dust can be trapped by vegetation and settle out quickly. The forested region in the study area may have the effect of reducing particulate emissions by 80% or more (Pace 2005). Had the mitigating influence of forested vegetation been considered, $PM_{2.5}$ predictions may have been less than AAQOs in all cases.

There is a higher level of uncertainty and conservatism in regional community and highway emission estimates, particularly for $PM_{2.5}$ (see CR #1a, Appendix A). Furthermore, an ambient background concentration, derived from monitoring data, was added to the CALPUFF predictions.

E.1.3.3.5 PM_{10}

In CR #1a, Table 5.5-1 and CR #1b, Table 6.0-1, the predicted PM_{10} concentrations, with no accounting for the mitigative effects of vegetation, are compared to the maximum daily B.C. AAQO as no Alberta

AAQO exists for this dust size fraction. Ambient background concentration of 21 µg/m³ was added to the predictions for Baseline and Application cases. The spatial distribution of daily PM_{10} predictions is presented in CR #1a Figure 5.5-1 and Figure 5.5-2 for the Baseline case and Application case.

For the Baseline case, the predicted maximum daily concentrations are 72 µg/m³ at the RSA-MPOI and 64 µg/m³ at the special receptors maximum. Both predictions are higher than the BCAAQO of 50 µg/m³, and occurred in Blairmore as a result of emissions from the community and highway which is completely independent and outside of the influence of the Project.

The maximum daily prediction at the RSA-MPOI increases to 314 µg/m³ in the Application case with the influence of the Project. The RSA-MPOI in the Application case is located at the eastern pit boundary, a result of dust emissions from the haul road near the boundary of the pit. The maximum daily PM_{10} prediction at the MPB is 105 µg/m³ for Application case and, at that location, there are 66 days in the 5-year period (3.6 % of the time) when predictions are above the BCAAQO. These predictions occur in an area outside the MPB.

Maximum daily PM_{10} predictions at three special receptors in Blairmore and Coleman exceed the BCAAQO of 50 µg/m³ in both Baseline and Application cases; the change due to the addition of the Project at these three special receptors ranged from 0% to 2.5%. The maximum daily PM_{10} prediction at the special receptor located inside the MPB increased from 21 µg/m³ in the Baseline case to 55 µg/m³ in the Application/PDC case due to Project emissions. At that location, there are 3 days in the 5-year period (less than 0.2 % of the time) when predictions are above the BCAAQO.

E.1.3.3.6 TSP

The predicted maximum daily and annual TSP concentrations are presented in CR #1a, Table 5.6-1 and CR #1b, Table 6.0-1. Ambient background concentrations of 42 µg/m³ for daily average and 26 µg/m³ for annual average were added to the predictions for Baseline and Application cases. The patterns of TSP concentration for maximum daily and annual averages are shown in CR #1a, Figures 5.6-2 and 5.6-4 for the Application case, respectively.

The maximum daily RSA-MPOI prediction for the Baseline case was 220 µg/m³ and occurred in Blairmore as a result of emissions from the community and highway; this exceeds the AAAQO of 100 µg/m³. For the Application case, the daily maximum RSA-MPOI increased to 665 µg/m³ and shifted to the eastern side of the pit, as a result of dust emissions from the haul road. The maximum daily TSP prediction at the MPB is 232 µg/m³. At this location, the AAAQO is exceeded 107 days in a 5-year period (5.9% of the time).

The maximum annual RSA-MPOI prediction was 69 µg/m^3 for the Baseline case and occurred within Blairmore. This prediction exceeds the AAAQO of 60 µg/m^3. The maximum annual Application case predictions at the RSA-MPOI and MPB were 153 and 41 µg/m^3, respectively. The maximum annual TSP prediction at special receptors was 59 µg/m^3 for the Baseline and Application cases.

According to air quality modelling guidelines, annual TSP predictions are to be reduced by the frequency of days on which trace or greater amounts of precipitation occur. The effects of trace or greater amounts of precipitation, which occur on 117 days per year at the Connelly Creek climate station (CR #1a, Appendix C, Section C4.5), would be expected to reduce annual average TSP concentrations by about one-third to about 100 µg/m^3 at the RSA-MPOI. If the mitigative effects of vegetation also been applied, the concentrations would have been reduced further, by amounts ranging from 25% to a factor of four depending on the vegetation cover (CR #1a, Appendix A).

E.1.3.3.7 Dust Deposition

TSP deposition predictions are presented in CR #1a, Table 5.7-1 and compared to AEP dustfall guidelines. The dustfall guideline is typically meant to address the nuisance effects of dust particles larger than TSP.

The maximum 30-day TSP deposition for the Application Case was 203 kg/ha, occurring east of the pit boundary, as a result of dust emissions from the haul road which is very close to the boundary of the pit. In general, the greatest effects of TSP deposition are found near unpaved road sources. The maximum prediction is greater than the AEP dustfall guidelines for industrial areas of 158 kg/ha per 30 day period.

The maximum 30-day TSP deposition at the MPB and the most-affected special receptor for the Application Case were 22 kg/ha and 40 kg/ha, respectively; both predictions are less than the AEP dustfall guideline for residential and recreational areas (53 kg/ha).

E.1.3.3.8 Nitrogen Deposition Leading to Eutrophication

The results of CALPUFF modelling are listed in CR #1a, Table 5.8-1, indicating that the regional maximum predicted nitrogen deposition was 6.5 kg/ha/yr for Baseline and 9.4 kg/ha/yr for Application cases. The pattern of deposition is presented in CR #1a, Figures 5.8-1 to 5.8-3. Outside the MPB in the RSA, the Project increases the area of deposition above the threshold of 3.5 kg/ha/yr by 0.5 km^2 and increases the area above the 5 kg/ha/yr threshold by 0.1 km^2.

E.1.3.3.9 Potential Acid Input

The results of CALPUFF modelling in the RSA are shown in CR #1a, Table 5.9-1. The pattern of PAI is presented in CR #1a, Figures 5.9-1 to 5.9-2. There are no predicted exceedances of the target load of 0.45 keq/ha/yr for moderately sensitive ecosystems in the RSA in any assessment case.

The predicted maximum annual PAI at the RSA-MPOI is approximately 0.11 keq/ha/yr in the Baseline and 0.18 keq/ha/yr in Application/PDC cases; both are below the threshold of 0.35 keq/ha/yr for moderately sensitive ecological areas. Predicted annual PAI at the MPB was 0.02 keq/ha/yr for Baseline and 0.04 keq/ha/yr for Application and PDC cases. Outside the MPB, there is no deposition above the threshold of 0.17 keq/ha/yr for sensitive soil.Predicted annual RSA-MPOIs for PAI are located near Highway 3 and the community of Blairmore, primarily influenced by regional community and highway emissions.

E.1.3.3.10 VOC and PAH

The Project generates trace chemical compounds from incomplete combustion of fuel for vehicles and mine equipment.

There is limited availability of local ambient measurements for some VOC and PAH concentrations, so measurements from outside the RSA were used (sources of background concentrations are presented in CR #1a, Appendix C). For all species, this resulted in very conservative predictions as the modelling predictions (for all cases) were often much smaller than the background values. Ambient measurements were added to predictions for Baseline and Application cases, but not the Project-Only case.

Predictions of Chemicals of Potential Concern (COPCs) at the RSA-MPOI, MPB, and special receptors near the Project, for chemicals subject to AAAQOs, are presented in CR #1a Tables 5.10-1 to 5.10-6. No exceedances of AAAQOs were predicted for any COPC and, in most cases, the concentrations for the Project case at the MPOIs were many orders of magnitude below the AAAQOs. For most chemicals, the Project contribution was negligible at all locations.

E.1.3.3.11 Metals

Sources of metals include exhaust emissions from diesel combustion and fugitive emissions from the re-suspension of road dust and material handling in pit operations. There is limited availability of background ambient measurements for metals so measurements from outside the RSA were used (CR #1a, Appendix C) and tend to be available from areas with higher levels of industrialization than the Project area, so the background concentrations introduce additional conservatism to the predictions.

No exceedances of the AAAQO were predicted for any metal, for any averaging period (CR #1a, Tables 5.11-1 to 5.11-5). At some locations, the relative increase over the Baseline is large. However, the actual magnitude of the increase is small, and is well below the AAAQO. Model results indicated a larger relative increase in the Application predictions at the RSA-MPOI and MPB. The change due to the addition of the Project at all special receptors was small or negligible.

E.1.3.3.12 Odour

A summary of the chemicals included in the odour assessment is presented in CR #1a, Table 5.12-1, and indicates that the mean odour thresholds were not exceeded by the 3-minute predictions, except for NO_2.

The results of the odour assessment for these chemicals are presented in CR #1a, Tables 5.12-2 and 5.12.3. The main exceedances of the odour threshold for NO_2 were predicted to occur on the eastern Project boundary, mainly influenced by blasting activities. The highest Application case frequency of exceedance at special receptors influenced by the mine operation was 14% at the receptor located inside the MPB where the concentrations would be largely influenced by blasting emissions.

E.1.3.3.13 Ozone

Fox and Kellerhaus (2008) used the CMAQ model to estimate future O_3 concentration throughout Alberta that could result from foreseeable emission increases. Of the source sectors considered in the study, those most applicable to the Project area were oil and gas and on-road emissions; future emission increases in oil and gas were estimated to be negligible in the province. On-road emission changes were also negligible and are likely to decline with new vehicle emission reduction advances. With these emission assumptions, Fox and Kellerhaus predicted future increases in ozone concentrations (4^{th} highest 8-h average values) of between zero and 1% in the region of the Project.

According to CR #1a, Tables 4.2-5, 4.4-2, and 4.4-3, Project NOx emissions are about five times total RSA baseline emissions of NOx of 0.69 t/d, resulting from highway and community sources. Thus the Project contribution would correspond to a less-than 5% increase in 4^{th} highest 8-h average O_3 concentrations.

E.1.3.4 Greenhouse Gas

There are two primary sources of direct GHG emissions for the Project:

- fugitive emissions of coal bed methane; and
- diesel combustion in the mine fleet and haul vehicles.

There is also propane combustion for space heating requirements but the contribution of this component to the total GHG emissions from the Project is negligible. As such, only the two primary direct GHG sources described were included, as well as indirect GHG emissions from electricity purchases.

Fugitive methane emissions from surface coal mining were estimated as 0.87 t/kt of coal production, using emission factors provided by the Intergovernmental Panel on Climate Change (IPCC 2006). GHG emission estimates for diesel combustion are based on the amount of fuel consumed and Environmental Canada emission factors. The GHG emissions associated with electricity consumption is based on the electricity generation intensity for Alberta of 930 g CO_2e/kWh (EC 2015). Further details about these emission factors along with sample calculations are provided in CR #1a, Appendix A, Section A8.0.

A summary of direct annual GHG emissions for the Project from both fugitive and combustion sources as well as electricity consumption is shown in Table E.1.3-3.

Table E.1.3-3 Project Total GHG Emissions in Year 19 and Over the Life of Project

Source	GHG Emissions in Year 19 (kt CO_2e)	Lifetime GHG Emissions (kt CO_2e)
Fugitive Methane	70	1,692
Diesel Combustion	172	4,139
Electricity Consumption	120	2,896
Total	**362**	**8,727**

The maximum equivalent CO_2 emissions from the Project were estimated to be 362 kt/year in Year 19 (CR #1a Section 4.3.1). According to Environment Canada (2015), total national GHG emissions were 726 Mt in 2013 and Alberta's share was 36.8% or 267 Mt. Therefore, direct GHG emissions of the Project in Year 19 will be approximately 0.14% of 2013 Alberta GHG emissions and 0.05% of national emissions.

The total GHG emission over the life of the Project is 8,727 kt, also scaled from annual GHG emissions in Year 19, based on total coal production.

E.1.3.5 Climate Change

E.1.3.5.1 Assessment Considerations

The climate change assessment for the Project included the following elements:

- determine projections for climate parameters during the Project lifetime;
- identify potential effects of climate change on Project stages; and
- identify implications that climate change may have on the Project.

The existing and projected changes to the selected climate parameters are provided for the region near the Project. The selected parameters are:

- number of warm and cold days;
- seasonal precipitation; and
- frost free days.

Predicted changes in the 2050s for these parameters near the expected end of the Project lifetime are listed in CR #1a, Table 5.14-1.

E.1.3.5.2 General Influences on Air Quality

Air quality is strongly dependent on specific weather variables and could therefore be sensitive to climate change. The observed correlation between surface ozone and temperature in polluted regions points to a detrimental effect of warming. Warmer temperatures will increase summertime surface ozone in regions with anthropogenic emissions (Jacob and Winner, 2009); at the same time, increased water vapour in the future climate is expected to decrease the ozone background, so these two parameters have opposite sensitivities to climate change.

The effect of climate change on particulates is more complicated and uncertain than for ozone. Precipitation frequency is an important factor in mitigation, and increased storminess is predicted.

E.1.3.5.3 Sensitivity to Climate Change

Construction

Construction on the Project is largely limited to new haul road corridors in stages throughout the Project life, the Plant and the conveyor system. Extreme weather conditions may affect fugitive dust emissions and the frequency of windblown dust. However, the impact is expected to be low, occurring either prior to the beginning of operations (for construction of the conveyors, plant, and main haul road) or during operations for construction of secondary haul roads within the various mine segments. Any increases in dust can be readily managed with appropriate dust control. Therefore, the impact of climate change on construction is expected to be minor.

Operations

An increase in mean temperature will have no impact on the plant, as it is designed for operation in a wide range of temperatures. There may be a small effect on ozone and VOC concentrations, depending on the seasonality of the temperature changes. Biogenic VOC emissions may increase slightly if the temperature increases occur in summer, resulting in slightly higher background concentrations. Increased VOCs could increase the rate of ozone formation. In addition, ozone production increases quickly with increased temperature and solar radiation.

Increases in the frequency of extreme temperature will result in an increased frequency of high ozone concentrations, as a result of the increase in temperature/radiation and possibly through increases in biogenic emissions of precursors.

At the same time, increases in annual moisture index and degree days likely cause additional drying. Mitigation by road watering could adapt to changes as they occur. $PM_{2.5}$ emissions, which arise largely from combustion, are not expected to change as much as those of coarser particulate.

Decommissioning and Reclamation

For the decommissioning phase of the Project, climate change may impact reclamation and re-vegetation activities, potentially increasing fugitive dust emissions as evidenced by increases in the annual moisture index and degree days in the 2050s. These impacts are anticipated to be low and can be readily managed with appropriate dust control.

Overall, the change in climate will have low to no impact on air quality associated with the Project as potential increases in fugitive dust can be managed through adaptive road watering practices.

E.1.4 Cumulative Effects Assessment

Dispersion modelling included Project, regional industrial and non-industrial emissions sources in the RSA. Predictions also included measured background concentrations and thus the criteria for an air quality cumulative effects assessment were met. No planned industrial developments were identified in the RSA and thus the Application Case predictions were the same as the Planned Development Case.

E.1.4.1 Mitigation

The primary sources of $PM_{2.5}$, PM_{10} and TSP emissions are dust from haul road activity and material handling. Riversdale has introduced mitigative measures to reduce particulate emissions along their private haul roads and for pit activities. All of these measures were incorporated into emission estimation and dispersion modelling:

- The mine fleet is regularly upgraded and by Year 19, equipment will be newer and more efficient than assumed in emission estimation. Exhaust emissions from the U.S. EPA Tier 4 (2010) standards were used in Project emission estimates and it is likely that off-road standards will be more stringent by Year 19.
- Water is systematically applied to haul roads and to the plant access road to minimize dust using a water truck dedicated to this purpose. An emission control efficiency of 80% during the summer months is expected from this measure.
- Snow cover is retained on the road as a mitigative measure during the winter months, unless the cover would compromise the safety of vehicle operations. Winter ground is frozen and, since the soil and overburden have elevated moisture contents, there is a reduction of dust emissions at that time.
- Gravel or crushed rock is used on the haul roads. Gravel is observed to produce less dust than clay and sandy surfaces.
- Use of a grader to maintain the active surface of the road. This procedure is expected to reduce the effective silt content of the portion of the road where the wheels of the haul trucks travel. The grader blade would tend to move the silt particles to the inactive portion (side) of the road.
- The mined areas are reclaimed promptly and backfilled with overburden and soil from pre-strip areas, and then covered by vegetation which reduces windblown fugitive dust emissions from the barren land.
- Trees and bushes will be preserved around mines and plant, effectively trapping dust emissions from mining activities and reducing dust concentrations further from mining activities.
- The two coal processing plant (CPP) modules will be contained within an enclosed area and all coal material handling will be *via* covered conveyors.
- Dust generation from transferring coal from the conveyor to the stock pile will be minimized by the use of luffing stackers (those that can lower and raise their boom) which will minimize the drop height and drop time of the coal.
- Fugitive dust generation will be minimized at the rail load-out, with full cladding on the sides of the load-out structure to create a wind shelter, and with the movable discharge chute of the bin located as close as practical to the coal within the rail cars.

Mitigation measures for NOx emissions include the use of Tier 4 engines in heavy duty mine equipment. Benga will also investigate alternative ANFO formulations that reduce NOx emissions during blasting.

E.1.4.2 Monitoring

Benga established a monitoring program in spring 2016, comprised of passive monitoring of SO_2, NO_X and O_3 near the proposed plant site. A network of six dustfall monitoring stations was also implemented, one at the plant site and five in other locations in the communities. Initial monitoring results are provided in CR #1a, Appendix C.

Benga proposes to establish an ambient air quality monitoring program designed to document the potential, localized, fugitive dust impacts due to Project operation. The measurement program is designed to measure dustfall. Details of the required monitoring are a function of the operational configuration at any time. As such, the monitoring program will need to be developed when the mine plan is established and operations begin, and then modified as mining progresses.

Benga commits to developing a more detailed monitoring program when the mine plan is more advanced than it is now, and commits to reviewing its adequacy periodically in future. Benga will provide the draft monitoring plan to AER six months before planned start-up and to implement the program three months or more prior to the beginning of construction.

E.1.5 Summary

E.1.5.1 Air Quality Predictions

The assessment of air quality impacts consisted of identifying key air quality concerns and parameters resulting from the proposed mine development project, including sulphur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), particulate matter ($PM_{2.5}$, PM_{10} and TSP), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), metals and particulate deposition. Assessments were completed for Baseline, Project-only, Application (Year 19 with peak emissions) and PDC cases. As no new industrial emissions were forecast for the region, Application and PDC case results were identical.

Dispersion modelling for each of the scenarios was conducted with CALPUFF in accordance with the AEP model guideline (AESRD 2013b). Predictions were made over a grid of receptors, and maximum values were presented at the RSA-MPOI, MPB, and special receptors for input to the human health risk assessment.

The Project will be developed in an airshed that has few other industrial emission sources. Table E.1.5-1 lists key emissions for each of the assessment cases and shows the contribution of the Project to the Baseline case in the study area. For most CAC emissions, except CO, emissions associated with the Project are larger than Baseline regional missions. Uncertainties in emission estimates from communities and Highway 3 traffic are expected to be larger than those associated

with Project combustion emissions. Uncertainties associated with fugitive and windblown dust are larger than uncertainties in combustion emissions.

Table E.1.5-1 Summary of Annual Average Emissions

Scenario	SO_2	NO_x	CO	$PM_{2.5}$	PM_{10}	TSP
Baseline Emissions (t/year)	2.8	253	1,395	35	117	568
Project (t/year)	5.6	929	420	114	1,001	3,866
Application/PDC (t/year)	8.4	1,182	1,815	149	1,118	4,434
Application/PDC increase relative to Baseline (%)	201	367	30	322	856	680

A summary of air quality model predictions at the RSA-MPOI, MPB and special receptors is presented in CR #1a, Table 6.3-1 to Table 6.3-3. Comparisons to ambient objectives are made at or beyond the MPB, or at special receptors. The predictions are summarized below:

- Blasting resulted in large relative increases in predicted maximum 1-hour concentrations of combustion emissions (SO_2, NO_2, and CO) on the eastern pit boundary. For longer averaging periods, the actual and relative increases due to the Project were negligible. The AAAQOs were met for all averaging periods at and beyond the MPB in all three assessment cases, and also at special receptors.
- The 24-hour $PM_{2.5}$ AAAQO or CAAQS was not exceeded at or beyond the MPB or at any special receptors in Application/PDC and Project-only cases.
- PM_{10} daily predictions exceeded the BCAAQO in Blairmore in the Baseline case as a result of community and highway emissions. Exceedances were predicted 3.6% of the time at the MPB in the Application/PDC assessment cases over a small area as a result of fugitive dust emissions from the haul road located very close to the boundary of the pit.
- Predicted TSP concentrations were above the AAAQOs at Blairmore in the Baseline case. In the Application case, predictions were also above the AAAQOs east of the pit at the MPB, occurring up to 5.9% of the time over a small area. Exceedances of the daily AAAQO were also predicted at a number of special receptors in both Application and Baseline cases, while the Project contribution was negligible.
- Predicted concentrations of all VOCs, PAHs and metals were below AAAQOs at and beyond the MPB in Baseline and Application cases.

- Odours from NO_2 were predicted to be detectable in communities in the Baseline case, up to 44% of the time. The Project did not change those frequencies in the community and added a new location with detectable odour on the MPB in the Application case, likely the result of blasting.

Results from the rail loadout facility assessment are summarized in CR #1b, Section 6.0, and indicate:

- baseline concentrations for annual average NO_2, annual average $PM_{2.5}$, daily average PM_{10}, and daily and annual average TSP are near or above AAAQOs;
- the loadout contributions to air quality in the community are generally small fractions of Baseline concentrations and small fractions of the AAAQOs;
- the loadout has minimal contribution to the maximum predictions in the community.

E.1.5.2 Fugitive Dust Impacts

The impacts of fugitive dust are summarized in CR #1a, Section 6.4.1. The magnitude of residual impacts was high for fugitive dust (PM_{10} and TSP) when accounting for the effects of road watering and winter snow but not for any mitigative effects of vegetation or trapping by small terrain features. Predictions in the Baseline case were above ambient air quality objectives; predictions increased with the addition of the Project while the locations of the maxima shifted to nearer the Project. Project predictions were due to the particular configuration of mining and haul roads during Year 19 and are not necessarily indicative of a long-term impact. Predictions at the permit boundary are relevant for comparison to ambient objectives because access within the boundary is controlled.

The predicted exceedances of PM_{10} and nuisance TSP occurred relatively infrequently (at the mine permit boundary, at most 3.6% of the time for 24-hour PM_{10} and 5.9% of the time for 24-hour TSP). There was no exceedance of the AAAQO for annual TSP predictions at the MPB. The areas within which exceedances were predicted to occur were small.

Measured concentrations of fugitive dust are likely to be less than predicted because of the presence of dust-trapping small scale terrain features and vegetation on the west and east sides of the mine that are not accounted for in modelling. Additionally, atmospheric turbulence and the parameterization of the roughness length Zo has likely been underestimated in current modelling see Appendix B), and larger values are expected to reduce predicted concentrations. For these reasons, the predicted effects of PM_{10} and TSP are considered not to be significant (Table E.1.5-2).

E.1.5.3 Air Quality Impacts

Table E.1.5-2 summarizes air quality impact ratings for Project residual effects. In the table, Project residual effects are those associated with maximum (daily) Project emissions or annual average emissions as appropriate. Project emissions cease after operations cease. For most air quality emissions associated with mining operations, effects are largest at the source and decrease with distance and are therefore local not regional in nature. Impact ratings are typically based on effects at the point of maximum prediction because maximum concentrations there are usually associated with Project facilities. Key points related to Project impacts (as determined by comparison of Application and Baseline cases) are summarised in CR #1a, Section 6.4.2.

Table E.1.5-4 Summary of Impact Significance on Air Quality

Measurable Parameter	Nature of Potential Impact or Effect	Mitigation/ Protection Plan (CR #1)	Type of Effect	Geographic Extent[a]	Duration[b]	Frequency[c]	Reversibility[d]	Magnitude[e]	Project Contribution[f]	Confidence Rating[g]	Probability of Occurrence[h]	Significance[j]
1. NO_2 Concentration												
	Potential human health effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Moderate (blasting)	Negative	High	High	Insignificant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low (localized impact of blasting)	Negative	Moderate	Medium	Not Significant
2. SO_2 Concentration												
	Potential human health and vegetation effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Moderate	Negative	High	High	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative	Moderate	Medium	Not Significant
3. $PM_{2.5}$ Concentration												
	Potential human health effects and visibility impairment	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	High (localized on Project boundary)	Negative	Moderate (greater uncertainty in PM secondary formation and fugitive component)	High	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative	Moderate	Medium	Not Significant

Table E.1.5-4 Summary of Impact Significance on Air Quality

Measurable Parameter	Nature of Potential Impact or Effect	Mitigation/ Protection Plan (CR #1)	Type of Effect	Geographic Extent[a]	Duration[b]	Frequency[c]	Reversibility[d]	Magnitude[e]	Project Contribution[f]	Confidence Rating[g]	Probability of Occurrence[h]	Significance[j]
4.TSP Concentration												
	Nuisance effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	High. Would be reduced by the effects of precipitation and vegetation.	Negative	Low (more uncertainty in fugitive emissions). Mitigative effects of vegetation not considered.	High	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	High (localized exceedances at special receptors). Would be reduced by the effects of precipitation and vegetation.	Negative	Low	Medium	Not Significant
5. CO Concentration												
	Potential human health effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Moderate (localized impact of blasting)	Negative	High	High	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative	Moderate	Medium	Not Significant

Table E.1.5-4 Summary of Impact Significance on Air Quality

Measurable Parameter	Nature of Potential Impact or Effect	Mitigation/ Protection Plan (CR #1)	Type of Effect	Geographic Extent[a]	Duration[b]	Frequency[c]	Reversibility[d]	Magnitude[e]	Project Contribution[f]	Confidence Rating[g]	Probability of Occurrence[h]	Significance[j]
6. PAI Deposition												
	Potential acidification of sensitive soils, water bodies and vegetation	Based on management of precursors as identified in Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Low	Negative	Moderate (more uncertainty in deposition estimates)	Medium	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative	Low	Low	Not Significant
7. Nitrogen Deposition												
	Potential eutrophication of sensitive ecosystems	Based on management of precursors as identified in Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Low	Negative	Moderate (more uncertainty in deposition estimates)	Medium	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative.	Low	Low	Not Significant
8. Particulate Deposition												
	Potential nuisance effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Moderate	Negative	Moderate (more uncertainty in deposition estimates)	Medium	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative.	Low	Low	Not Significant

Table E.1.5-4 Summary of Impact Significance on Air Quality

Measurable Parameter	Nature of Potential Impact or Effect	Mitigation/ Protection Plan (CR #1)	Type of Effect	Geographic Extent[a]	Duration[b]	Frequency[c]	Reversibility[d]	Magnitude[e]	Project Contribution[f]	Confidence Rating[g]	Probability of Occurrence[h]	Significance[j]
9. Ozone Concentration												
	Potential human health effects	Based on management of precursors as identified in Section 6.3	Project Residual	Regional	Medium	Continuous	Reversible in short term	Moderate	Negative	High	High	Not Significant
			Cumulative	Regional	Medium	Continuous	Reversible in long term	Low	Negative	Low	Medium	Not Significant
10. VOC, PAH and Metal Concentration												
	Potential human health effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	Low in an absolute sense (Moderate in relative sense)	Negative	Moderate	Medium	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Low	Negative	Low future (regional emissions less certain)	Medium	Not Significant
11. Odour												
	Potential nuisance effects	Section 6.3	Project Residual	Local	Medium	Continuous	Reversible in short term	High (localized exceedances of thresholds)	Negative	Moderate	Medium	Not Significant
			Cumulative	Local	Medium	Continuous	Reversible in long term	Moderate (exceedances of thresholds at some special receptors)	Negative	Low future (regional emissions less certain)	Medium	Not Significant

Table E.1.5-4 Summary of Impact Significance on Air Quality

Measurable Parameter	Nature of Potential Impact or Effect	Mitigation/ Protection Plan (CR #1)	Type of Effect	Geographic Extent[a]	Duration[b]	Frequency[c]	Reversibility[d]	Magnitude[e]	Project Contribution[f]	Confidence Rating[g]	Probability of Occurrence[h]	Significance[j]
12. Greenhouse Gas												
	Potential ecological effects	Section 6.3	Project Residual and Cumulative	Regional	Long	Continuous	Reversible in long term	Low	Negative	Moderate (information on indirect emissions is more uncertain)	Medium	Not Significant

(a) Local, Regional, Provincial, National, Global
(b) Short, Long, Extended, Residual
(c) Continuous, Isolated, Periodic, Occasional
(d) Reversible in short term, Reversible in long term, Irreversible - rare
(e) Nil, Low, Moderate, High
(f) Neutral, Positive, Negative
(g) Low, Moderate, High
(h) Low, Medium, High
(i) Significant, Not significant

E.2 NOISE

E.2a NOISE IMPACT ASSESSMENT

E.2.1 Introduction and Terms of Reference

Benga conducted a Noise Impact Assessment (NIA) for the proposed Project. The following section is a summary of the NIA and the baseline noise report that was prepared by Acoustical Consultants Inc. (aci) and included as Consultants Report #2a (CR #2a). For full details of the assessment, please refer to CR #2a.

The final Terms of Reference (ToR) for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to noise have been addressed in this report:

4.1 Air Quality, Climate and Noise

4.1.1 Baseline Information

[A] Provide representative baseline noise levels at receptor locations

4.1.2 Impact Assessment

[C] Identify components of the Project that have the potential to increase noise levels and discuss the implications. Present the results of a noise assessment. Include:

a. potentially-affected people and wildlife;
b. an estimate of the potential for increased noise resulting from the development; and
c. the implications of any increased noise levels.

The following CEAA requirements were also addressed in the noise assessment:

6.1.1. Atmospheric Environment

- current ambient noise levels at key receptor points (e.g., Aboriginal communities), including the results of a baseline ambient noise survey. Information on typical sound sources, geographic extent, and temporal variations will be included.

6.2.1. Changes to the Atmospheric Environment

- changes in ambient noise levels

The purpose of the NIA was to generate a computer noise model of the study area with the Project at various operational stages, to determine the noise levels at the surrounding residential and theoretical 1,500 m receptors, and to compare the noise levels to the permissible sound levels (PSLs) defined in the Alberta Energy Regulator (AER) *Directive 038*. In accordance with *Directive 038* the broadband A-weighted (dBA) sound levels were also compared to the C-weighted (dBC) sound levels to

determine if there is the potential for the noise to have a low frequency tonal component. If the dBC-dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component.

The noise modelling results cover all residential receptors within the LSA and within 1,500 m from the LSA, including any located within Blairmore or Coleman (CR #2, Figure 1). The area in and around the LSA also contains some small, non-operational well-sites; otherwise, there are no industrial noise sources close enough to the Project that would contribute to noise impact. Nearby transportation facilities include Highway 3, which runs along the north end of the Town of Blairmore and through the middle of Coleman. There is a Canadian Pacific (CP) Rail line that runs parallel to the south of Highway 3, through the middle of Blairmore and the southern portion of Coleman.

Topographically, the noise study area has significant changes in elevation. Within the area formed by the 1,500 m noise boundary encompassing the LSA, there is a change in elevation of approximately 900 m. Within the LSA and some of the areas adjacent to the LSA, the digital elevation contours have a vertical resolution of 5 m, which covers all of the noise modelling receptors of consequence. Farther beyond the 1,500 m noise boundary, the vertical resolution for the digital elevation contours is 50 m. Throughout the assessment area the ground is generally covered in vegetation, but throughout most of the mining areas there are minimal trees. At the outer portions of the RSA (*i.e.* near the 1,500 m noise boundary), there are larger concentrations of trees. Trees have been incorporated into the noise model, where present.

E.2.2 Baseline Conditions

In regards to ambient noise levels, although they were not measured at the Project location, they have been quantified as per the methods defined in AER *Directive 038*, which defines the average Ambient Sound Level (ASL) based on population density and proximity to heavily traveled roadways or rail lines. There are no relevant industrial noise sources within the study area, thus the ambient noise levels are largely the result of the area roadways and the rail line. Currently, there are no municipal (within Crowsnest Pass), provincial or federal noise criteria for roadways or rail lines. In addition, there are no specific municipal, provincial, or federal criteria for comparing the relative increase in noise levels (*i.e.* how much the noise levels will increase with the addition of the Project related noise). As such, the noise study focused on comparing the Project related noise levels plus the AER *Directive 038* ASLs to the AER *Directive 038* Permissible Sound Levels (PSL) to determine compliance. This meets the requirements of the Project Terms of Reference and the CEAA Guidelines for Preparation of the Environmental Impact Statement since neither document specifies how the ambient noise levels are to be obtained (*i.e.*, how, when, where) and neither document specifies any assessment criteria for such noise levels or the relative increase in noise associated with the Project. Thus, it is common

practice within Alberta to resort to the methods and criteria of the AER *Directive 038* since the AER will be the regulating authority for the Project once it is operational.

E.2.3 Potential Impacts

The proposed mining operations involve using earth moving equipment (dozer, back hoe, trucks), drilling and blasting, CHPP, haulroads, and an overland conveyor to the proposed rail track alignment. These operations occur 24 hours a day. The equipment and processes occur in various areas at various times throughout the life-span of the Project.

The noise sources for the equipment associated with the Project were obtained from:

- noise measurement assessments carried out for other projects using similar operating equipment;
- aci in-house information and calculations using methods presented in various texts; and
- sound level information provided by equipment suppliers/manufacturers.

E.2.3.1 Permissible Sound Levels

AER *Directive 038* sets the PSL at the receiver location based on population density and relative distances to heavily traveled road and rail (CR #2, Table 4.0-1). In most instances, there is a Basic Sound Level (BSL) of 40 dBA at night and 50 dBA during the day. For some receptors, the BSL can increase up to 48 dBA due to population density, proximity to Highway 3 or proximity to the CP Rail Line. In all cases, the BSL forms the PSL for the night-time while the day-time PSL is 10 dBA higher.

AER *Directive 038* specifies that new or modified facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSLs at a distance of 1,500 m from the MPB are a LeqNight of 40 dBA and an LeqDay of 50 dBA.

The computer noise modelling was conducted using the CADNA/A (version 4.6.153) software package. Results were calculated in two ways:

- at specific receiver locations (*i.e.*, residential and theoretical 1,500 m receptors); and
- using a 50 m x 50 m grid over the entire study area.

To determine the effect of the Project on the surrounding noise climate, three scenarios (mining activity for years 01, 06, and 18) were modelled to cover the mining activity in different stages of the Project.

For Years 01, 06, and 18, Project noise levels during the night-time and day-time, with the addition of the ASLs, will be below the PSLs for all residential and theoretical 1,500 m receptors. Results are provided for each Year in CR #2:

- Year 01 Tables 5.1-1 to 5.1-4, Figures 2 and 3;
- Year 06 Tables 5.2-1 to 5.2-4, Figures 4 and 5; and
- Year 18 Tables 5.3-1 to 5.3-4, Figures 6 and 7.

For each modelled year, the results also indicate that the C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels for approximately half of the receptors. As specified in the AER *Directive 038*, if the dBC - dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. For the other half of the receptors, the dBC - dBA sound levels are greater than 20 dB. This elevated low frequency noise is generally associated with the locomotives operating at the rail loadout, at the southern portion of the Project.

E.2.4 Cumulative Impacts

The noise modelling results indicate that the Project noise levels during the night-time and day-time, with the addition of the average ambient sound levels, will be below the PSLs for all residential and theoretical 1,500 m receptors. There are no existing or known planned projects close enough to the Project that would contribute to the noise impact. Therefore, no cumulative effects on noise are expected.

E.2.5 Mitigation and Monitoring

E.2.5.1 Mitigation

Rock Disposal Area Sequencing: At approximately Mining Year 02, there will be increased equipment operating in the south disposal area (CR #2, Figure 1). As the Mining years progress, the elevation of the south disposal area will increase and the activity will move closer to the two residential receptor locations to the east of the Mine Permit Boundary. For these two receptors, the dominant Project noise sources will be the haul trucks accessing the south disposal area as well as the dozers operating on the disposal area. In order to achieve noise levels below the PSLs for these two residential receptor locations, there are two specific operational noise mitigation measures that Benga will undertake. These include:

- route the haul trucks (conveying waste rock and coal) along the western slope of the south disposal area such that the south disposal area itself provides noise shielding between the operating equipment and the residential receptors to the east; and

- install and maintain a 15 m tall earthen berm along the eastern edge of the south disposal area. The earthen berm will be constructed and maintained during the day-time (when required) and the 15 m earthen berm will increase in overall elevation as the height of the south disposal area increases.

Blasting Noise and Vibration: A portion of the mining operations will involve use of explosive charges to loosen the raw materials. The noise and vibration levels associated with blasting can have a potential impact on nearby residents and can cause sensory disturbance to wildlife. There are no specific noise or vibration level limits for blasting in the AER *Directive 038*, nor are there any specific other provincial or federal criteria.

Despite the lack of specific criteria or guidelines, the following blasting procedures will be adhered to in order to minimize potential noise and vibration impacts associated with blasting:

- blasting to occur only on weekdays during typical day-time hours;
- minimal blasting during cloud cover; and
- blasting to be limited to smaller more localized blasts, which reduces the amount of explosives used at any one time.

Low Frequency Noise Mitigation: The equipment used for the mining operations is predominantly internal combustion engine driven machinery. Similarly, the noise from the rail loadout activity will be largely comprised of diesel locomotives. The frequency content generally contains a relatively high level of low frequency engine noise with typical peaks near 63 -125 Hz. The measurement data obtained for each of the different types of operational equipment did not indicate a specific low frequency tonal component as defined in the AER *Directive 038*.

Light Duty Vehicle Back-up Alarms: Common sources of industrial noise for local residents are safety back-up alarms used on industrial equipment. As with the low frequency noise, the relative impact of the back-up alarms is difficult to predict since the orientation of the trucks and surrounding topography, both of which are constantly changing, will have a considerable influence on the noise levels. If, during active operations at the mine, concerns are raised by local residents, specific noise mitigation measures can be put in place. For example, the alarm noise can be replaced during night-time activities with a flashing light, which provides the necessary safety warning while eliminating the noise. During the day-time there are directional back-up alarms available that focus the noise to areas directly behind the vehicle and minimize the omni-directional noise radiation or back-up alarms with varying tones which provide the necessary safety warnings while minimizing the impact on receptors further away.

Equipment Mechanical Condition Mitigation: The operational sound level measurements conducted for equipment similar to the Project involved equipment which was in good working condition and good mechanical repair. In general, as equipment is used and general 'wear and tear' occurs, the noise levels tend to increase. There will be on-site maintenance shops to ensure that equipment is kept in good repair. When new equipment is purchased, it is also important to consider the noise levels of the equipment during the procurement process and to consider manufacturers options which result in lower noise levels.

E.2.5.2 Monitoring

The NIA modelling results indicate the possibility of a low frequency tonal noise. Assessment of any actual low frequency tonal noise would require noise monitoring to be conducted during normal operations of the Project. Based on this, should, upon start-up of the Project, a low frequency noise complaint be received, Benga will conduct a comprehensive sound level (CSL) survey in accordance with the requirements of the AER *Directive 038.*

E.2.6 Summary

The noise modelling results indicate that throughout the life of the Project noise levels during the night-time and day-time, with the addition of the ASLs, will be below the PSLs for all residential and theoretical 1,500 m receptors. Overall, the increase in noise levels will not be significant (Table E.2.6-1).

The results also indicate that the C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels for approximately half of the receptors. For the other half of the receptors, the dBC - dBA sound levels are greater than 20 dB. This elevated low frequency noise is associated with the locomotives operating at the rail loadout, at the southern portion of the Project. The modelling results indicate the possibility of a low frequency tonal noise. If, upon start-up of the Project, a low frequency noise complaint is received, Benga will conduct a comprehensive sound level (CSL) survey in accordance with the requirements of the AER *Directive 038.*

The noise model assumed two specific operational noise mitigation measures will be undertaken by Benga:

- Route the haul trucks (waste and coal) along the western slope of the south disposal area such that the disposal area itself provides noise shielding between the haul trucks and the residential receptors to the east.
- Install and maintain a 15 m tall earth berm along the eastern edge of the south disposal area. The earth berm will be constructed/maintained during the day-time when required and will grow in elevation as the height of the disposal area increases.

Table E.2.6-1 Significance Rating for Impacts on Noise

VC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence – Ecological Context[8]	Significance[9]
Ambient sound levels	Mine equipment increasing sound levels	See E.2.5 and CR#2	Application	Local	Long	Continuous	Short term	Moderate Impact	Negative	Moderate	Medium	Not Significant

[1] Local, Regional, Provincial, National, Global
[2] Short, Long, Extended, Residual
[3] Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
[4] Reversible in short term, Reversible in long term, Irreversible – rare
[5] No Impact, Low Impact, Moderate Impact, High Impact
[6] Neutral, Positive, Negative
[7] Low, Moderate, High
[8] Low, Medium, High
[9] Significant, Not Significant

E.2b NOISE IMPACT ASSESSMENT FOR RAIL ALIGNMENT AND LOADOUT COMPONENTS

E.2.7 Introduction

Benga prepared a Noise Impact Assessment Summary (NIA Summary) for the proposed Project's rail alignment and associated loadout components (referred to as 'the Project' in Section E.2b). The following section is a summary of the NIA Summary that was prepared by Acoustical Consultants Inc. (aci) and included as Consultants Report #2b (CR #2b). For full details of the NIA Summary please refer to CR #2b.

The purpose of the NIA Summary was to conduct Baseline noise monitoring at three locations south of Highway 3 within Blairmore (CR #2a Figure 7) and to generate a computer noise model of the study area. The predicted noise levels of the rail alignment and loadout were added to the existing baseline/measured levels to determine the total project noise levels. A number of residential receptors were identified around Blairmore and Coleman, and were used in the predictive noise model to determine the relative impact of the Project on the local noise climate. The NIA Summary is not mandated under the Alberta Energy Regulatory (AER) *Directive 038*, but rather is a standalone study.

E.2.8 Baseline Conditions

Baseline monitoring results are described in CR #2b Section 4.1. The typical A-weighted (dBA) sound levels and the C-weighted (dBC) sound levels were measured. The background noise monitoring results for from 47.1 to 51.6 dBA for night-time and from 49.2 to 56.8 dBA for day-time (CR #2b Table 1). Trains contributed 0.2 to 3.1 dBA to day-time results and 0.8 to 3.1 dBA to night-time results.

If the difference between the dBC and the dBA sound levels are substantial (approximately 15 - 20 dB) then there is a likelihood of a notable low frequency component to the sound levels. The difference between the monitored dBC – dBA sound levels ranged from approximately 7 – 10 dB (largely associated with heavy trucks on the Highway and diesel locomotives on the Rail Line), indicating that there is already a notable amount of low frequency noise within the area. An additional measure of low frequency noise (1/3 Octave band) was monitored and also indicated a notable amount of baseline low frequency noise within the area. Low frequency sounds tend to have a higher annoyance factor because they travel farther with less distance attenuation and transmit through walls/windows into residential structures easier than middle to high frequency sounds.

The predicted background noise results generated by the model matched very well with baseline monitoring results (CR #2b Table 2). The night-time modelling results for the 68 receptors varied from 30.0 to 53.7 dBA (CR #2b Table 3), due primarily to their relative proximity to the area roadways

(particularly Highway 3) and the rail line. Similarly, the modelled day-time noise levels ranged from 34.8 to 56.4 dBA.

E.2.9 Potential Impacts

The existing noise levels are expected to increase slightly at each receptor when the rail alignment and loadout are operational. For most of the receptors, the predicted night time noise increase is less than 2.0 dBA which is considered a minimal increase. The maximum increase was predicted to be +4.1 dBA. For most of the receptors, the predicted day time noise increase is less than 2.0 dBA which is considered a minimal increase. The maximum increase was predicted to be +2.5 dBA.

It is common and generally accepted practice to set +5.0 dBA as a maximum tolerable increase in noise levels for residential receptors. Any increase in noise levels above 5 dBA are expected to be noticed by the residential receptors. This guidance is provided by the Alberta Energy Regulator (AER) in *Directive 038*. All the relative night-time increase in noise levels are considered to be within acceptable limits.

E.2.10 Summary

Anticipated increases in noise arising from the operating rail alignment and associated loadout components are expected to fall within the range of +5.0 dBA, which is the accepted maximum tolerable increase for residential receptors, and therefore will not be significant.

E.3 HYDROGEOLOGY

E.3.1 Introduction and Terms of Reference

Benga conducted a hydrogeological assessment for the proposed Project. The following section is a summary of the Hydrogeological Assessment that was prepared by MEMS and is included as Consultant Report #3 (CR #3). For full details of the assessment please refer to CR #3. All figures are presented in CR #3, Appendix A and all tables in CR #3, Appendix B unless indicated otherwise.

The final Terms of Reference (ToR) for the Project (AER 2015) are provided in the Project Application (Appendix 1). The specific requirements for the hydrogeology component include:

4.2 Hydrogeology

4.2.1 Baseline Information

[A] Provide an overview of the existing geologic and hydrogeologic setting from the ground surface down to, and including, the coal zones, and if applicable, to the base of any deeper strata that would be potentially impacted by mining. Document any new hydrogeological investigations, including methodology and results, undertaken as part of the EIA, and:

a) *present regional and Project Area geology to illustrate depth, thickness and spatial extent of lithology, stratigraphic units and structural features;*

b) *present regional and Project Area hydrogeology describing:*

i. *the major aquifers, aquitards and aquicludes (Quaternary and bedrock), their spatial distribution, properties, hydraulic connections between aquifers, hydraulic heads, gradients, groundwater flow directions and velocities. Include maps and cross sections,*

ii. *the chemistry of groundwater aquifers including baseline concentrations of major ions, metals and hydrocarbon indicators,*

iii. *the potential discharge zones, potential recharge zones and sources, areas of groundwater-surface water interaction and areas of Quaternary aquifer-bedrock groundwater interaction,*

iv. *water well development and groundwater use, including an inventory of groundwater users,*

v. *the recharge potential for Quaternary aquifers, and*

vi. *potential hydraulic connection between coal zones and other aquifers resulting from Project operations.*

4.2.2 *Impact Assessment*

[A] Describe Project components and activities that have the potential to affect groundwater resource quantity and quality at all stages of the Project.

[B] Describe the nature and significance of the potential Project impacts on groundwater with respect to:

a) *inter-relationship between groundwater and surface water in terms of surface water quantity and quality;*

b) *implications for terrestrial or riparian vegetation, wildlife and aquatic resources including wetlands;*

c) *changes in groundwater quality and quantity;*

d) *conflicts with other groundwater users, and proposed resolutions to these conflicts;*

e) *potential implications of seasonal variations; and*

f) *groundwater withdrawal for Project operations, including any expected alterations in the groundwater flow regime during and following Project operations.*

[C] Describe programs to manage and protect groundwater resources including:

a) *the early detection of potential contamination;*

b) *groundwater remediation options in the event that adverse effects are detected; and*

c) *monitoring groundwater production or dewatering impacts.*

The final CEAA Guidelines for the Project (CEAA 2015) and associated concordance table are provided in (Appendix 2). The following CEAA Guidelines relating to groundwater have been addressed in this report:

6.1.4. Groundwater and Surface Water

- *the characterization of the hydrogeology at the local and regional scales, including:*
  - ✓ *the hydrogeological context (e.g., hydrostratigraphy with aquifers and aquitards, major faults, etc.) including the delineation of key stratigraphic and hydrogeologic boundaries;*
  - ✓ *the physical properties of the hydrogeological units (e.g., hydraulic conductivity, transmissivity, saturated thickness, storativity, porosity, specific yield);*
  - ✓ *the groundwater flow patterns and rates;*
  - ✓ *a discussion of the hydrogeologic, hydrologic, structural, geomorphic, climatic, and anthropogenic controls on groundwater flow;*
  - ✓ *temporal changes in groundwater flow (e.g., seasonal and long term changes in water levels);*
  - ✓ *a delineation and characterization of groundwater surface water interactions, including the locations of groundwater discharge to surface water and surface water recharge to groundwater;*
- *hydrogeological maps and cross-sections for the mine area to outline the extent of aquifers and aquitards, including bedrock fracture and fault zones, locations and depths of wells and strainers, groundwater types springs, surface waters, and project facilities.*
- *Groundwater levels, potentiometric contours, flow directions, groundwater divides, and areas of recharge and discharge should be included;*
- *all groundwater monitoring wells, including their location, in respect to the project area, including geologic, hydrostratigraphic, piezometric, and construction data (e.g., depths of surficial and bedrock units, quality, fracture zones, piezometric levels, hydraulic conductivity, diameter and screen depth, and intercepted aquifer unit);*
- *monitoring protocol for collection of existing groundwater and surface water data;*
- *a conceptual hydrogeological model that integrates the geological, hydrogeological, and hydrological data to provide the overall conceptual understanding of groundwater flow and chemistry and their controls for the area;*
- *an appropriate numerical hydrogeologic model for the project area, in which quantifies groundwater fluxes, flow path ways, and residence times; the model will be properly calibrated, fully documented and*

include a sensitivity analysis to test model sensitivity to climatic variations (e.g., recharge) and hydrogeologic parameters (e.g., hydraulic conductivity);

- *graphs or tables indicating the seasonal variations in groundwater levels, flow regime, and quality;*
- *local and regional potable groundwater supplies, including their current use and potential for future use;*
- *bedrock fracture sizes and orientations in relation to groundwater flow.*

6.2.2. Changes to Groundwater and Surface water

- *hydrogeological maps and cross-sections for the mine area modified to indicate project facilities and predicted changes in topography, hydrogeology, and groundwater flow;*
- *changes groundwater flow patterns, fluxes, and divides based on the results of groundwater flow modelling that incorporates changes related to mining.*

The hydrogeological local study area (LSA) was defined as a 1.6 km buffer (one land section) around the proposed Mine Permit Boundary excluding part of the access road to the south. The LSA is intended to include the extent of Project related impacts beyond which the potential effects are expected to be non-detectable. The regional study area (RSA) was defined based on natural features that are likely to represent groundwater flow divides, such as river valleys (*e.g.* Crowsnest River) or mountain ridgelines. The RSA was extended to the north to include Daisy Creek as part of the assessment to evaluate potential impacts to groundwater in the southernmost portion of its watershed (headwaters). Both the LSA and the RSA are presented on CR #3, Figure 1.1-1

E.3.2 Baseline Conditions

The baseline study was completed based on a review of publically available information (which includes maps and reports from the AGS and local study conducted by Waterline (2013)) and data collected specifically for the Project. Baseline information was obtained from a network of monitoring wells, core holes and vibrating wire piezometers (VWP) established for the Project. Hydraulic heads were measured, hydraulic conductivity testing was completed, and water samples were collected and analyzed for major ion and trace metals analysis. Baseline also included information collected at selected surface water and groundwater discharge features.

The coal handling processing plant (CHPP), mine and associated facilities are located on Grassy Mountain between Blairmore Creek and Gold Creek. Blairmore Creek and Gold Creek flow in a north to south direction along the western and eastern margin of the Mine Permit Boundary, respectively, before discharging into the Crowsnest River. Their headwaters are generally located at high elevations (2,100 metres above sea level (m asl)), and their discharge point is at 1,390 m asl. Daisy Creek flows from south to north, with headwaters at an elevation of about 1,800 m asl

(CR #3, Figure 4.1-1). The following sections provide a discussion of the geological units and a structural overview. A stratigraphic column is presented on CR #3, Figure 4.2-1. Additional description of the geology, structure and groundwater system is provided in CR #3, Section 4.2.1., Section 4.2.3, Section 4.4 and Section 4.6.

E.3.2.1 Geology

Bedrock units present beneath the Project include rocks from the upper Paleozoic, upper Jurassic and the Cretaceous and surficial deposits. The regional geology of the RSA is presented on CR #3, Figure 4.2-2, while the regional distribution of the formations on an east-west cross-section parallel to the Crowsnest River is presented on CR #3, Figure 4.2-3. Major faults present within the RSA include, from east to west, the Livingstone Thrust, the McConnell Thrust, the Turtle Mountain Fault, and the Mutz Fault (CR #3, Figure 4.2-2).

Paleozoic bedrock subcrops locally directly east and south of the Project and consists of Cambrian carbonate, shale and sandstone, Devonian limestone and dolomite and Mississippian (Carboniferous) shale and carbonate. Formations from the Pennsylvanian, Permian and Triassic were not identified within the RSA. Thrust faulting and folding is common (Waterline, 2013). Karstic features were not identified within the RSA.

The Upper Jurassic includes the Fernie Formation predominantly composed of recessive brown sandstones, siltstones and black-dark gray-green shales, which may be fractured (CSPG 1997). Within the RSA, the Fernie Group consists of up to 200 m of dark grey to black marine claystones that turn green in colour when weathered.

The upper Jurassic to lower Cretaceous Kootenay Group conformably overlies the upper Jurassic Fernie Formation. The Group is comprised of three formations; Morrissey, Mist Mountain, and Elk formations, which are predominantly sandstone with some interbedded siltstone, mudstone, coal and shale.

Within the RSA, the Morrissey Formation is present as the upper Moose Mountain Member, which is a cliff-forming hard siliceous grey sandstone. The Mist Mountain Formation contains the economic coal for the Project and is comprised of the Adanac, Hillcrest and Mutz members. The Mutz Member comprises up to 90 m of fluvial siltstone with minor interbedded claystone and coaly partings. Seams 1 and 2 occur at the top and base of this unit respectively. The Adanac Member consists entirely of Seam 4 and is a coaly unit up to 30 m thick, with numerous siltstone and claystone interbeds at the base of the Mist Mountain Formation. Four cross-sections illustrate the geology at the Project. Alignments are presented on CR #3, Figure 4.2-4, with Figures 4.2-5 to 4.2-8 presenting the east-west cross-sections within the LSA.

The Elk Formation of the Kootenay Group is absent within the RSA. Resting disconformably over top of the Kootenay Group is the lower Cretaceous Blairmore Group, consisting of interbedded sandstone, mudstone, conglomerate, and shale deposited in a fluvial setting (CSPG 1997). The Blairmore Group is divided into four formations which are defined by type successions: Cadomin, Gladstone, Beaver Mines and Mill Creek (Ma Butte) (CSPG 1997).

The upper Cretaceous consists of the Crowsnest Formation and the Alberta and Brazeau group. The Crowsnest Formation volcanics is a distinctly recognized marker in the Crowsnest Pass region. The Alberta Group consists mainly of silty mudstone with the Blackstone Formation in its lower succession, followed by a prominent sandstone unit of the Cardium Formation, and the Wapiabi Formation in its upper succession. The Alberta Group is present in the western portion of the LSA and RSA and in a small area north of the LSA (CR #3, Figure 4.2-2). The Brazeau Group includes the Belly River, Bearpaw and St. Mary River formations. The formations consist of interbedded sequences of sandstone, siltstone, mudstone and shale. The Brazeau Group is not present within the RSA.

Surficial geology within the LSA consist of alluvial sediments deposited by ancient (post-glacial) and present-day rivers and streams, and materials deposited prior to or during glaciation (Waterline 2013). Along the Crowsnest River valley, recent sand and gravel form an alluvial deposit (Waterline 2013). Surficial geology of the Crowsnest Pass area is summarized in CR #3, Figure 4.2-9.

E.3.2.2 Hydraulic Conductivity

The Kootenay Group includes coal and sandstones units interbedded with siltstone, mudstone and shale. Within the LSA, potential water bearing units investigated during the field program were the three main coal seams of the Mist Mountain Formation. Eight slug tests conducted at the monitoring wells show that hydraulic conductivity values of the coal seams range from less than 1.3×10^{-8} to 2.3×10^{-6} m/s, with a geometric mean of 1.6×10^{-7} m/s. Hydraulic conductivity data is summarized in CR #3, Figure 4.4-3 and Table B3a. Reviewing hydraulic conductivity seam by seam, the following comments can be made:

- Seam 1 - hydraulic conductivity is estimated at 4.2×10^{-7} m/s (one well);
- Seam 2 - hydraulic conductivity was measured as 3.6×10^{-8} and 2.3×10^{-6} m/s (two wells). A value estimated at less than 1.0×10^{-10} is interpreted to be representative of the claystone between Seam 2 and Seam 4;
- Seam 4 - hydraulic conductivity ranges from 1.3×10^{-8} to 4.2×10^{-7} m/s (five wells), with a geometric mean of 1.0×10^{-7} m/s; and

- RGOH3012 - an artesian flowing well, hydraulic conductivity is estimated at 4.0 x 10^{-7} m/s (transmissivity of 4 x 10^{-5} m^2/s) as measured for over 100 metres of saturated thickness (Golder 2015).

Packer tests targeting one or more of the coal seams (and including bedrock between coal seams) have hydraulic conductivity values ranging from 5.0 x 10^{-9} to 5.0 x 10^{-6} m/s. Three tests targeting specifically bedrock between the coal seams have a hydraulic conductivity ranging between 2.0 x 10^{-8} and 7.0 x 10^{8} m/s. A summary table of the packer tests results is located in CR #3, Table B3b.

The Blairmore Group, overlying the Kootenay Group, is both located east and west, downslope of the proposed pit. Three monitoring wells are interpreted as completed within the upper portion of the Gladstone Formation. MW15-11-9 and MW15-11-18.5 are nested and located at the CHPP (CR #3, Figure 4.4-8). The wells are completed within two different mudstone beds and have a tested hydraulic conductivity of 5.2 x 10^{-7} and 5.2 x 10^{-6} m/s. MW15-12-14 is located near Blairmore Creek and also completed across mudstone. The hydraulic conductivity was determined as 2.6 x 10^{-6} m/s.

Surficial deposits within the LSA and RSA are limited and as a result only three monitoring wells were completed within gravel deposits (CR #3, Figure 4.4-7). Near Blairmore Creek, MW15-12-7 is completed across gravelly material and is the only well completed within surficial deposit that is saturated. Hydraulic conductivity near MW15-12-7 is estimated at 5.1 x 10^{-6} m/s.

E.3.2.3 Groundwater Heads and Hydraulic Gradients

The groundwater flow system in the area is not simplistic as a result of the complex geology within the LSA and RSA. Despite the effort of the regional study to collect all available data and supplement them with additional drilling, the study concludes that the scarcity of water level data, coupled with the significant topographic relief, and the complexity of the flow system makes it impossible to create regional potentiometric contour maps based solely on field measurements with any degree of accuracy (Waterline 2013). Therefore, no potentiometric contour maps based on field data are presented for surficial deposits or bedrock formations. In addition, as the Project is located within the Disturbed Belt, the elevation of the base of groundwater protection is arbitrarily set at 600 metres below ground surface (m bgs)(AER 2015a).

Observations regarding pressure head in each of the coal seams show that:

- Seam 1 is only partially saturated with unconfined conditions at higher elevation, and generally dry at lower elevation;
- Seam 2 is generally saturated and confined across the mountain and regardless of elevation; and

- Seam 4 is saturated and generally confined, with greater heads encountered at higher elevation.

Vertical hydraulic gradients were calculated between seams where sufficient head data were available. Generally, downward gradient between Seam 1 and Seam 4 and/or between Seam 2 and Seam 4 were encountered across the mountain within the Kootenay group. Downward gradients were estimated to range between 0.1 and 4 m/m. Two locations in LSD 36-008-04 W5 were monitored to have an upward gradient between Seam 4 and Seam 1 or between Seam 2 and Seam 1. Upward gradients were estimated to range between 0.1 and 0.8 m/m.

Long term water level information was collected from selected monitoring wells and VWPs between summer/fall 2014 and spring 2016. Hydrographs are presented on CR #3 Figure 4.4-2. In general, hydrographs show a decline in hydraulic heads between August and March and an increase in hydraulic heads between April and July. The decline in hydraulic heads is interpreted as corresponding to a decrease in recharge during the fall and winter (*i.e.*, as rain is replaced by snow), while the increase in hydraulic heads can be explained by snowmelt and spring precipitation (freshet). Groundwater response to precipitation is observed in all three coal seams, but the response is attenuated with depth. The amplitude of water level variation is generally within the range of 2 m to 5 m with the greater variations at shallower depth. Hydrographs from VWP installed near Test Well 1 show no groundwater variation in the intermediate and deeper interval monitored and are interpreted as installed above the water table. VWP locations show the amplitude in water level variation is about 10 m at shallow depth and between 2 m and 5 m for the intermediate and deep intervals.

Seam 1 and Seam 2 were the target of the historical underground mining that occurred in the early 1900s. Two of the original portals used to access the lower Greenhill Mine are still present. The portals are at an elevation of about 1,324.5 m asl. From April 2014 to June 2014, the flow rate at the Greenhill Portal (Main) steadily increased from approximately 950 cubic metres (m^3/day) to 1,728 m^3/day (CR #3, Figure 4.4-2). Between June 2014 and March 2015, the flow rate steadily decreased from 1,728 m^3/day to 260 m^3/day. Groundwater discharge at the portal appears to mimic the hydrographs, with higher discharge in the spring and lower discharge during fall and winter.

E.3.2.4 Groundwater Chemistry

Kootenay Group

Groundwater sampled and analyzed at eight of the 13 monitoring wells installed within the LSA; the remaining five wells were not sampled as they were either dry or had an insufficient amount of water for sampling. Results from the groundwater sampling program are presented in CR #3, Tables B7 to

B10 and indicate several monitoring wells failed the QA/QC review due to elevated pH or ion balance outside the acceptable range or both, which is likely attributed to the influence of cement.

Groundwater from the coal seams is characterized as being of the calcium-bicarbonate, with a few location of the calcium-sulfate type as mapped on CR #3, Figure 4.4-4. Calcium-sulfate type water appears to be associated with Seam 2 and Seam 4. A piper plot is presented on CR #3, Figure 4.4-5. The following summarizes the groundwater chemistry in the coal seams;

- total dissolved solids ranges between 101 and 398 mg/L. Similar values were inferred from the geophysical logs from an oil and gas well located 01-20-009-03 W5 at depth ranging between 2,500 m and 2,750 m bgs;
- chloride concentration is less than 10 mg/L and concentrations of nitrate and nitrite are generally below detection limit and all below the fresh water aquatic life (FWAL) guidelines;
- both dissolved and total aluminum and iron were detected at concentrations above the Canadian drinking water (CDW) and/ or FWAL guidelines at a few of the monitoring wells;
- concentrations of arsenic, antimony, barium, chromium, lead and manganese (total and/or dissolved) were occasionally detected above the CDW; and
- total and dissolved mercury and selenium, and total arsenic, cadmium, copper, lead, silver and zinc concentrations were occasionally detected above the FWAL.

Selenium is one of the potential parameters of concern for coal mining activities. Dissolved selenium concentrations in groundwater were reported ranging from less than the detection limit (0.0004 mg/L) to 0.00252 mg/L. Total selenium was reported at concentration ranging from less than detection limit (0.0001 mg/L) to 0.00235 mg/L (CR #3, Tables B8 and B9). The FWAL guideline for selenium is 0.001 mg/L while the CDW is set at 0.05 mg/L. The maximum selenium concentration in groundwater exceeds the FWAL, but is below the CDW at all monitoring wells. Concentrations above the FWAL could be naturally occurring in groundwater within the LSA.

Isotope analyses were conducted on groundwater samples collected at the main Greenhill's Portal and selected surface water locations as presented on CR #3, Figure 4.4-6. Analyses included ^{3}H, ^{14}C (dissolved inorganic carbon - DIC), $\delta^{18}O$, $\delta^{13}C$ (dissolved organic carbon - DOC) and $\delta^{34}S$. Tritium was monitored at 9.9±1.1 TU at the Greenhill Portal (Main), indicative of modern age water. A comparison of $\delta^{34}S$ with sulphate (SO_4^{2-}) shows that the Greenhill Portal (Main) water is deriving sulphur from a different source than surface water in the creeks (CR #3, Figure 4.4-6). Finally, a comparison of the $\delta^{13}C$ with bicarbonate (CO_3^{2-}) demonstrate that the carbon present in surface water and the carbon present in the water discharging from the Greenhill Portal (Main) are quite distinct (CR #3, Figure 4.4-6).

Blairmore Group

Chemistry analyses indicate groundwater is of the calcium bicarbonate type (CR #3, Figures 4.4-5 and 4.4-6). The following summarizes the groundwater chemistry in the Blairmore Group:

- total dissolved solids ranges between 327 and 392 mg/L;
- chloride concentration is less than 10 mg/L and concentrations of nitrate and nitrite are less than 0.62 and 0.008, respectively;
- dissolved and/ or total aluminum or iron was detected at concentrations above the CDW and FWAL guidelines at one of the monitoring wells;
- total arsenic and lead was detected at concentration above the CDW and FWAL guidelines at one of the monitoring wells during one of the sampling events;
- concentrations of dissolved and total barium, chromium and manganese were occasionally detected above the CDW; and
- dissolved selenium and total cadmium, copper, mercury, nickel, selenium, silver, and zinc concentration were occasionally detected above the FWAL.

Surficial Deposits

Chemistry analyses indicate groundwater is of the calcium bicarbonate type (CR #3, Figures 4.4-4 and 4.4-5). Maximum concentrations were 349 m/L for TDS and 10.5 mg/L for chloride. Dissolved aluminum and manganese concentrations were above the CDW and the cadmium, copper, selenium and zinc concentration was above the FWAL. Total aluminum and iron concentrations were above the CDW, and total cadmium, copper, selenium, silver and zinc were above the FWAL.

E.3.2.5 Groundwater and Surface Water Interactions

Groundwater in the RSA exhibits extensive interactions with the surface water bodies. Most of the groundwater in the RSA is expected to eventually discharge to the Crowsnest River, except for the deep regional groundwater system that flows from west to east paralleling the Crowsnest River (Waterline 2013). Locally groundwater discharges to the Blairmore and Gold creeks and tributaries, to the Crowsnest River, through underground flows or springs. Existing historic mine workings and features create additional groundwater and surface water interactions, such as groundwater discharge through mine portals, discharge to or recharge from mine ponds, and toe springs from mine dumps.

E.3.2.5.1 Natural Springs

A Crowsnest River Watershed study conducted in 2013 by Waterline indicated three types of springs to be present in the Crowsnest Pass area. Two of these types of spring occur near the RSA – fault-related and other springs. Locations of the springs are presented on CR #3, Figure 4.3-3.

No major natural springs are reported within the LSA and RSA. The Turtle Mountain Spring is located just south of RSA in the Crowsnest valley (CR #3, Figure 4.5-1). It is a fault-related spring and associated with a thrust fault that places the Upper Paleozoic Sequence (Banff Formation) over the Fernie Formation (Waterline, 2013). Field sampling results of this spring are presented in CR #3, Tables B7 to B8.

There are a number of small springs and groundwater discharge points observed within the LSA (CR #3, Figure 4.5-1). Some of them represent groundwater discharges to the creeks and others caused by historic mining activities and are further discussed in the following sections.

E.3.2.5.2 Mining Related Groundwater Discharges

Mine Portals and Historic Mine Discharge

The Greenhill Portal (Main) and Greenhill Portal (Secondary), and one spring, Spring 1 (Upstream), are associated with drainage from old mine workings specifically the Greenhill Mine and Greenhill Boisjoli Mine, respectively, within the LSA (CR #3, Figures 4.3-1 and 4.5-1). The Greenhill Portal (Main) has a continuous groundwater discharge (as discussed in CR #3, Section 4.4.2.2.1); however, Greenhill Portal (Secondary) is blocked with only a little water trickling out (CR #3, Table B5).

Chemistry from the Greenhill Portals was compared to other historical mines located in the vicinity of the RSA. Most of the discharge waters have dominant calcium and/or magnesium cations, with only one spring having a sodium-bicarbonate type. Selenium concentration above the FWAL guideline is observed at the Greenhill Portal (Main) (maximum of 0.0022 mg/L), and Bellevue Mine (maximum of 0.0018 mg/L). At the Greenhill Portal (Secondary), selenium is observed at 0.00041 mg/L, which is below the FWAL guideline. Selenium is below the detection limit at the International Spring and McGillivray Mine.

Historic Mine Ponds

Numerous ponds associated with historical surface mining activities are present within the LSA. In general, chemistry from the different ponds is very similar, as presented on the piper plot on CR #3, Figure 4.5-2. Groundwater is generally of the calcium-magnesium bicarbonate type. Selenium is generally present in pond water at concentrations above the FWAL guideline.

Historic Toe Springs

Four toe springs (Spring two to five) associated with old waste dumps and waste rock piles were identified within the LSA. Water at these locations is of the calcium bicarbonate type (CR #3, Figure 4.5-1). Selenium was only detected above FWAL at 0.00264 mg/L at Spring 3.

E.3.2.5.3 Comparison with other Groundwater Discharge

For comparison with the water quality of the mine related discharges, six small creeks in the LSA were sampled (CR #3, Figure 4.5-1 – watercourses are labelled as 'Stream'). Water is of the calcium bicarbonate type, and all data points plot very closely on a piper diagram (CR #3, Figure 4.5-2). Selenium is the only element above FWAL with concentrations from 0.00071 mg/L to 0.0073 mg/L. General water chemistry from the sampled watercourses within the LSA is very similar to chemistry of Blairmore Creek, Gold Creek and Crowsnest River; however the latter do not present selenium concentrations above CDW and FWAL.

E.3.2.5.4 Groundwater Interaction with Major Creeks

There are two major creeks in the LSA. Blairmore Creek watershed (CR #3, Figure 4.1-1) is relatively steep, with an average slope of 22% and elevations ranging between 1,300 m and 2,300 m asl. Gold Creek has similar geomorphological characteristics with an average slope of 19% and elevations ranging from 1,300 to 2,500 m asl (CR #4 - Hydrology, Section 3.1). Both creeks ultimately discharge into the Crowsnest River. The substrate of Gold Creek is almost exclusively cobble associated with gravel or boulder with limited portions including silt, fines and coal sediments. The substrate of Blairmore Creek is predominantly of cobble, with a few portions where the creek directly flows over bedrock.

Field observations indicate that both Blairmore Creek and Gold Creek are generally "receiving creeks" (*i.e.*, groundwater discharging into the surface water). A number of groundwater seeps exist along Blairmore Creek and Gold Creek as well as their tributaries. Creek base flow studies concluded both Blairmore Creek and Gold Creek receive groundwater (CR #4 – Hydrology, Section 3.4). A review of the base flow data shows that the base flow rate generally increases in a downstream direction for both creeks, indicating continuous groundwater discharge to the creeks within the LSA (CR #3, Appendix C Figure 3-14).

This general groundwater and creek water relationship is mainly determined by the topography in the area. Topographic relief within the LSA is significant, with the crest of Grassy Mountain being up to 580 m above Blairmore Creek and 540 m above Gold Creek. Groundwater receives precipitation infiltration at higher elevations and discharges to the creeks and their tributaries at lower elevations.

Two hydrogeological cross-sections, AA' and DD' (CR #3, Figures 4.2-5 and 4.2-8), illustrate the relationship between groundwater and surface water (creeks). The cross-sections present the lithology around the proposed new mine pit as well as baseline groundwater elevation contour lines. Contour lines are extracted from the numerical model presented in CR #3, Appendix C. The baseline average contour lines present the long term average groundwater condition without the influence of the proposed mining activities. Groundwater flow is very complex due to complex geology and topography but some trends are clearly visible:

- recharge occurs at higher elevation and groundwater generally flows downward at higher elevation; and
- discharge occurs at lower elevation and groundwater generally flows upward at lower elevation, towards the creek where it discharges and contributes to base flow.

E.3.2.6 Groundwater Flow System

Groundwater recharge occurs on topographic highs, where precipitation is the most abundant. Recharge water infiltrates through the ground and percolates to bedrock to depth equivalent or greater than coal Seam 1 (Kootenay Group. Overall, the bulk of the system is saturated, with a relatively shallow water table, as illustrated on CR #3, Figures 4.2-5 and 4.2-8.

Hydraulic conductivity of units belonging to the Kootenay Group, including coal, range from less than $1x10^{-10}$ to $5x10^{-6}$ m/s as tested by falling and/or rising head tests and packer tests, indicating that the rocks are not very permeable. The higher conductivities in the 10^{-6} m/s range are not common indicating that no significant aquifers are present within or beneath the mine pit.

Groundwater hydraulic heads generally indicate a downward hydraulic gradient at elevation and depth. Beneath topographic highs, groundwater primarily flows downward to great depth as illustrated on CR #3 Figure 4.2-8 showing the flow pattern beneath Grassy Mountain. As the slope becomes more gradual and the elevation decreases towards the topographic lows and the river valleys, groundwater primarily flows upward and discharges into local surface water features, including Blairmore Creek and Gold Creek (CR #3, Figures 4.2-5, 4.2-8 and 4.6.1). At the south end of the Project, the hydrogeological regime is influenced by the presence of the historic underground Greenhill Mine as supported by lower observed hydraulic heads in the area. Groundwater flow direction and divides are presented on CR #3, Figure 4.5-3. Groundwater divides are correlated and match the main surface water divides separating the watersheds of Blairmore Creek, Gold Creek and Daisy Creek.

The groundwater flow path indicates that two systems coexist, with a deep system driving groundwater recharge to depth and a shorter pathway driving groundwater discharge to the river

valleys within a relatively short timeframe. Modeling of groundwater shows that the average groundwater residence time is over 50 years, with travel time of over 100 years beneath the topographic highs, and shorter residence time in the vicinity of the creeks. Groundwater is expected to reside in the system for greater than 50 years.

Major thrust faults are expected to be a control mechanism for lateral groundwater flow. Locally, fractures appear to be parallel to bedding planes, enhancing flow within units, rather than across bedding planes. Where the bedding planes are intersected by faults (transecting the bedding planes), groundwater is expected to then follow strike, either northward or southward, or continue to percolate downward across bedding planes. The actual behavior of each fault is uncertain, as some may act as barriers, while others may act as conduits likely depending in part on the rock type at a particular location.

E.3.2.7 Groundwater Users

A review of the Alberta Environment and Parks (AEP) Water Well Information Database indicated that there are 177 water well records and ten records of springs within the RSA. Out of the 175 active water wells within the RSA, 47 water well records and one spring are located within the LSA. About 73% of the wells (35 records) are for domestic use, 23% are for industrial use (11 records), with the remaining records listed as unknown use. Eight records are located within the mine permit boundaries; six records are listed as industrial (Scurry Rainbow Oil and Devon) and two as domestic (located in the south portion in NE-10-08-04 W5 and NE-14-08-04 W5).

There are 11 licenced groundwater users within the RSA. Nine of the licences are for domestic use, including one for subdivision use and eight for the Municipality of Crowsnest Pass. The other two records include a registry for a farm and another for industrial use at a wood processing facility.

E.3.3 Potential Impacts

VCs for the hydrogeological assessment include bedrock aquifers, groundwater discharge to surface water bodies, and water wells. The measurable parameters for hydrogeology are water quantity (hydraulic head) and water quality (chemistry). This assessment evaluates the following:

- effect of pit dewatering on water quantity;
- effect of mine waste rock on groundwater quality;
- effect of mine operations on groundwater quality; and
- effect of surface facilities on groundwater quality.

The mine plan and environmental management are described in the Section C.1 to C.7. The proposed Project footprint is presented on CR #3, Figure 5.1-1. Key components and/or assumptions of the mine plan relevant to the hydrogeological assessment are presented in CR #3, Section 5.1.

E.3.3.1 Effect of Pit Dewatering on Water Quantity

Pumping of groundwater out of the open pit will cause the water level (hydraulic head) within the aquifers to decrease. This effect spreads outward as the cone of depression (or drawdown cone) increases with the pit depth and extent with time. This will result in a reduction of hydraulic head in the formation. This could result in a reduction of water available in the adjacent bedrock unit or hydraulically connected units and could alter the seepage or discharge to hydraulically connected surface water bodies.

A numerical groundwater model was completed to estimate the predicted drawdown associated with the mining operations. The model was also used to assess potential changes to groundwater-surface water interactions and evaluate potential base flow reduction. A detailed description of the model and results are presented in CR #3, Appendix C.

For the end-of-mine (EOM) scenario (year 23 of mining, prior to reclamation), predicted drawdowns are highest in the vicinity of the pit and range between 30 m and 430 m, as presented on CR #3, Figure 5.3-1. The head at the base of the pit is predicted to be between 1,600 and 1,800 m asl on average (CR #3, Figure 5.3-2). Measurable drawdowns (considered, in the context of annual natural fluctuations, to be greater than 5 m) and the mine pit capture zone are mostly located within 400 m of the pit boundary, and are contained within the Mine Permit Boundary, as shown on CR #3, Figure 5.3-1. Measurable drawdown from the pit dewatering does not extend to Blairmore Creek, Gold Creek and Daisy Creek, but does extend below some of their headwater tributaries. Overall, groundwater flow directions are consistent between the baseline and EOM simulations as presented on cross-sections AA' and DD' on CR #3, Figures 4.2-5, 5.3-3 and 5.3-4. Most of the changes are expected directly beneath the pit, associated with the pit dewatering and drawdown. Existing groundwater divides are not affected, except within the pit boundaries. Drawdowns at the mine permit boundary are not predicted to be measurable and are expected to be within the natural range of variation. The area of measurable drawdown is predicted to be contained within the LSA.

For the long-term closure (LTC) scenario (long term equilibrated conditions following closure), predicted drawdowns are similar in magnitude as for the EOM with the maximum drawdown predicted at 388 m and the drawdown cone similar in extent (CR #3, Figure 5.3-5). Heads are presented on CR #3, Figure 5.3-6. Groundwater flow direction patterns are similar as for the EOM, with some slight changes beneath the mine pit, but with the general pattern of recharge and discharge consistent with baseline conditions (CR #3, Figures 5.3-7 and 5.3-8). Similar to EOM, the pattern of the

groundwater divides will be modified within the pit boundaries with the saturated zones of the pit and the end-lake capturing local groundwater. Predicted drawdowns at the mine permit boundary are within the natural range of variation of groundwater. The area of measureable drawdown is predicted to be contained within the Mine Permit Boundary and within the LSA.

Bedrock Aquifers

Results from the numerical models indicate drawdown in the bedrock units associated with pit dewatering will occur within the pit, and will be contained within the LSA and Mine Permit Boundary. The drawdown in the vicinity of the pit is to be expected, as part of the mountain will be physically removed, with the open pit acting as a drain. The 430 m of drawdown are consistent with the depth of the pit which will be close to 430 m. The drawdown cone diminishes quickly with distance away from the pit. Changes in topography associated with mining (*i.e.*, the physical removal of the top of the mountain) will permanently change the groundwater regimen to a new equilibrium as presented with the LTC scenario.

Potential effects related to mine dewatering on groundwater quantity in bedrock aquifers resulting from Project activities have been assessed as low magnitude, local extent, residual in duration, irreversible and continuous in frequency. The confidence rating of the assessment is moderate and the probability of occurrence is high. Overall, the residual Project impact of pit watering on bedrock aquifers is not significant as effects will be contained within the Mine Permit Boundary and the LSA.

Water Wells

Water wells monitored during the field survey and other wells potentially operated for domestic use are located approximately 4 km south west of the closest proposed pit boundary and 3 km south west of the proposed CHPP. Drawdown associated with pit dewatering is predicted to be less than 5 m at the domestic wells which is within the natural variation of the groundwater heads at EOM and LTC (CR #3, Figures 5.3-1 and 5.3-5).

Potential effects related to mine dewatering on groundwater quantity in the water wells resulting from Project activities have been assessed as negligible in magnitude and not significant.

Surface Water

Pit dewatering is predicted by the model to affect watercourse base flow at the EOM and LTC. Owing to the assumption that watercourse base flow is supported by groundwater discharge, a reduction in groundwater discharge would reduce base flow by the same amount. In the groundwater numerical model, a change in groundwater discharge to watercourse was measured, which is then interpreted as a change in base flow. At a local scale, change in base flow was

evaluated for five gauging stations for each of Blairmore Creek and Gold Creek and an average for each creek was estimated. The percentage reduction for each station is presented in CR #3, Table 5.3-1 and locations of the surface water stations are presented on CR #3, Figure 5.1-1. On average, Blairmore Creek is predicted to have greater base flow reduction than Gold Creek. Blairmore Creek is predicted to see a base flow reduction of 26% at EOM and of 9% during LTC. Gold Creek is predicted to have base flow reduction of 12% at EOM and 6% during LTC. Maximum base flow reductions are predicted for both EOM and LTC at station BC-03 for Blairmore Creek and station GC-02 for Gold Creek. Base flow reductions at station BL-03, which is located upgradient of the mining activities, Daisy Creek, and the Crowsnest River are predicted to be negligible at both EOM and LTC.

Base flow reduction values from the model (for EOM, LTC and other intermediate modelling steps) were incorporated to a surface water flow model (GoldSim) taking into account surface run-off and water discharge from the ponds, pit lake and saturated zones to assess the actual predicted base flow changes for both Gold Creek and Blairmore Creek. Accounting for all source of water, base flow is estimated to decrease slightly for Gold Creek and increase for Blairmore Creek (with the amount of decrease or increase varying seasonally and depending of the mining stage). Further discussion on the predicted flow changes in Blairmore and Gold creeks is provided in CR #4 - Hydrology, Section 5.2.

The drawdown of hydraulic head and interception of the groundwater by the pit will reduce baseline groundwater discharge to local surface watercourses. The magnitude of the base flow reduction for EOM and LTC for both creeks is largely due to the fact that groundwater is captured in the pit, pumped into the sediment ponds, and not able to contribute to base flow of the creeks. However, under the surface water management plan, water from the sediment ponds will be discharged into the creeks to mitigate the base flow reduction. This is described in the surface water management system presented in Section C.5 of the Application. At LTC, base flow reduction is still observed for both creeks even though mining and active pit dewatering has ceased, because the groundwater levels in the new equilibrium conditions are lower than under baseline conditions. Water levels in the saturated zones and the end-pit lake are either controlled by spill points or horizontal drains. Base flow reduction is predicted to be a lasting effect during LTC, as the groundwater flow system will not return to the pre-mining conditions. The physical removal of a substantial portion of Grassy Mountain will alter recharge to groundwater and results in a shift in the groundwater divide. These changes will permanently alter the groundwater flow system, which will affect the surface water conditions through changes to base flow.

Potential Project effects related to mine dewatering on water quantity in surface water bodies during operations and post-closure conditions of the Project are expected to be not significance. This is further discussed in the Hydrology (Section E.4) and Aquatic Resources (Section E.6) assessments, respectively.

E.3.3.2 Effects of Mine Waste Rock on Groundwater Quality

Effects of mine waste rock and mine operations on groundwater quality relate to the composition of the coal and waste rock and to the use of explosives for the mining. A geochemistry study was conducted for the Project and indicates that sulphide sulphur and selenium, and to a lesser degree cadmium, are the main elements present in the rock that have the potential to be affect water quality (Appendix 10A of the Application). Selenium can be treated using sub-oxic saturated backfills, potentially enriched with carbon, to favour microbial activity to degrade selenium. The selenium management plan for the Project will rely on this attenuation mechanism. Saturated zones will be created by backfilling the mining pits. Residence time will be targeted to exceed one year. Long term carbon source will be provided to enhance the selenium attenuation and could come from plant-refuse. Nitrate denitrification will also be implemented in the saturated zones through a similar mechanism as the selenium attenuation. Acid rock drainage (ARD) will be neutralized by carbonate minerals, and by blending potential acid generating (PAG) rock with non-PAG rock. The management plan includes capturing and diverting water run-off from the waste rock dumps to surge ponds for temporary storage before disposing of it in the saturated zones.

Measures will be taken as part of the water management plan to pro-actively treat PAG rocks, selenium and nitrate before the release of water to the environment. This will ensure that released water meet the FWAL guidelines and is protective of the fresh water receptors. For selenium, the site specific objectives (0.0017 mg/L to 0.0093 mg/L) are more stringent and lower than the CDW (0.05 mg/L), thus meeting the site specific objectives will automatically meet the CDW guidelines and be protective of drinking water receptors, including domestic and municipal wells. The presence of the historical underground mine workings and potential karst features could represent a pathway to water wells located in the Crowsnest River Valley near Blairmore. However the groundwater flow pattern and location of the underground workings is such that a constant conduit does not exist from Grassy Mountain, through Bluff Mountain and into the Crowsnest River Valley. If groundwater impacted by the Project were to find a pathway into the known historical underground mine workings or potential karst features, the travel times would likely be increased from the current situation of decades to weeks, months or years, reducing the risk of impacted water from reaching the groundwater users.

Baseline groundwater flows radially from two topographic highs present within the Mine Permit Boundary, *i.e.*, Grassy Mountain and Bluff Mountain, which is just to the south of the Mine Permit Boundary (CR #3, Figure 4.5-3). Groundwater generally flows east and west of these features towards Blairmore and Gold creeks. In between, groundwater moves south from Grassy Mountain and north from Bluff Mountain, before discharging into Blairmore Creek or Gold Creek. EOM and LTC head distributions show that other than local groundwater flow being re-directed towards the pit,

groundwater flow directions will remain basically the same. Water from the pit and saturated zones will be confined there, groundwater underlying the north rock disposal is going to flow towards Blairmore Creek, and from the south rock disposal will flow north from Bluff Mountain or south from Grassy Mountain and then towards Blairmore or Gold creeks as illustrated by the groundwater flow path on CR #3, Figures 5.3-2 and 5.3-6. These flow paths re-emphasize that the primary concerns are the surface water receptors. Management and mitigation of these potential effects are required and outlined in CR#5 – Water Quality, Section 4.

Groundwater residence time (travel time to the creeks) from the LTC scenario is predicted to be mostly greater than 10 years (CR #3, Figure 5.3-9), except below sedimentation ponds and close to creeks and tributaries. Within the proposed ex-pit and in-pit rock fill footprint, groundwater residence time is predicted by the model to be approximately less than 20 years (CR #3, Figure 5.3-9). The groundwater modelled with longest residence time (greater than 50 years) is close to the topographic highs and the shortest (less than 20 years) are close to the topographic lows. Therefore, most basal leakage from the waste rock dumps would reside in the groundwater system for a duration that substantially exceeds the critical residence time to attenuate any selenium. Areas with short residence time (*i.e.*, less than 10 years) are of limited extent (*i.e.*, less than 5%) in comparison to areas with long residence time; therefore substantial mixing will occur with groundwater where selenium has attenuated or remains at baseline levels. The pit saturated zones and end pit lake will form their own small groundwater basin, as illustrated by the groundwater divide pattern on CR #3, Figure 5.3-6. Groundwater flow will actually be towards the pit and therefore migration of water away from the pit would not occur, providing further residence time and opportunity for mixing.

Bedrock Aquifers

Groundwater flow direction patterns for EOM and LTC, as predicted by the numerical model, indicate that the pit will capture nearby groundwater towards the pit. It is predicted that the end pit lake will take approximately 13 years to fill. Head distribution indicates that groundwater further away from the pit will flow southward away from Grassy Mountain, but will flow northward from Bluff Mountain. Groundwater accumulating between the two mountains will ultimately discharge to Blairmore and Gold creeks and will therefore be discharged from the groundwater system.

Potential effects related to mine spoil and mine operations on the bedrock aquifers' groundwater quality from Project activities have been assessed as not significant.

Water Wells

Groundwater stored in the Paleozoic units, forming the bulk of Bluff Mountain, will flow radially, including northward before discharging into Blairmore or Gold creeks (CR #3, Section 5.4.2.2). Groundwater contours also indicate that a divide exists within the Greenhill Mine, with part of the

water flowing primarily to the south while the remaining flows north and east (CR #3, Figure 5.4-1). This is consistent with the interpretation of a radial groundwater flow around Bluff Mountain. Particle paths (from particle tracking conducted in the numerical model) indicate that groundwater within the Greenhill Boisjoli will travel primarily to the north, towards the open pit, as the pit will intersect the mine and act as a drain. Particles within the Greenhill Mine confirmed the presence of a divide, with particles travelling north, south and east. Groundwater flow direction and particle path tracking indicates that groundwater potentially impacted from mining operations will not travel from north to south through the existing underground mine. There is no apparent ability for impacted groundwater to travel southwards towards the Crowsnest River valley where the municipal water wells utilize the alluvial aquifer. As a result, municipal water wells are not predicted to have any groundwater quality impacts associated with mine spoil and mining activities.

The closest domestic wells are located 3.1 km southwest of the CHPP. The residence time of the groundwater located between the mine and the water wells is generally over 50 years (except locally close to the creeks where groundwater discharges; CR #3, Figure 5.3-6) providing sufficient time for selenium attenuation to occur. In addition, groundwater supplying these wells is mostly coming from topographic highs located west of the Project, which not have been impacted by mining activities or mine spoil. Potentially impacted groundwater would discharge to Blairmore Creek, located between the Project and the domestic wells, before discharging into the Crowsnest River. As a result, these water wells are not predicted to have any groundwater quality impacts associated with mine spoil and mine activities.

The Project effects on water well groundwater quality are deemed to be not significant.

Surface Water

Assessment of the effects of mine spoil and mine operations on water quality is discussed in the Surface Water Quality (Section E.5; CR #5, Section 4) assessment. The following presents a very high level summary.

A total of 39 variables were modelled, of which 21 variables have published Alberta water quality guidelines. Predicted concentrations of all of these 21 regulated water quality variables during the construction, operation, closure and post-closure periods of the Grassy Mountain Mine fell within published Alberta guidelines (or for selenium, the proposed site-specific objective) in Gold Creek. In Blairmore Creek, predicted concentrations of all variables fell within these guidelines or the proposed selenium objective except sulphate, for which concentrations are predicted to increase steadily over mine life. Sulphate is predicted to remain below the AB guideline during mine life until the mid-to-late 2030s, when it is predicted to exceed this guideline in all seasons until mine closure, after which time concentrations are predicted to decline to a stable, long-term average, which would still remain

consistently above this guideline at all modelled locations downstream of the West Sedimentation Pond water release.

Based on the anticipated management of runoff and controlled release rates from sedimentation ponds, negligible effects are anticipated on surface water quality from sediment-associated inputs. All process water with elevated selenium, nitrogen species, and other constituents will be treated in surge ponds and saturated zones with sufficient water residence time. All other elevated metal concentrations will be treated in treatment facility before releasing to the environment.

After mitigation, the residual effect of the Project on water quality is considered to be not significant**.**

E.3.3.3 Effects of Surface Facilities on Groundwater Quality

Surface facilities relevant to groundwater quality include the wash bay, cold storage, lube storage, fuel farm, potable and wastewater treatment plants, and storage yards. Waste generated on site will be stored and disposed of in accordance with regulatory requirements. Products handled at the Project CHPP will include hydrocarbons fuels (gasoline and diesel), lubricants (for light duty, mobile equipment and mining trucks), engine coolant, flotation reagents, and anionic and cationic flocculants. Explosives will be handled by a third party service provider. A service bay with fuel and lube will be initially located at the plant site administrative office, shop, and maintenance area, and additional satellite stations will subsequently be located at various points throughout the mine area. All fuel depots will have secondary containment berms around the storage tanks and site drainage will be managed. Regular maintenance of the fuel depots will minimize spills and leaks. Flotation reagents will be stored in a reagent farm. Flocculants will be stored in either dry-powder form (500 kg bags) or liquid form (1,000 L plastic bulk bins).

Water released to the environment will be tested in advance of release to ensure that it meets water quality requirements in accordance with the operating approval. Accidental releases may allow chemicals, either fluids or solids that are dissolved or transported by precipitation events, to seep into the ground where they could alter shallow groundwater quality. The impact to groundwater quality will depend on the volume and type of product released, the characteristics of the surface materials at the release location, the presence of liners, and the underlying groundwater conditions. Given the presence of fractured bedrock overlain by thin surficial deposits, it is recommended that some additional protection measures may put in place (such as, but not limited to, installation of liners).

<u>Bedrock Aquifers</u>

As a result of the best management practices for material handling methods, there should be a low possibility of potential effects to shallow groundwater quality, except through upset conditions (*i.e.*, accidental spills or leak). In the event of a spill or leak, the spill response plan will be executed to

control and minimize the extent of any impact. In the unlikely event that a spill resulted in groundwater quality impacts that represented a potential concern for freshwater aquatic life or other receptors, remediation activities could include source removal or groundwater recovery.

Potential effects related to surface facilities on the bedrock aquifers' groundwater quality from Project activities have been assessed as not significant as no adverse effects are anticipated with mitigation measures in place.

E.3.4 Cumulative Effects

Groundwater levels in the vicinity of the mine pit will be impacted by the pit dewatering program. Effects associated with the reclaimed Project site are anticipated to be moderate and restricted to a localized area within the LSA. Surface facilities have the potential to result in localized changes in groundwater quality as a result of accidental spills or leak. Mine operations and mine waste rock also have the potential to locally change the groundwater chemistry associated with selenium leaching or the presence of residues from blasting.

Groundwater effects associated with surface facilities, mining operation, mine waste rock and pit dewatering have low to moderate impact ratings and are all local in extent within the LSA. There are no other planned or reasonably foreseeable projects within the RSA that are expected to act in cumulative manner with these effects; consequently, a cumulative effects assessment is not required for this Project.

E.3.5 Mitigation and Monitoring

E.3.5.1 Mitigation

Mitigation requirements for the three key potential impacts of the Project to groundwater are discussed below.

Pit dewatering is necessary for the mine operations, therefore drawdown of groundwater in the bedrock units will occur during the Project, but effects to bedrock aquifers are predicted to be localized so that no mitigation measures are required. No impacts are predicted at the water wells, therefore no mitigation is proposed. Specific to watercourses' base flow reduction, effect assessment and mitigation options are discussed in the Hydrology (Section E.4), Surface Water Quality (Section E.5) and Aquatics (Section E.6).

Mitigation measures on the effect of mine waste rock on groundwater quality will include the development of a water management plan as described in Section C.5.

Mitigation measures for minimizing or preventing adverse impacts on shallow groundwater quality include industry-standard operating practices, preparedness for upset conditions and the appropriate management of upset conditions.

E.3.5.2 Monitoring

Groundwater monitoring for the Grassy Project will include a groundwater monitoring program and a groundwater response plan. The combination of these two programs will ensure effects from pit dewatering and site operations are monitored and assessed and mitigative measures are implemented, as required.

The groundwater monitoring program for the Project will have the following main purposes:

- to evaluate water level changes associated with pit dewatering; and
- to detect any impacts to shallow groundwater quality.

The details of the monitoring program will be the subject of the pending EPEA Approval of this application and the *Water Act* Licence (for site water management and use).

The majority of the existing groundwater monitoring wells completed for the baseline investigation are located within the proposed mine pit footprint; therefore, these wells will need to be decommissioned prior to the mining operations. As the mining progresses from south to north in several phases, it is anticipated that some of the monitoring wells may be temporarily used in the monitoring program until mining advances to that location; however, additional locations will be required. It is expected that selected locations will change, but will include the following:

- wells (nested sets where possible) in proximity of the pit for water level monitoring to monitor water quantity;
- shallow monitoring wells downgradient of waste rock disposal areas, and sedimentation ponds, primarily for groundwater sampling to monitor water quality; and
- shallow monitoring wells downgradient of surface facilities (at the proposed CHPP) primarily for groundwater sampling to monitor water quality.

E.3.5.2.1 Overview of the Approach Groundwater Monitoring Program

The groundwater monitoring program will monitor both groundwater quality and quantity by monitoring the both hydraulic heads, and groundwater chemistry. The groundwater monitoring program will be tailored to the mine activities, with hydraulic head monitoring implemented around and downgradient of the pit, and chemistry monitoring implemented near facilities handling a variety of chemicals and fuels and around the waste rock and sedimentation ponds. Baseline data

will be collected from the wells included in the groundwater monitoring program monitoring network to assess variations in hydraulic heads and baseline chemistry. Monitoring wells for the groundwater monitoring program will be installed during the construction of the Project so that baseline data are collected (and chemical parameters stabilized) prior to the commencement of mining.

The water level monitoring may be monthly during an initial period when water levels are stabilizing in order to establish baseline conditions prior to mining. Once drawdowns become more predictable, monitoring frequency may be decreased. The water sampling frequency is expected to be either bi-annual or annual. Analytical parameters are expected to include major ion chemistry, metals and hydrocarbons depending on location.

Criteria that would trigger the groundwater response plan include hydraulic heads below threshold values near the pit, increase in concentrations of inorganic, dissolved and/or total metals parameters, and detection of parameters above the detection limit for chemicals not naturally present at the site. Typically the first step consists in confirming the value that triggered the groundwater response plan (including, but not limited to, confirming value with the laboratory, re-monitoring the anomalous water level and/or resampling the monitoring wells). If the value is confirmed, additional response plan activities will be initiated such as source identification, risk assessment, remediation and/ or mitigation. A resolution of the event that triggered the groundwater response plan could result in changes to the monitoring program, such as increased frequency of monitoring, adding additional monitoring locations, *etc*.

Annual GMP reporting describing the information collected and an analysis of the results will be completed for submission to AER.

E.3.5.2.2 Groundwater Response Plan Approach

In the unlikely event of a decrease in hydraulic head in privately owned water wells that impedes use of this water supply, mitigation could include either drilling a new well, or connecting the affected user(s) to the municipal water network.

A change in groundwater quality near the pit and the selenium control ponds will be addressed as part of the management of the treatment cells. Change in chemistry near the facility will be investigated for spills or upset conditions resulting in a discharge of chemicals to the surface and seeping to the shallow groundwater. Response measures could include spill investigation, source removal, remediation, risk assessment and/or risk management.

E.3.6 Summary

The conclusions of the Projects effects evaluations are summarized in Table E.3.6-1 and as follows:

- pit dewatering through sump pumps placed at the bottom of the pit during active mining should have no impact on water wells and a moderate impact on the quantity of groundwater in bedrock aquifers;
- mine waste rock and mining operations are assessed to have a low residual impact on the quality of groundwater within bedrock aquifers and no impact to water wells; and
- surface facilities are assessed to have a low residual impact on groundwater quality within bedrock aquifers.

Table E.3.6-1 Summary of Impacts Ratings on Groundwater Valued Components (VCs)

VC	Nature of Potential Impact or Effect	Mitigation Protection Plan	Magnitude1	Geographical Extent2	Duration3	Frequency5	Reversibility4	Project Contribution6	Confidence Rating7	Probability of Occurrence8	Significance9
Bedrock Aquifers	Pit dewatering on water quantity	Monitoring Program	Low	Local	Residual	Continuous	Irreversible	Negative	Moderate	High	Not significant
	Mine waste rock and mining operations on water quality	Selenium & Nitrate Management Plan Monitoring Program	Low	Local	Long	Continuous	Reversible in Long Term	Negative	Moderate	Medium	Not significant
	Surface facilities on water quality	Spill Prevention & response plan, Monitoring program	Moderate	Local	Long	Occasional	Reversible in Short Term	Negative	Moderate	Medium	Not significant
Discharge to Surface Water Bodies	Pit dewatering on water quantity	Surface Water Management Plan Monitoring Program	- 10	- 10	- 10	- 10	- 10	- 10	- 10	- 10	- 10
	Mine waste rock and mining operations on water quality	Selenium & Nitrate Management Plan Monitoring Program	- 10	- 10	- 10	- 10	- 10	- 10	- 10	- 10	- 10
Water Wells	Pit dewatering on water quantity	Monitoring Program	Nil	Local	N/A	N/A	N/A	Neutral	High	Low	Not significant
	Mine waste rock and mining operations on water Quality	Selenium Management Plan Monitoring Program	Nil	Local	N/A	N/A	N/A	Neutral	High	Low	Not significant

1. Nil, Low, Moderate, High
2. Local, Regional, Provincial, National, Global
3. Short, Long, Extended, Residual
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Continuous, Isolated, Periodic, Occasional
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Not significant, Significant
10. Impact rating is presented in CR #4 – Hydrology; CR #5 – Water Quality.

N/A – Not applicable

E.4 HYDROLOGY

E.4.1 Introduction and Terms of Reference

Benga conducted a hydrology assessment for the proposed Project. The following section is a summary of the Surface Hydrology Assessment that was prepared by SRK Consulting and is included as Consultant Report #4 (CR #4).

The AER final Terms of Reference (ToR) and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1A). The following ToR relating to hydrology have been addressed in this report:

4.3 Hydrology

4.3.1 Baseline Information

[A] Describe and map the surface hydrology. Include flow regimes of streams in the Project Area.

[B] Provide surface flow baseline data, including:

a. *seasonal variation, low, average and peak flows for watercourses; and*
b. *low, average and peak levels for waterbodies.*

[C] Identify any surface water users who have existing approvals, permits or licenses.

4.3.2 Impact Assessment

[A] Discuss changes to watersheds, including surface and near-surface drainage conditions, potential flow impediment, and potential changes in open-water surface areas caused by the Project.

[B] Describe the extent of hydrological changes that will result from disturbances to groundwater and surface water movement:

a. *include changes to the surface flow, water levels and channel regime in watercourses (during minimum, average and peak flows) and water levels in waterbodies;*
b. *assess the potential impact of any alterations in flow on the hydrology and identify all temporary and permanent alterations, channel realignments, disturbances or surface water withdrawals;*
c. *discuss both the Project and cumulative effect of these changes on hydrology (e.g., timing, volume, peak and minimum flow rates, river regime and lake levels), including the significance of effects for downstream watercourses; and*
d. *identify any potential erosion problems in watercourses resulting from the Project.*

[C] Discuss changes in sedimentation patterns in receiving waters resulting from the Project.

[D] Describe impacts on other surface water users resulting from the Project. Identify any potential water use conflicts.

[E] Describe potential downstream impact if surface water is removed.

[F] Discuss the impact of low flow conditions and in-stream flow needs on water supply and water and wastewater management strategies.

[G] Discuss how potential impacts of temporary and permanent roads on wetland hydrology will be minimized and mitigated.

For the CEAA Guidelines, the following excerpts are specific to the hydrology assessment, with the associated concordance table in (Appendix 2A):

6.1.4 Groundwater and Surface Water

- *monitoring protocol for collection of existing groundwater and surface water data;*
- *the delineation of drainage basins, at appropriate scales (water bodies and watercourses), including intermittent streams, flood risk areas and wetlands, boundaries of the watershed and subwatersheds, overlaid by key project components;*
- *hydrological regimes, including monthly, seasonal, and annual water flow (discharge) data;*
- *for each affected water body, the total surface area, bathymetry, maximum and mean depths, water level fluctuations, type of substrate (sediments);*
- *any local and regional potable surface water resource.*

6.2.2 Changes to the Groundwater and Surface Water

- *changes to the hydrological and hydrometric conditions including stream baseflow conditions.*

This surface hydrology assessment component addresses the above to assess the impacts of changes in surface water flows and levels. This surface hydrology assessment provides input and background to other environmental assessments including water quality, aquatics, and groundwater. The conceptual designs of water management aspects for the project are also discussed.

The hydrology LSA spatial boundaries are congruent with the surface water quality (Section E.5 and CR #5) and aquatic resources (Section E.6 and CR #6) LSA and encompass areas where Project activities have the potential to impact aquatic habitat or fish populations and communities. The LSA is comprised of the Blairmore Creek and Gold Creek watersheds, as the Project footprint is located

entirely within these two watersheds (CR #4, Figure 2). The Blairmore Creek and Gold Creek watersheds are located in the eastern slopes of the southern Canadian Rockies, with a watershed area of 5,121 ha and 6,209 ha, respectively.

The aquatic ecology, water quality, and hydrology RSAs are also congruent. Project effects have the potential to interact with other projects within the Crowsnest River watershed; therefore, the RSA is comprised of the entire Crowsnest River watershed to evaluate potential cumulative effects at the regional level (CR #4, Figure 3). Taken together, Blairmore Creek and Gold Creek represent approximately 16% of the watershed area of the Crowsnest River.

For the hydrology assessment, the VCs are water flow in Blairmore Creek and Gold Creek and water quality (total suspended sediment [TSS]) for Blairmore Creek and Gold Creek.

E.4.2 Baseline Setting

Long-term data are required to describe surface hydrology conditions because of the considerable natural seasonal and annual variability of water flow and sediment concentrations. In the absence of site-specific long-term data, available long-term regional data from hydrologically similar areas were used and compared with short-term site-specific data. This comparison facilitates the generation of long-term flow patterns, high and low flow values, and sediment conditions that are applicable to the Project area watercourses.

The baseline data consist of local data from the following sources:

- long-term regional streamflow data on local watersheds; and
- short-term site-specific streamflows in the LSA.

The baseline description forms the hydrologic basis for computing flows and conducting water balances for water use and the design of settling ponds and water management infrastructure.

Historic climatic data (primarily temperature and precipitation) are available from 59 Environment Canada stations located within 110 km from the Project. CR #4, Table 1 and Table 2 provide summaries of the regional temperature data and the regional precipitation data, respectively.

E.4.2.1 Climate

Climatic factors are important for characterizing surface water hydrologic conditions because variability in precipitation, temperature, and evaporation significantly affects basin runoff characteristics and streamflows. The region is described as having cold winters, cool summers, and no dry season, or Köppen-Geiger climate classification of Dfc. This classification is defined as having

fewer than four months with average temperatures greater than 10°C, with the coldest month having an average temperature below 0°C.

The mean annual precipitation in the Project area was estimated using historical precipitation data from 18 regional stations (CR #4, Section 2.4). Based on a regional linear regression, the mean annual precipitation in the Project area was determined to range between 611 mm/yr and 992 m/yr, depending on elevation. Short duration rainfall estimates were estimated based on a regional analysis of maximum annual 24-hour precipitation events from each year on record for all regional stations (CR #4 Section 2.5). Lake evaporation and average annual evapotranspiration were estimated to be 738 mm/year and 262 mm/year, respectively (CR #4 Section 2.6).

E.4.2.2 Regional Flow

The Project site is located within the Blairmore Creek and Gold Creek watersheds. Blairmore Creek and Gold Creek collect runoff from an upstream area of 50 km² and 60 km², respectively, and both discharge into the Crowsnest River. The Blairmore Creek and Gold Creek watersheds are part of the Oldman River watershed flowing into the Saskatchewan River ultimately discharging into Lake Winnipeg.

The Blairmore Creek watershed is relatively steep, with an average slope of 22% and elevations ranging between 2,300 and 1,300 m asl. Gold Creek has similar geomorphological characteristics with an average slope of 19% and elevations ranging from 2,500 to 1,300 m asl in the region.

Streamflow data from eight local site-specific gauging stations located in the vicinity for the Project and data from eight regional Water Survey of Canada (WSC) gauging stations with natural hydrologic regimes were compiled to evaluate long-term (1908 – 2014) runoff trends for the Project area (CR #4 Section 3). Local streamflow data were collected by Benga from eight local gauging stations along Crowsnest River, Blairmore Creek, and Gold Creek (CR #4 Section 3.2, Figure 22). Continuous stage records were obtained at these local stations from September 2013 to May 2014, with several gaps during the winter season. The continuous stage records were complemented with spot measurements of stage and flow.

The mean annual runoff was calculated for each WSC gauging station by dividing total flow by the corresponding catchment area. From this regional analysis, the mean annual runoff for the Project area is 323 mm/year (CR #4 Section 3.5). The local gauging stations displayed similar runoff values to the annual runoff predicted at the site. Runoff coefficients were calculated based on mean annual runoff (323 mm/yr) and mean annual precipitation (628 mm/yr), and were assumed to be valid for both low and high elevations in the Project area (CR #4 Table 11).

E.4.2.3 Base Flow Seasonal Data

To estimate the proportion of streamflow coming from groundwater, abase flow separation analysis was conducted (CR #4 Section 3.6). Surface runoff was separated in two components: quickflow and base flow. Quickflow is defined as the portion of streamflow that comes from either surface runoff or interflow. Base flow is the portion of streamflow that comes from the sum of deep subsurface flow and delayed shallow subsurface flow. Table E.4.2-1 presents the results of the base flow analysis.

Table E.4.2-1 Unit Base Flow for Crowsnest River at Frank and at the Grassy Mountain Project

Location	Base Flow [L/s/km²]											
	January	February	March	April	May	June	July	August	September	October	November	December
Blairmore Creek	0.9	0.9	0.9	1.1	2.3	4.4	3.1	2.1	1.7	1.4	1.1	1.0
Gold Creek	1.4	1.4	1.4	1.7	3.5	6.7	4.6	3.1	2.6	2.2	1.7	1.5
Crowsnest River At Frank	2.8	2.7	2.7	3.3	6.9	13.2	9.1	6.2	5.1	4.3	3.4	3.0

E.4.2.3.1 Low Flow Analysis

Low flow estimations include seven-day period low flows for a 2-year, 5-year, 10-year, and 100-year return periods (*i.e.*, 7Q2, 7Q5, 7Q10, 7Q100) by month and year (CR #4, Section 3.7, Table 13). The catchments in and around Blairmore Creek and Gold Creek were estimated using the linear relationship defined for Crowsnest Rive at Frank (CR #4 Section 3.4) This methodology resulted in annual 7Q10s of 0.6 L/s/km² for Blairmore Creek, 1.0 L/s/km² for Gold Creek, and 1.91 L/s/km² for the Crowsnest River at Frank.

E.4.2.3.2 Peak Flow Analysis

The peak flows were estimated with a frequency analysis conducted over the peak flow data at the Crowsnest River at Frank station (CR #4 Section 3.8). The relationship between the Crowsnest River regional station, the Gold Creek regional station and project stations within the local watersheds was then used to determine watershed specific average unit peak flows (CR #4 Table 14). The relationship between the watershed size and the mean annual flood for the region is presented as an average trend and an upper envelope curve (CR #4 Figure 38). The site unit peak flow for a return period of 100 years is estimated to be 725 L/s/km² for Blairmore Creek and 907 L/s/km² for Gold Creek(CR #4, Section 3.8, Table 14).

E.4.2.4 Sediment Concentrations

The available data for TSS concentration or sediment concentration were reviewed and summarized for the region (CR #4, Section 3.9). The two sources of regional data are the regional EC gauge and sediment station at Crowsnest River at Frank, and the Project-specific aquatic habitat data collected for Blairmore Creek and Gold Creek (CR #5, Section 3.2.3.1). Average monthly flows and suspended sediment data recorded at the Crowsnest River at Frank station from 1976 to 1980 are plotted in CR#4, Figure 39).

The data indicate that there is generally a strong correlation between flow and suspended sediment in the Crowsnest River at Frank (CR #4, Figure 40). However, when hydraulic characteristics such as gradient or water level change, the sediment concentrations can vary by one order of magnitude for the same flow. This is because sediment concentrations are related to sediment particle size at the water course and banks, the stream slope, and seasonal events such as freshet snowmelt. Thus, flows cannot reliably predict sediment concentrations but can provide an indication of expected suspended solids concentrations.

The available Gold Creek and Blairmore Creek habitat data display similar geomorphological characteristics in their mainstems as in their tributaries, with sections protected by gravel and cobbles and longitudinal slopes between 5% and 20% with average watershed slopes of 19% and 22%, respectively. The station Crowsnest River at Frank is in an area with a smaller transversal slope with an average watershed slope of 15%, meandering water courses in the section close to the town of Frank and an increased tendency for small-size sediment particles.

Gold Creek and Blairmore Creek have a greater capacity for suspended sediment from their steeper slopes compared with those of Crowsnest River. However, because of ongoing scour in those streams there are fewer small sediment particles to be suspended.

Daily maximum sediment concentration data at the Crowsnest River at Frank station are available intermittently from 1972 to 1983, with continuous records during the period from 1976 to 1980. The maximum recorded concentration was 602 mg/L in 1972. The continuous record of the period from 1976 to 1980 represents approximately 1:3 year wet to 1:34 year dry for the complete region of Gold Creek, Blairmore Creek, and Crowsnest River. During winter, the maximum monthly sediment concentration has reached 20 mg/L with an average of 7 mg/L. During summer, the maximum monthly sediment loads have reached 55 mg/L with an average of 17 mg/L. No sediment samples are recorded in the region after 1980.

Monitoring of suspended sediment concentrations over a range of flows and times would be required to refine the sediment regime for Gold Creek and Blairmore Creek.

E.4.3 Potential Impacts

The Project has developed a water management strategy that facilitates both the management and use of water from the Project (Section C.5). There will be interaction with surface water and groundwater resources during the construction, operation, and reclamation phases of the Project. The Project has been designed to manage the surface water and groundwater efficiently and to minimize hydrological effects.

E.4.3.1 Project Water Use

An assessment of annual water use by the Project is important from a water licencing perspective. The water and load balance model for the Project was used to estimate net water use by the coal mine operation (Appendix 10B). A complete description of methodology and assumptions used in the development of the water balance model is available in Appendix 10B.

The only true loss of water from the Project area is the moisture associated with the clean coal that is shipped off site to market (CR #4 Section 5.1). However, within the Project area there are changes to surface water flows as water is collected, diverted, treated, and discharged, and changes to the inventory of water stored in various reservoirs such as ponds, saturated zones, and groundwater. Changes to surface characteristics of the developed mine areas are expected to result in higher runoff, which is a net gain in terms of the water balance. Estimated net change to discharge from Blairmore Creek and Gold Creek is provided in CR #4 Figure 41.

In the long-term, the annual discharge volume is expected to be greater than baseline conditions by approximately 600,000 m^3/year in years with annual average precipitation. The increase is caused by the higher runoff coefficient associated with the legacy highwalls.

E.4.3.2 Streamflow Changes

E.4.3.2.1 Average Hydrological Conditions

Potential changes to stream flow were evaluated at various stations along Gold Creek and Blairmore Creek (CR #4, Section 5.2, Figure 42). Estimates of potential changes to stream flow for average hydrological conditions are illustrated in CR #4 Figure 43 for Gold Creek and CR #4 Figure 46 for Blairmore Creek.

The proposed open pit intersects portions of the upper reaches of the western catchments for Gold Creek. Water intercepted by those areas may be routed to saturated zones and from there to the proposed water treatment plant, which would discharge to Blairmore Creek. An intermediate step may require the discharge from the saturated zones to be treated for removal of metals. In this instance, the treatment plant would discharge to Blairmore Creek. Therefore, a net loss of flow is

anticipated in the lower reaches of Gold Creek. However, flow changes are estimated to be just over 10% along the stretches of the Gold Creek that are most affected, but, for the most part, flow changes are estimated to be around or less than 5%. The long-term increase in flow estimates for station GC10, which is located in the upper reaches of Gold Creek, is caused by the contribution of flows from the Pit Lake, which will overflow to Gold Creek when full.

Flows in Blairmore Creek are expected to increase compared to baseline conditions because of the additional contribution of flow from some Gold Creek sub-catchments, but more importantly because of the estimated increase in runoff caused by changes to the hydrological characteristics of the developed mine areas (*i.e.*, increase in runoff coefficients for it walls and waste rock areas). For most of the year, the maximum change to flow is expected to be less than 15% for all stations. Large flow changes are possible during the low flow season (December to March). However, the water balance model assumes that the discharge from the saturated zones or water treatment plant will be controlled based on the rate of accumulation of water in the saturated zone and the stream flow conditions in Blairmore Creek.

E.4.3.2.2 Dry and Wet Hydrological Conditions

Estimated stream flow changes to Blairmore Creek and Gold Creek for 1 in 10 dry and wet years are shown in CR #4 Figure 44 and 45, and estimated changes to flows in Blairmore Creek are shown in CR #4 Figure 47 and 48. The flow changes during dry and wet conditions are similar to the patterns discussed for average conditions and the estimated magnitude of the changes is similar.

E.4.3.3 Effects Assessment

The potential hydrologic effects of proposed Project activities depend on the number, size, and location of the facilities and activities within the watershed at the time.

The valued components (VCs) identified and considered in the hydrological assessment include:

- high, mean, and low flows on Blairmore Creek during the operations phase and after closure;
- high, mean, and low flows on Gold Creek during the operations phase and after closure; and
- sediment concentration in Blairmore Creek and Gold Creek during the operations phase and after closure.

Assessment of these VCs includes effects in terms of stream flows as measured quantities (as summarized in E.4.3.2 and CR #4 Section 5.2) or changes to TSS as measured by analytical methods (reported in CR #5 Section 3.2.3.1).

The potential effects to flows in Blairmore Creek and Gold Creek were assessed as changes to monthly flows (CR #4 Section 6.4). The monthly flows estimated by the water balance model, both during baseline conditions (in 2017) and through the life of the mine (2018 to post-closure), were assumed to be mitigated by the operational water management. Mitigation consists of interception, diversion, treatment, and release of treated water to Blairmore Creek. For Gold Creek, mitigation consists of the routing of water from the Pit Lake, when filled, to the creek.

The magnitude of effects depends on the season. During the open water season (April/May through October/November), flows in Blairmore Creek are expected to increase by less than approximately 15%. Winter low flow conditions could have a greater magnitude; therefore, the magnitude of flow changes was estimated as low to moderate for Blairmore Creek. Changes in monthly flows in Gold Creek are generally expected to be less than 10% and, in most cases, less than about 5%, which was deemed to be a "low" magnitude. The geographical extent is "local" for both creeks because changes are expected to be noticeable only in the immediate vicinity of the Project area. The duration of the potential effects include both the operational period and closure and was therefore rated "long" and the frequency "continuous". In terms of reversibility, the potential effects were rated "irreversible" because effects to the hydrological regime are expected to persist long-term and are not expected to gradually return to baseline conditions.

The overall significance rating for the hydrology assessment for Blairmore Creek and Gold Creek was judged to be Not Significant (Table E.4.6-1). The rating was primarily based on the low magnitude rating for the reduced flow in Gold Creek and the low to moderate rating for estimated increases to flow in Blairmore Creek. Overall, the estimated changes are well within the range of variability that would naturally occur between wet and dry years.

Potential effects related to sediment concentrations in Blairmore Creek and Gold Creek were also deemed to be Not Significant. This rating is primarily based on the assumption that engineering controls and a sediment and erosion control and prevention plan will be implemented for the Project (Section C.5.3.2).

Additionally, Crowsnest River receives flows from both the Blairmore Creek and Gold Creek catchments; therefore, any effects within these catchments have the potential to affect the flows within the larger Crowsnest River. The Crowsnest River represents a watershed area five to six times bigger than these catchments. Therefore, any effects to flow in the Crowsnest River would be proportionately lower. In addition, the estimated increase of flow in Blairmore Creek and decrease of flow in Gold Creek would diminish effects to the Crowsnest River further. Consequently, hydrological effects judged to be Not Significant to Blairmore Creek and Gold Creek would also be Not Significant for the Crowsnest River.

E.4.4 Cumulative Effects

The Planned Development Case and a cumulative effects assessment were not included because of the absence of anticipated future developments or activities that would significantly affect hydrology in the region.

E.4.5 Mitigation and Monitoring

E.4.5.1 Mitigation

To reduce the impacts of the Project on surface hydrology, Benga will:

- implement a water management plan to address selenium management and augmentation of potentially impacted tributaries for the Project;
- ensure the coal handling and processing plant facilities will be aligned in such a way to minimize drainage diversions and runoff interception (*e.g.*, maintain natural vegetated buffers between active mine areas and undisturbed streams);
- direct runoff from active mining roads and areas, the north and south waste rock disposal areas, and topsoil stockpiles to the water management sedimentation and surge ponds for sediment settling treatment and as it relates to surge ponds, for Project use;
- design settling ponds according to the latest sizing methodology (1:10 year storm event and safely convey up to the 1;100 year flood event);
- direct all dirty water to settling facilities or the fines settling pond and then to the water supply pond or receiving stream when required to ensure regulatory guidelines have been met;
- where possible, maintain a 100 m minimum setback from Blairmore Creek and Gold Creek mainstems, and a 30 m setback from associated headwater tributaries;
- design and construct any potential watercourse crossings to meet or exceed the regulatory requirements for approval under the provincial *Water Act*;
- construct clear span crossings over all watercourses identified as potential fish bearing streams;
- use appropriately sized culverts, as required, to maintain drainage along non-fish bearing headwater tributaries and/or ephemeral drainage draws;
- install haul road berms to contain road runoff and direct it to designated runoff control works;
- incorporate flow and erosion control measures, such as ditch check structures, natural depressions or low areas to trap sediment, silt fences or exfiltration ditches in small, low gradient areas adjacent to soil and stockpiles areas; and

- train personnel to minimize disturbances and use and maintain drainage and sediment controls.

E.4.5.2 Monitoring

To reduce potential impacts of the Project on surface hydrology, Benga will:

- conduct flow and TSS monitoring at all settling ponds;
- conduct regular inspections of all drainage works and upstream and downstream water quality sampling; and
- conduct continuous monitoring of flow on Blairmore Creek, Gold Creek, and all potentially impacted tributaries.

E.4.6 Summary

Table E.4.6-1 summarizes the impact ratings for the hydrology-related VCs. A cumulative effects assessment was not conducted as there are no foreseeable projects that will have an additional direct impact on regional hydrology.

Table E.4.6-1 Summary of Effects Rating for Hydrologic Valued Components

Valued Component	Nature of Potential Effect	Mitigation/ Protection Plan	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Project Contribution	Confidence Rating	Probability of Occurrence	Significance Rating
High, Average and Low Monthly Flows of Blairmore Creek During and After Mining	Change to monthly flows	Pacing of discharge from the Project Area	Low to Moderate	Local	Long	Continuous	Irreversible	Positive	Moderate	High	Not Significant
High, Average and Low Monthly Flows of Gold Creek During and After Mining	Change to monthly flows	Routing of end-pit lake to the creek	Low	Local	Long	Continuous	Irreversible	Negative	Moderate	High	Not Significant
Sediment Concentration in Blairmore Creek and Gold Creek During and After Mining	Change to TSS Concentrations	Sediment and Erosion Control	Low	Local	Long	Periodic	Reversible in short-term	Positive/ Negative	Low	High	Not Significant

E.5 Surface Water Quality

E.5.1 Introduction and Terms of Reference

The following is a summary of the Project Water Quality Assessment Report that was prepared by Hatfield Consultants Partnership (Hatfield) and included as Consultants Report #5 (CR #5).

The AER final ToR and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to Surface Water Quality have been addressed in this report:

4.4 Surface Water Quality

4.4.1 Baseline Information

[A] Describe the baseline water quality of watercourses and waterbodies. Discuss the effects of seasonal variations, flow and other factors on water quality.

4.4.2 Impact Assessment

[A] Identify Project components that may influence or impact surface water quality.

[B] Describe the potential impacts of the Project on surface water quality:

a) discuss any changes in water quality resulting from the Project that may exceed the Surface Water Quality Guidelines for Use in Alberta or the Canadian Water Quality Guidelines;

b) discuss seasonal variation and potential impacts on surface water quality;

c) assess the potential Project related and cumulative impacts of acidifying and other air emissions on surface water quality; and

d) discuss the effect of changes in surface runoff or groundwater discharge on water quality in surface waterbodies."

Section 6.0 Traditional Ecological Knowledge and Land Use

[B] Describe how TEK and TLU information was incorporated into the project design and development, technical components of the EIA, the conservation and reclamation plan, monitoring and mitigation plans.

Section 9.0 Mitigation Measures

[B] Identify those mitigation measures that will be implemented for each associated impact and provide rationale for their selection.

[C] Discuss the effectiveness of the proposed mitigation.

Section 10.0 Residual Impacts

[A] Describe the residual impacts of the Project following implementation of the Proponent's mitigation measures and the Proponent's plans to manage those residual impacts.

Specific requirements for the water quality assessment provided in Section 6.1.2 and 6.2.2 of the Canadian Environmental Assessment Agency (CEAA)'s Guidelines for the Preparation of an Environmental Impact Statement for the Grassy Mountain Coal Project (Appendix 2) were considered and addressed.

Grassy Mountain straddles the watersheds of Blairmore Creek and Gold Creek, which are tributaries of the Crowsnest River, which itself is a tributary to the Old Man River. Based on the proposed activities and the area topography, local and regional study areas (LSA and RSA) were identified. The LSA for aquatic resources was defined based on the lease area and local drainage basins, and encompasses the area where Project activities have the potential to directly affect water quality, hydrology, and fish and aquatic habitat. Given the majority of the mine permit area (MPA) is located within the watersheds of Blairmore Creek and Gold Creek, the entire watershed of both creeks is included in the LSA (CR #5, Figure 3). The combined total area of these LSA watersheds is approximately 11,300 ha. The RSA was defined on the basis of potential effects of construction and operation of the Project on flows, water levels, and water quality in regional water courses, including potential surface water/groundwater interactions. Taken together, Blairmore Creek and Gold Creek represent approximately 16% of the watershed area of the Crowsnest River (CR #5, Figure 3). Project effects have the potential to interact with other projects within the Crowsnest River watershed; therefore, the entire Crowsnest River watershed is included in the RSA for evaluation of potential cumulative effects.

E.5.2 Baseline Conditions

E.5.2.1 Overview

The following section provides a summary of the baseline condition for surface water quality as a valued component. Detailed water quality data are presented and summarized in CR #5.

Seasonal surface water samples were collected from LSA locations in: the Blairmore Creek mainstem (3 stations); two Blairmore Creek tributaries (2 stations); the Gold Creek mainstem (2 stations); Gold Creek tributaries, including Caudron Creek (seven stations); and three existing pit lakes associated with historical mining activities. In the RSA, three stations were sampled in the Crowsnest River mainstem (CR #5, Figure 4). Sediment samples also were collected from three stations at Blairmore Creek and four stations at Gold Creek (CR #5, Figure 4).

Water quality sampling programs began in May 2013 and continued until June 2016. Not all sampling stations were sampled on the same dates due to changes in the mine plan over time. Efforts were made to collect additional samples to include tributaries that became apparent during mine footprint revisions issued by Benga's engineering team.

Seasons were defined as follows:

- Spring: April, May;
- Summer: June, July, August;
- Fall: September, October; and
- Winter: November, December, January, February, March.

Sampling station locations were identified using GPS coordinates and Alberta Forestry, Lands and Wildlife Resource Access Maps and accessed by trucks, ATV, or foot. *In situ* measurements of water temperature, pH, and specific conductivity were conducted from just below the water surface using a hand-held Hanna multi-meter probe (model 98129). Dissolved oxygen was measured using a portable Winkler titration kit (LaMotte 5860).

For laboratory analyses, grab samples were collected from each station by submerging each sample bottle to a depth of approximately 10 to 30 cm. Sample bottles were uncapped, filled, and recapped at depth with the exception of total hydrocarbons (oil and grease) and BTEX, which were collected from the water surface to ensure capture of any floating hydrocarbons, and to ensure that the pre-charged preservative remained in the bottle. Sufficient Quality Assurance/Quality Control (QA/QC) samples were collected to represent at least 10% of all surface water samples.

All water samples were collected, preserved, and shipped according to protocols specified by analytical laboratories. Water quality samples were analyzed for a full list of water quality variables by ALS Environmental Ltd. (Calgary, AB) except samples collected by Riversdale Resources (in July and October 2014 and January 2015). These samples were analyzed by Maxxam Analytics (Calgary, AB). Full suite water quality variables included conventional variables, general organics, major ions, nutrients, metals (total and dissolved), hydrocarbons, BTEX, and polycyclic aromatic hydrocarbons (PAHs).

Data were screened against AEP's most recent *Environmental Quality Guidelines for Alberta Surface Waters*, which includes the CCME *Guidelines for the Protection of Aquatic Life*. For hardness-dependent guidelines, median hardness concentration of the corresponding station was used in determining the appropriate guideline value. Selenium concentrations were screened against a preliminary site-specific water quality objective dependent on sulphate concentrations (CR #5 Appendix A1).

Selenium in surface waters was identified as an important potential issue for this Project. Therefore, a site-specific objective for selenium for the protection of aquatic life has been developed linked to concentrations of sulphate, which at higher concentrations modifies and attenuates the uptake of selenium present as selenate. This study drew upon the recently updated British Columbia guideline (BCMOE 2013), and used site water and varying concentrations of dissolved selenium and sulphate to evaluate uptake of selenium into the aquatic food chain through periphytic algae (*Pseudokirchneriella subcapitata* and *Scenedesmus acutus*) and duckweed (*Lemna minor*), with derived Se-objective values used to predict likely effects of selenium on aquatic biota in local creek waters.

Sediment samples were analyzed for total metals by ALS. Sediment quality data were compared to the Canada Council of Ministers of the Environment (CCME) freshwater *Interim Sediment Quality Guidelines* (ISQG) for the protection of aquatic life. For selenium in sediment, the British Columbia alert concentration was used for screening, given the absence of a published Alberta guideline.

E.5.2.2 Summary of Baseline Results

An assessment of samples collected during baseline studies for QA/QC purposes (*i.e.*, trip and field blanks and duplicates) indicated clean field sampling and laboratory techniques and good analytical precision. Therefore, water quality and sediment quality data generated for these baseline programs are considered to be of acceptable quality to address the objectives of this study.

Surface waters in the LSA (CR #5, Section 3.2.3.1) and RSA (CR #5, Section 3.2.3.2) were generally clear, with low concentrations of suspended solids and organic carbon. All watercourses always were well-oxygenated, and at times observed to be over-saturated. The pH was mostly in alkaline range. Consistently higher total hardness and alkalinity levels indicate all sampled watercourses are "hard" water creeks/river with substantial buffering capacity (indicating low sensitivity to acid depositions).

Concentrations of major ions were dominated by calcium and bicarbonate. Surface waters in the LSA and RSA contained low concentrations of nutrients, with total ammonia, nitrite, and nitrate concentrations being often below the detection limits, and phosphorus concentrations generally indicating oligotrophic (low-productivity) conditions.

Approximately half of the 25 metals measured as both dissolved and total (dissolved + particulate) forms were non-detectable in LSA (CR #5, Section 3.2.3.1) and RSA (CR #5, Section 3.2.3.2) waters. Concentrations of detectable metals were generally within Alberta water quality guidelines, with the exception of total mercury, total selenium, and dissolved aluminum, which occasionally exceeded water quality guidelines for the protection of aquatic life. Total mercury exceeded the guideline in 20% of the samples at Blairmore Creek and 25% of the samples at Gold Creek during summer. Total selenium and dissolved aluminum exceeded the guidelines only at Gold Creek. Total selenium exceeded the proposed site-specific objective in 25% of the samples during summer, and 20% of the samples during winter. Dissolved aluminum exceeded the guideline in 11% of the samples during summer and 20% of the samples during winter. No guideline exceedances for metals were noted in the Crowsnest River in the baseline data. However, historical data collected in the Crowsnest River indicate that concentrations of total copper, total chromium, total cobalt, total lead, total silver, total mercury, and total zinc were higher than the water quality guidelines in at least one season. Concentrations of organic compounds were usually below detection limits in all watercourses and all seasons. Pit-lake water quality was generally similar to that of creeks and fell within Alberta water quality guidelines.

Metals measured in baseline sediments with concentrations above CCME ISQGs included arsenic (100% of samples at Blairmore Creek and 50% of samples at Gold Creek), cadmium (50% of samples at both creeks), and zinc (25% of samples at both creeks). The concentration of selenium in sediments was below the British Columbia alert concentration of 2 mg/kg in all LSA samples except one sample collected from Gold Creek.

E.5.3 Potential Impacts

Community surveys of Treaty 7 First Nations identified water quality as an important concern about the Project, particularly the potential for springs and streams near Grassy Mountain to be affected by mine runoff and cause deaths of animals. Community members recommended an emergency preparedness plan in the event of leaks, spills, and other disasters, and effective mitigation plans for the protection of animals and watercourses at the site, developed in consultation with First Nations.

The Project has the potential to affect surface water quality *via* a multiple impact pathways related to activities during mine construction, operation, and reclamation phases. Specific activities that may influence the surface water quality include:

- **Construction:** development of the mining (haul roads), soil stripping and vegetation clearing, development of water management drainage ditches, sedimentation ponds, and surge ponds, construction of the rail loop alignment (and associated crossing of Blairmore Creek);
- **Operations:** pit dewatering, surface water runoff, leaching (*via* groundwater seepage) of overburden rock, accidental leaks and spills, domestic wastewater, and use of explosives; and
- **Reclamation:** abandonment of open pit workings, surface and rock disposal area recontouring, and abandonment of roads and water management systems.

Additionally, there is potential for acidifying effects of air emissions released from the Project and other regional developments.

Each of these activities has the potential to influence the natural drainage, infiltration, runoff, and soil erosion of the existing pre-disturbed Project area, which could influence surface water quality. Therefore, water management is a key design feature for all phases of the Project. The main objective of the water management plan is to control surface water runoff (to minimize loading of total suspended solids into nearby watercourses) and to ensure other constituents of water quality (*e.g.*, selenium and other metals) are treated before release to natural watercourses.

E.5.3.1 Surface Water Quality Issues

From planned Project activities and the mine plan, the following potential water quality issues were identified:

- release of process-related water to the natural watercourses;
- use of nitrogen-based explosives;
- accidental leaks and spills of hydrocarbons, chemicals and waste products used and stored within the Project footprint;
- generation of domestic wastewater from camp operations; and
- acidifying/air emission effects.

These water quality issues were assessed for two scenarios: (1) the Application Case, including construction, operation, decommissioning, and reclamation of the Project along with existing and approved developments; and (2) the Planned Development Case (PDC), which includes the Application Case plus the cumulative effects associated with other planned development projects in the region.

E.5.3.2 Assessment Approach

Potential effects of the Project on surface water quality were evaluated both qualitatively and quantitatively. Qualitative analyses were based on other EIA components, monitoring programs, scientific literature, and professional judgment. Results from other EIA components were evaluated with regard to their potential to cause changes in surface water quality. Quantitative analyses were based on the results of mechanistic water quality modelling. Results of effects analyses were used to classify residual impacts.

The assessment is organized as follows:

- assessment of the validity of causal relationships linking Project activities to possible changes in surface water quality;
- description of mitigation measures to be implemented to prevent or avoid potentially negative environmental consequences of Project activities;
- an analysis of residual effects after the application of mitigation measures; and
- a classification of residual effects using a range of environmental impact assessment criteria.

Conservative assumptions were used throughout the impact assessment to ensure that residual effects were not underestimated.

Environmental significance was used to identify predicted impacts that have sufficient magnitude, duration, and geographic extent to cause fundamental changes to surface water quality. Significance is determined by the risk to desired water quality. The following two criteria are followed to evaluate the residual effects:

Not significant - impacts are measurable but are not likely to deteriorate water quality to an extent expected to have a significant adverse effect on aquatic life. For example, effects are predicted to be within the range of natural variability and below the water quality guidelines or threshold levels; and

Significant - impacts are measurable and likely to deteriorate water quality that eventually has an irreversible effect on aquatic life. For example, effects are predicted to be beyond the water quality guidelines or threshold levels.

E.5.3.3 Summary of Assessment Results

The following potential water quality issues due to project activities were evaluated (CR #5 Section 4):

- release of process-related water that does not meet surface water guidelines to the natural watercourses;

- use of nitrogen-based explosives;
- accidental leaks and spills of hydrocarbons, chemicals and waste products used and stored within the Project footprint;
- generation of domestic wastewater from camp operations; and
- acidifying/air emission effects.

Water quality effects for these issues were assessed for the Project after implementation of mitigation measures, and are summarized in Table E.5.6-1 and described in CR #5 Section 4 and in Section E.5.6. In summary, based on the anticipated management of runoff and the controlled release rates from sedimentation ponds during construction (see mitigation in the later section), no significant Project effects on water quality are anticipated from sediment-associated chemical inputs.

During operations, all generated mine water with elevated selenium, nitrogen species, and other constituents will be diverted in surge ponds from where water will be passed through the sequential saturated zones with sufficient water residence time to reduce selenium and nutrient concentrations (Section C.5, C.8). Selenium and nitrate/nitrite will be removed through microbial activities that will be enhanced by labile carbon sources. If required, the outflow from the saturation zones will be directed to a water treatment plant to reduce other elevated metal concentrations. The proposed treatment method is aeration, followed by high-density sludge (HDS) lime treatment combined with sulphide precipitation of metal.

To assess the effectiveness of these mitigation measures, a water balance (stochastic model) and load balance (mechanistic model) were developed using GoldSim and applied to predict the effects of process-related water release into receiving waters for Blairmore Creek and Gold Creek (Appendix 10B). Altogether, 39 water quality variables were modelled, including metals, major nutrients, and major ions for typical best-estimate scenario based on hydrology model outputs and median concentrations of source terms, considered to be most likely outcomes. Models were run at a daily timescale with results reported as monthly averages and summarized as annual ranges throughout the Project's life cycle from construction to post-closure. Five prediction nodes were selected on each of Blairmore and Gold creeks to resolve water quality and stream flows for multiple reaches along each creek, and provide a special gradient of any project related effects. Predicted results were summarized by season for all phases of mine cycle and compared with relevant water quality guidelines for the protection of aquatic life.

In addition to a best-estimate scenario using conservative but realistic model source terms, the LSA model was also run using worst-case geochemistry source terms. These worst-case predictions are not considered to be likely or realistic, but were used as a sensitivity analysis to assess what additional mitigation could be required to address water quality issues in such a case.

Water quality modelling results indicate that in Gold Creek, the predicted concentrations of all 21 water quality variables with published Alberta guidelines for protection of aquatic life would be below these guidelines throughout construction, operation, closure, and post-closure periods of the Grassy Mountain Mine (or, for selenium, below the proposed site-specific objective).

In Blairmore Creek, predicted concentrations of all variables were within these guidelines or the proposed selenium objective except sulphate. Sulphate concentrations in Blairmore Creek are predicted to increase steadily over mine life to above the maximum published Alberta guideline of 429 mg/L (at 181 to 250 mg/L hardness) at all modelled locations downstream of the West Sedimentation Pond release (*i.e.*, from BC-07 downstream). Sulphate is predicted to remain below the Alberta guideline during mine life until the mid-to-late 2030s, when it is predicted to exceed this guideline in all seasons until mine closure, after which time, concentrations are predicted to decline to a stable, long-term average, which would still remain consistently above this guideline at all modelled locations downstream of the West Sedimentation Pond water release.

Results of the LSA water quality model were extended into the RSA using a simple volumetric-dilution (mass-balance) model that predicted water quality concentrations in the Crowsnest River downstream of each creek after complete mixing, using outputs of the LSA model, baseline chemistry information for the Crowsnest River, and historical (1964 to 2013) monthly flow data obtained from the Water Survey of Canada. Concentrations of selenium and sulphate in the Crowsnest River were specifically modelled, given Project concerns regarding selenium and predicted exceedance of the Alberta sulphate guideline in Blairmore Creek late in mine life. Concentrations were estimated on a monthly basis to capture seasonal variability for the entire cycle of the mine (2017 to 2099). For each month, three predictions were made of downstream sulphate variable concentration to capture approximate conditions in low-flow, high-flow, and typical conditions.

Results of volumetric dilution modelling predicted that sulphate and selenium concentrations will remain below published Alberta guidelines in the RSA throughout mine construction, operation, closure and post-closure.

To minimize nitrogen enrichment of LSA surface waters from blasting residues, packaged explosives will be kept on-site; all runoff from the ammonium nitrate storage areas, mine pits, and mine rock piles will be contained within the water management system. All process water with elevated nitrogen species will be treated in surge ponds and saturated zones by microbial uptake of nitrogen enhanced by the addition of labile carbon source. Site facilities and associated rail loop alignment will be constructed to comply with regulatory guidelines and best management practices, to minimize the potential for leaks and spills. Pipelines and storage areas will be inspected and maintained regularly.

Emergency spill procedures will be in place for rapid spill containment and clean-up; therefore, potential effects on water quality from leaks and spills will be minimized.

Facility sewage will be collected and treated in a sewage treatment package plant located on the mine infrastructure area (MIA) pad. Further details are provided in Section C.6.13 and Section E.5.5.1.

Expected acid deposition due to Project air emissions is less than the monitoring level for moderately sensitive ecosystems; therefore, acidification effects are not expected to occur from aerial emissions of the Project.

In conclusion, water quality issues due to Project activities would be addressed by applying appropriate mitigation measures. After mitigation, effects of these water quality issues on receiving environment are assessed as not significant in both LSA and RSA. Sulphate concentrations in Blairmore Creek are predicted to exceed the hardness-dependent sulphate guideline value of 429 mg/L for a maximum hardness level of 250 mg/L, as well as a published no-effect-threshold of 725 mg/L in winter only during late mine life (*i.e.*, mid-to-late 2030s). Therefore, development of a site-specific sulphate objective based on site water hardness is recommended, and an adaptive-management approach to monitoring and assessment of any potential effects of sulphate in Blairmore Creek waters late in mine life should be adopted. Water quality model outputs should be considered as represent information for decision-making rather than representing absolute predictions of receiving water quality; monitoring vigilance is recommended to track and identify any trends in water quality and further refine model predictions.

E.5.4 Cumulative Effects Assessment

Because no significant effects on surface water quality in the LSA and RSA are predicted for the Application Case, none of the effects of the Project on the same water quality variables will have the potential to overlap with potential effects from other planned developments. Therefore, the results of the PDC analysis are identical to those from the Application Case.

E.5.5 Mitigation and Monitoring Recommendations

E.5.5.1 Mitigation

The water management strategy (Section C.5) aims to minimize water diverted from streams, maximize the separation of clean and contact water, and pump water with high selenium and nitrate concentrations to saturated zones for attenuation. Water collected in the pits during mining will be pumped to ponds for treatment and discharge. Nine ponds are included in the water management system. They are classified as either surge ponds or sedimentation ponds. Sedimentation ponds collect all other runoff and water pumped out of the pits for treatment and release. Surge ponds

collect and hold water that is deemed contact water, may contain selenium, and will require further treatment *via* pumping through the saturated backfill zone.

The Project will implement a range of mitigation measures to effectively prevent Project effects of suspended sediments and associated water quality constituents (*e.g.*, selenium, acidic conditions, and metals) or reduce them to acceptable levels. A full description of the mitigation is summarized below.

Managing Suspended Sediments

A series of collection ditches, sumps, pumps and sedimentation ponds will be established to manage all surface water on the mine site. A total of six sedimentation ponds are proposed to remove total suspended solids and associated constituents in the water before releasing to the environment. Surface water runoff from mining areas, haul roads, overburden disposal areas and any other disturbed areas, as well as groundwater captured in the pit will be directed to sedimentation ponds for treatment. Once suspended solids are settled, supernatant water will be released to Blairmore Creek and Gold Creek.

Slope grading and stabilization techniques will be adopted (Section F.3.6). Slopes will be contoured to produce moderate slope angles to reduce erosion risk. Other stabilization techniques used to control erosion include: ditching above the cutslope to channel surface runoff away from the cutslope, leaving buffer (vegetation) strips between the construction site and a watercourse, and placing large rock rip rap to stabilize slopes.

Progressive reclamation to reduce the amount of disturbed area at any given time will be applied (Section F.3). During reclamation, permanent plant cover will be established. Soil erosion will be reduced by minimizing the time that reclaimed surfaces are left bare.

Whenever possible, construction activities in close proximity to watercourses will be carried out during periods of lowest potential impact, typically during the winter months. Benga will maintain a 100 m undisturbed buffer zone between development activities and Blairmore Creek and Gold Creek.

The design and construction of rail loop and associated stream crossings will be done in compliance with the *Alberta Code of Practice for Watercourse Crossings* and associated guidelines. This means that all stream crossings constructed by the Project will meet regulatory requirements for protection of fish resources and aquatic habitat, which also will effectively mitigate against effects on surface water quality.

Managing Capture of Contact Water

To meet the site-specific selenium objective, it will be necessary to capture and pump the waste rock seepage to surge ponds and then to saturated zones where selenium can be attenuated. The LSA water quality model assumed that the efficiency of the contact water capture system will be 95%.

Attenuation of Selenium and Inorganic Nitrogen in Saturated Rock Zones

Specific mitigation measures will be implemented to attenuate and reduce selenium and inorganic nitrogen concentrations in process water before its release to the receiving environment in lower Blairmore Creek (Section C.8.3). Surge ponds will receive all potentially mine-affected water draining from external rock-disposal areas. From there, water will be directed to the various anaerobic saturated zones for treatment. The backfilled open pit will be sequenced to provide three anaerobic, saturated fill zones. Three saturated rock zones will be developed during the mine life (SZ1, SZ2, and SZ3). SZ1 will be engineered and constructed to function as a semi-passive bioreactor for selenium attenuation. As pit areas are backfilled, the saturated zone area will be increased. Project-affected water will flow from the newest saturated zone to the oldest one. To maximize the residence time of water within the saturated zones, discharge from the saturated zones will be from the first saturated zone established. Given enough retention time, dissolved selenium (*e.g.*, selenite) will reduce to elemental selenium and fall out of solution through microbial action in an anoxic environment. In the LSA water quality model, saturated zones are assumed to attenuate 99% of selenium loading. The LSA water quality model predicts that up to 95% of the influent nitrate and nitrite loading will be removed from water routed through saturated backfill zones. These applied attenuation factors assume that a carbon source will be added if required to enhance anaerobic reduction and meet the post-treatment concentrations predicted by the water quality model.

Water Treatment

Water in the saturation zones is expected to require treatment prior to release to the environment especially due to elevated metal concentrations based on on-site monitoring during operations (Section C.5.3). If required, the outflow from the saturation zones will be directed to a water treatment plant. The proposed treatment method is aeration, followed by high density sludge (HDS) lime treatment combined with sulphide precipitation of metal. Predicted final effluent characteristics are based on general performance data for typical HDS water treatment plants. The treated water will be released to natural environment only after water quality testing to prove compliance of water quality guidelines. The water will be released into Blairmore Creek and Gold Creek, which will eventually flow into the Crowsnest River.

Facility sewage will be collected and treated in a sewage treatment package plant located on the MIA pad (Section C.6.13). The treatment plant will treat all sewage produced at the MIA facilities and has been based on an estimated sewage treatment requirement of 30 m^3/day. Effluent water quality will be in accordance with relevant regulations as well as appropriate standards. The treatment plant effluent produced will be pumped to the plant site sediment pond located adjacent to the CHPP product stockpiles. Excess sludge will be collected for removal from the package treatment plant by vacuum trucks and disposal off site. Sewage and grey water from the CHPP service buildings will be pumped to the water treatment plant for processing and discharge.

Management of Acid-Generating Materials

Static geochemical characterization results have shown acid rock drainage potential that will require management. During operations, neutralizing the acid-generating material by blending with non-acid generating materials or sub-aqueous disposal will be performed (Section C.8.3.2). During mine closure, all acid-generating pit walls will be actively managed by blending with non-acid-generating materials. The LSA water quality model assumes that 80% of loadings generated by acidic rock types will be mitigated.

Management of Leaks and Spills:

The Project will incorporate design features, management practices, and mitigation plans to minimize the potential for spills that may adversely affect surface water quality. Appropriate design features (*e.g.*, berms and containment areas around potential sources), best management practices, and an emergency spill response plan will be followed. Spills of produced water or other potentially hazardous substances will be cleaned up according to emergency response procedures and regulations (Section C.7). Leaks and spills will be cleaned up in a timely manner and reported to AER and AEP as required.

E.5.5.2 Monitoring

Water quality compliance monitoring will be an integral component of the Project operations (Section C.5.7 and C.5.8). Sedimentation/release ponds will be tested before release to the surrounding environment to verify acceptability of release waters for variables to be defined under the approval(s) for the Project. A water quality monitoring program will be implemented in natural watercourses both upstream and downstream of the Project to capture any Project related water quality effects.

Reference locations will be incorporated into the monitoring design, including locations in the mainstems and tributaries of Blairmore and Gold creeks and Crowsnest River upstream of Project

influences, as well as potentially reference locations in other similar, nearby creeks flowing to the Crowsnest River or other similar drainages. Where possible and appropriate, reference water quality sampling locations will be co-located with relevant aquatic ecology monitoring locations and/or fish-habitat offsetting and habitat enhancement locations, which will be determined in advance of mine construction.

Recent EPEA approval conditions for similar coal mines require the runoff and wastewater treatment and control system to be monitored for the following parameters:

- TSS;
- Turbidity (NTU);
- pH;
- floating solids;
- nitrate-nitrogen;
- visible foam;
- acute lethality test using rainbow trout (for any ponds within the system using approved flocculant agents); and
- oil and grease.

Specific monitoring variables may vary depending on the type of pond and approval conditions. The frequency of sampling will vary depending on whether the sedimentation pond is classed as a major or minor pond in the approval. All sedimentation ponds will be equipped to use flocculants to assist with the removal of TSS, and will be classed as major ponds. Flocculants will be field tested for effectiveness and approved by the AER prior to use.

Additional sampling will be conducted of the components of the runoff, wastewater treatment and control system (*e.g.*, sedimentation ponds, surge ponds, saturated backfill zones, groundwater monitoring, Blairmore Creek upstream, Blairmore Creek downstream, Gold Creek upstream, Gold Creek downstream, Crowsnest River upstream, Crowsnest River downstream) on a monthly/quarterly/annual basis for the following variables:

- inorganic variables listed in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, 2003, CCME as amended; and
- flow, nitrate-nitrogen, ammonia, BOD, BTEX, colour, oil and grease, phenols, total phosphorous, sulphate, TDS, temperature, total sulphide, selenium, hardness, TSS.

Compliance monitoring will be reported monthly and all monitoring (including effects monitoring) will be reported in an annual report.

Given the potential for sulphate concentrations in Blairmore Creek to reach levels above a published no-effect-threshold in low-flow winter months late in mine life (*i.e.*, 2030s) before returning to below this threshold on mine closure, monitoring and adaptive management for sulphate should include development of a site-specific water quality for sulphate for Blairmore Creek. Development of this objective during early mine life would allow this process to include toxicity testing of process waters with ionic composition reflective of actual mine operations.

E.5.6 Summary

Table E.5.6-1 summarizes the potential impacts on surface water quality throughout the life of the Project.

Table E.5.6-1 Summary of Surface Water Quality Effects Assessment for the Grassy Mountain Coal Project

Potential Issues	Project Activity	Potential Effects	Proposed Mitigation	Residual Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Significance
Release of process-related water to natural watercourses	Construction, operations and closure	Increased turbidity and associated constituents, acid rock drainage, leaching, elevated concentrations of metals	Collection of surface runoff to sedimentation ponds; creation of anoxic saturated zones and addition of labile C sources to attenuate Selenium and nitrogen, metal treatment, adhere to EPEA approval	Neutral / Negative (sulphate in Blairmore Creek)	Low / Moderate (sulphate)	Local	Short / Residual (sulphate)	Occasional	Short-term	Not significant
Use of nitrogen-based explosives	Blasting during mining operations	Higher concentrations of ammonia, nitrite and nitrate	Anoxic saturated zones, addition of labile C sources to attenuate nitrogen species through microbial uptake	Neutral	Low	Local	Short	Occasional	Short-term	Not significant
Accidental leaks and spills	Construction and operations	Elevated concentrations of hydrocarbons, chemicals and waste products	Appropriate design features (*e.g.*, berms and containment areas around potential sources), best management practices and spill response plan	Neutral	Moderate	Local	Short	Low	Short-term	Not significant

Table E.5.6-1 Summary of Surface Water Quality Effects Assessment for the Grassy Mountain Coal Project

Potential Issues	Project Activity	Potential Effects	Proposed Mitigation	Residual Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Significance
Domestic wastewater	Construction, operations and closure	Elevated concentrations of nutrients resulting in increased primary productivity and oxygen depletion	Use of storage tanks; wastewater treatment to industrial standard; water quality testing	Neutral	Low	Local	Short	Isolated	Short-term	Not significant
Acidifying/ air emission effects	Construction and operations	Increase in acidity	No mitigation anticipated	Neutral	Low	Local	Medium	Continuous	Short-term	Not significant

E.6 FISH & AQUATIC RESOURCES

E.6.1 Introduction and Terms of Reference

A fish and aquatic resources baseline assessment program for the Project was conducted between 2014 and 2015 and has continued into 2016 to collect additional baseline data on fish population status and detailed habitat information for an Instream Flow Needs (IFN) study. This additional information was deemed critical components to understanding the potential impacts of the Project on fish and aquatic resources. Due to seasonal timing requirements for this information, the finalized assessment was not completed at the time of the Project's EIA report and EPEA application submission. In various discussions with the AER and CEAA, it was agreed that once the entire 2016 fish and aquatic resources field program is completed, a final impact assessment will be provided as an addendum to the EIA. This addendum will provide the complete baseline data set and impact assessment for fish and aquatic resources associated with the Project. The current Consultant Report (CR#6) (as well as the future addendum, which will be issued to the AER and CEAA Q1 2017) was prepared by Hatfield Consultants Partnership.

The scope, format and contents of the fish and aquatic resources assessment was guided by:

- the Terms of Reference for the Environmental Impact Assessment Report prepared by the Alberta Energy Regulator (AER, Section 4.5); and
- the Guidelines for the Preparation of an Environmental Impact Statement prepared by the Canadian Environmental Assessment Agency (CEAA, Sections 6.1.5 and 6.3.1).

Section 4.5 of Terms of Reference from AER:

Section in Final Terms of Reference for Project (AER 2015)	
4.5	**Aquatic Ecology**
4.5.1	**Baseline Information**
[A]	Describe and map the fish, fish habitat and aquatic resources (*e.g.*, aquatic and benthic invertebrates) of the lakes, rivers, ephemeral water bodies and other waters. Describe the species composition, distribution, relative abundance, movements and general life history parameters of fish resources. Also identify any species that are: a) Listed as "at Risk, May be at Risk and Sensitive" in the *General Status of Alberta Wild Species* (Alberta Environment and Sustainable Resource Development); b) Listed in Schedule 1 of the federal *Species at Risk Act*; c) Listed as "at risk" by COSEWIC; and d) Traditionally used species.

[B]	Describe and map existing critical or sensitive areas such as spawning, rearing, and over-wintering habitats, seasonal habitat use including migration and spawning routes.
[C]	Describe the current and potential use of the fish resources by Aboriginal, sport or commercial fisheries.
[D]	Describe and quantify the current extent of aquatic habitat fragmentation.

4.5.2 Impact Assessment

[A] Describe the potential impacts to fish and fish habitat, such as stream alterations and changes to substrate conditions on water quality or quantity, while considering:

a) Fish tainting, survival of eggs and fry, chronic or acute health effects, and increased stress on fish populations from release of contaminants, sedimentation, flow alterations, and temperature and habitat changes;
b) Potential impacts on riparian areas that could affect biological resources and productivity;
c) The potential for increased fishing pressures in the region that could arise from the increased workforce and improved access resulting from the Project. Identify the implications on the fish resource and describe any potential mitigation strategies to minimize these impacts, including any plans to restrict employee and visitor access;
d) Changes to benthic invertebrate communities that may affect food quality and availability for fish; and
e) The potential for increased fragmentation of aquatic habitat.

[B] Identify the key aquatic indicators that the proponent used to assess project impacts. Discuss the rationale for their selection.

[C] Discuss the design, construction, and operational factors to be incorporated into the project to minimize impacts on fish and fish habitat and protect aquatic resources. Describe how any water intakes have been designed to avoid entrapment and entrainment of fish and provide information on the species of fish considered.

[D] Identify plans proposed to offset any loss in the productivity of fish habitat. Indicate how environmental protection plans address applicable provincial and federal policies on fish habitat.

[E] Discuss the significance of any impacts on water quality and implications to aquatic resources (*e.g.*, biota, biodiversity, and habitat) and related implications for First Nations' traditional and current use of these resources.

[F] Describe the effects of any surface water withdrawals considered, including cumulative effects on fish and fish habitat.

Terms of Reference from CEAA Guidelines

Section in Final CEAA Terms of Reference for Project (CEAA 2015)
Project Setting and Baseline Conditions
6.1.5 Fish and Fish Habitat
For potential affected surface waters:
▪ a characterisation of fish populations on the basis of species and life stage, including information on the surveys carried out and the source of data available (*e.g.*, location of sampling stations, catch methods, date of catches, species, catch-per-unit effort);
▪ a description of primary and secondary productivity in affected water bodies, including a survey of benthic invertebrate communities with characterisation of seasonal variability;
▪ a list of any fish or invertebrate species at risk that are known to be present;
▪ a description of the habitat by homogeneous section, including the length of the section, width of the channel from the high water mark (bankful width), water depths, type of substrate (sediments), temperature, aquatic and riparian vegetation, and photos;
▪ a description of natural obstacles (*e.g.*, falls, beaver dams) or existing structures (*e.g.*, water crossings) that hinder the free passage of fish; maps, at a suitable scale, indicating the surface area of potential or confirmed fish habitat for spawning, rearing, nursery, feeding, overwintering, migration routes, *etc*. where appropriate, this information should be linked to water depths (bathymetry) to identify the extent of a water body's littoral zone; and
▪ the description and location of suitable habitats for fish species at risk that appear on federal and provincial lists and that are found or are likely to be found in the study area and in particular the westslope cutthroat trout in Gold Creek and Blairmore Creek drainages.

Predicted Effects on Valued Components
Based on the predicted changes to the environment identified in section 6.2, the proponent is to assess the environmental effects of the Project on the followings VCs:
6.3.1 Fish and Fish Habitat
▪ the identification of any potential serious harm to fish, including the calculations of any potential habitat loss (temporary or permanent) in terms of surface areas (*e.g.*, spawning grounds, fry-rearing areas, feeding), and in relation to watershed availability and significance. The assessment will include a consideration of:
○ the geomorphological changes and their effects on hydrodynamic conditions and fish habitats (*e.g.*, modification of substrates, dynamic imbalance, silting of spawning beds);
○ the modifications of hydrological and hydrometric conditions on fish habitat and on the fish species' life cycle activities (*e.g.*, reproduction, fry-rearing, movements);
○ potential impacts on riparian areas that could affect aquatic biological resources and productivity taking into account any anticipated modifications to fish habitat;
○ any potential imbalances in the food web in relation to baseline;
○ effects on primary and secondary productivity of water bodies, including a discussion of sensitive species in benthic invertebrate communities and how mine-related effects may affect fish food sources;
▪ the effects of changes to the aquatic environment on fish and their habitat, including;
○ the anticipated changes in the composition and characteristics of the populations of various fish species, including forage fish;
○ any modifications in migration or local movements (upstream and downstream migration, and lateral movements) following the construction and operation of works;
○ any reduction in fish populations as a result of potential overfishing due to increased access to the project area; and
○ any modifications and use of habitats by federally or provincially listed fish species (*i.e.* westslope cutthroat trout) including anticipated changes in water quantity and influence on the ability of fish to access spawning, nursery, rearing, food supply and migration habitat.
▪ a discussion of how project construction timing correlates to key fisheries windows for fish species, and any potential impacts resulting from overlapping periods;
▪ a discussion of how vibration caused by blasting may affect fish behaviour, such as spawning

or migrations;
▪ changes in concentrations of contaminants of concern in the aquatic ecosystem[1];
▪ changes to fish health resulting from increased contaminants of concern; and
▪ a description, or conceptual model as appropriate, of how changes in water quantity in watercourses will influence the ability of fish to access spawning, nursery, rearing, food supply and migration habitat

E.6.1.1 Valued Component Selection & Assessment Areas

Valued Components (VCs) are considered by the proponent, public, First Nations groups, scientists and other technical specialists, and government agencies involved in the assessment process to have scientific, ecological, economic, social, cultural, archaeological, historical, or other importance. The Aquatic Ecology VCs and assessment boundaries described herein reflect Benga's current understanding of the aquatic environmental issues associated with the Project.

A set of VCs was developed to describe fish and aquatic resources in the defined assessment areas (CR #6, Table 2.1). The selected VCs meet at least one of the following criteria:

- potential for interaction with the Project and sensitivity to effects:
- captured in baseline field programs conducted as part of this assessment;
- recent challenges and experience with similar projects in the region;
- fish species identified as important traditional resources; and
- species designated as having a status of special concern under SARA, COSEWIC, or Alberta Species at Risk.

Based on the criteria above, fish and aquatic resources VCs that were selected include westslope cutthroat trout (WSCT; *Oncorhynchus clarkii lewisi*) and, more broadly, Aquatic Health, which is represented by brook trout (BKTR; *Salvelinus fontinalis*) and lower trophic level organisms (periphyton and benthic macroinvertebrates). WSCT was selected as the primary fish VC based on their provincial and federal status in the fish and aquatic resources local study area (LSA). They are also the only native fish species within the LSA to be potentially affected through potential habitat loss and/or alteration (*i.e.* changes in flow). The aquatic health VC was included to consider potential water quality-related effects throughout the life of the mine and includes multiple fish species and lower trophic organisms. Non-native BKTR are used as a surrogate to evaluate potential water quality-related effects to all fish in the LSA given the conservation sensitivities surrounding WSCT.

[1] The aquatic ecosystem includes those species assemblages that comprise the food chain through which contaminants of concern are known to bioaccumulate. This includes, but is not limited to, the following fish species: Westslope cutthroat trout, rainbow trout, and mountain whitefish.

Evaluation of potential effects on the aquatic health VCs are addressed primarily through the Surface Water Quality Environmental Effects Assessment Consultant Report (CR#5).

E.6.2 Baseline Conditions

Fish, fish habitat, and aquatic resources (*e.g.*, benthic invertebrates and periphyton) baseline information has been compiled from multiple sources. Sources include historical information, data/information collected in the field as part of the Project in summer 2014 to summer 2015, and further data collected through an intense and focused field study program implemented in 2016.

E.6.2.1 Historical Fish and Aquatic Information

Both Blairmore Creek and Gold Creek are mapped Class B watercourses under the *Water Act* Code of Practice, which means they contains habitat important to the continued viability of a species and is considered sensitive to any type of activity. The restricted activity period (RAP) for both Blairmore Creek and Gold Creek is May 1 to August 15 and September 1 to April 15. All tributaries of both Blairmore Creek and Gold Creek are also considered Class B habitat for a distance of 2 km upstream from their confluence with the mainstems and Class C habitat beyond that.

The following summarizes publically available information describing fish and aquatic resources within the LSA (CR#6; Figure 3.1). Pertinent historical information has been generated from the following resources:

- The Fish and Wildlife Management Information System (FWMIS), accessed through an information request to Alberta Environment and Sustainable Resource Development (AESRD) and provided by AESRD in the form of a data report that included information on barriers to fish passage;
- Information contained in the recovery plans prepared for the westslope cutthroat trout (Alberta Westslope Cutthroat Trout Recovery Team 2013, Fisheries and Oceans Canada 2014);
- Published reports from the Alberta Conservation Association and available scientific literature; and
- Information gathered during traditional knowledge and traditional land use surveys with members of the Treaty 7 First Nations conducted as part of Project preparation (Kanai Nation 2015, Piikanii Nation 2015, Tsuut'ina Nation 2015, Siksika Nation 2015, Appendix 7c).

The following table provides a summary of the fish species reported to occur in both watersheds, and their provincial and federal status.

Table E.6.2-1 Fish species reported to occur in the Aquatic Assessment Study Area

Common Name	Scientific Name	Acronym	Provincial Status	Federal Status
Westslope cutthroat trout	*Oncorhynchus clarkii lewisii*	WSCT	Threatened	Threatened
Brook trout	*Salvelinus fontinalis*	BKTR	Exotic/Alien	-
Rainbow trout	*Oncorhynchus mykiss*	RNTR	Threatened	Endangered
Mountain whitefish	*Prosopium williamsoni*	MNWH	Secure	-
Bull trout	*Salvelinus confluentus*	BLTR	Threatened	Threatened

The majority of fish reported in the FWMIS as being captured upstream of the barrier are apparently BKTR. The source of these BKTR has been traced to deliberate stocking and is not a result of the barriers on the Gold Creek mainstem being passable to fish. Cutthroat trout (CTTR) comprise 76% of the fish captured on the Gold Creek mainstem that were BKTR, with the remaining 24% of fish captured being approximately equally distributed between rainbow trout (RNTR) and CTTR x RNTR hybrid.

Publically available fisheries inventory and/or detailed habitat assessment information for either Gold Creek or Blairmore Creek watersheds is relatively limited. Sparse information is available through the Alberta Government Fish and Wildlife Management Information System (FWMIS) (*i.e.*, fish presence/absence, species distribution) and peer reviewed publications or technical reports (*i.e.*, interspecific hybridization, population estimates) for both mainstem and/or associated tributaries. To date, only limited anecdotal information has been found with respect to fish habitat assessments and no information uncovered with respect to seasonal fish movement or reproduction dynamics specific to either watershed.

Westslope Cutthroat Trout , non-native Rainbow Trout (RNTR); WSCT x RNTR hybrids; and non-native brook trout (BKTR) have been reported in Gold Creek. A vast number of fish reported as being captured (upstream of the known migration barrier) were apparently BKTR; however, the location of their capture is unknown. The source of these non-native fish has been traced to deliberate stocking and not a result of barriers on the Gold Creek mainstem being passable to upstream fish movement.

Westslope Cutthroat Trout have been documented in two main tributaries to Gold Creek, both of which drain into Gold Creek from the east: Caudron Creek and Morin Creek. An assessment conducted in 2002 (Blackburn 2011) characterized Morin Creek as containing high fisheries potential with moderate spawning substrate, high value rearing habitat, and moderate overwintering habitat quality. The extent of Morin Creek surveyed is unknown. Caudron Creek was assessed in both 2002 and 2010 and was characterized as being primarily comprised of riffle habitat with sparse pools with

substrate comprised of equal proportions of cobble and gravel, sub-dominated by boulder and fines. The precise extent of Caudron Creek surveyed is unknown. Blackburn (2011) estimated the WSCT population abundance in upper Gold Creek and found that the population ranged between 65 and 271 individuals. The federal Recovery Plan designates portions of Morin and Caudron creeks as critical habitat for WSCT.

Similar to Gold Creek, WSCT, RNTR and BKTR have been recovered in Blairmore Creek. Blackburn (2011) has compiled historical sampling records for Blairmore Creek and completed population estimates of WSCT for both upper and lower Blairmore Creek. The population of upper Blairmore Creek WSCT was estimated to be between 121 and 277 individuals, while lower Blairmore Creek was estimated between 201 and 310. No publically available information could be found regarding previously conducted fish habitat assessments or spawning surveys. Fish inventory sampling specific to the Grassy Mountain Project took place in August 2014 at two locations on Blairmore Creek mainstem. Genetic samples from 170 trout collected from five sites in Blairmore Creek identified 132 of those fish as pure (100%) WSCT ranging in fork length from 62 mm to 250 mm. The remaining fish were identified as backcross hybrids. No new hybridization events (production of F1 hybrids) between pure strain WSCT and RNTR were evident based on the data.

A recent study that focused on spatial and temporal variation of benthic macroinvertebrate communities in Blairmore Creek, Gold Creek, and Daisy Creek was recently obtained (Ree, 2014). The study's objective was to describe and determine factors affecting benthic invertebrate communities in three Rocky Mountain watercourses that inhabit pure strain WSCT.

E.6.2.1.1 Westslope Cutthroat Trout Species at Risk Designation

Westslope Cutthroat Trout are the only subspecies of CTTR that are native to Alberta. Currently, genetically pure WSCT occur in isolated populations and inhabit only a small portion of the original WSCT distribution. As a result of their limited distribution, decline in extent of occurrence, the fragmented populations, decline in habitat quality, and barriers to dispersal, the Minister of Sustainable Resource Development supported the listing of WSCT as Threatened under Alberta's *Wildlife Act* in 2009.

E.6.2.1.2 Critical Habitat

Blairmore Creek and Gold Creek watersheds contain watercourses that DFO and the Alberta Westslope Cutthroat Trout Recovery Team have designated as critical habitat for WSCT. In November 2015, DFO issued a formal habitat protection order under SARA for the designated areas identified to occur in the Gold Creek watershed.

In addition to (and prior to) the habitat protection order, the Governments of Alberta (Alberta Westslope Cutthroat Trout Recovery Team 2013) and Canada (Fisheries and Oceans Canada 2014) have developed a recovery plan and strategy for WSCT (these two documents will be collectively referred to as "the Recovery Plan" in this report). The recovery plan was developed with the primary objective of: "To protect and maintain the existing ≥0.99% pure populations at self-sustining levels and re-establish additional pure populations to self-sustaining levels, within the species historical range in Alberta." (The Alberta Westslope Cutthroat Trout Recovery Team 2013).

The Recovery Plan identifies parts of four watercourses in the LSA, totaling approximately 16.5 km of watercourse, as critical habitat, each containing a population "that has no evidence of recent or contemporary introgression as determined by genetic testing (*i.e.*, >0.99 pure on average)". Three of these are in the Gold Creek watershed, including almost 14 km of the Gold Creek mainstem, while one is located on a tributary to Blairmore Creek (CR#6; Figure 3.2 and Table 3.3). Fish recovered in these designated critical habitats were determined to be 99% genetically-pure (Alberta Westslope Trout Recovery Team 2013, Fisheries and Oceans Canada 2014). Areas identified as critical habitat in these two watersheds are upstream of barriers that prevent immigration of other fish species and populations. In addition, the Recovery Plan identifies parts of two watercourses, totaling approximately 10 km in length, in the Blairmore Creek watershed as containing near-pure WSCT (CR#6; Figure 3.2 and Table 3.3).

Watercourses within the Projects Aquatic Ecology RSA designated as critical habitat (greater than 99% genetically pure) and near-pure (95% to 99% genetically pure) WSCT is summarized in CR#6, Table 3.4.

E.6.2.2 Summary of 2014 and 2015 Fish and Aquatic Resource Baseline Data

A set of field programs were completed from August 2014 to August 2015 in support of the Application. Figure 3.3 in CR#6 provides a visual summary of information and the locations of field programs conducted and Table 3.5 (in CR#6) provides an overview of the field programs that were completed. Appendix A1 (CR#6) contains a description of field methods used in these field programs.

Fish and fish habitat information for portions of the Gold Creek watershed was obtained from watercourse habitat assessments in June 2015 and in reconnaissance surveys conducted in August 2015. Surveys were conducted from the downstream delineation of critical habitat for WSCT to the upper reaches of Gold Creek, upstream of the Project footprint. For a summary of habitat information compiled during these field assessments, please refer to CR#6; Section 3.2.1.1. Of note, no fish inventory surveys were completed in 2014 or 2015. Some notable aquatic habitat features for Gold Creek include:

- Aquatic substrates of Gold Creek appear to be dominated by cobble associated with gravel patches or boulder.
- Groundwater inputs were documented along both the east and west slopes of Gold Creek that appear to contribute to the mainstem at various locations.
- There are a series of barriers to fish migration in lower Gold Creek approximately 1 km above the confluence of Gold Creek with the Crowsnest River consisting of an old water supply dam, three significant waterfalls, and a smaller dam. The most significant of these is the old water supply dam that is impassable to fish and marks the downstream extent of critical habitat on the Gold Creek mainstem for westslope cutthroat trout designated in the Recovery Plan.
- Additional waterfalls and chutes occur throughout most of the Gold Creek mainstem above the significant barriers described above. These do not appear to be barriers to migration of fish along Gold Creek.
- A number of reaches within Gold Creek display evidence of anthropogenic disturbance. In addition to known legacy mine outputs (*e.g.*, coal and sediments depositing to Gold Creek), rangeland activities (*e.g.*, grazing pastures, cattle crossings), recreational land use (*e.g.*, ATV vehicle ford crossings, bridges, and fence crossings), and private land use occur at various points along the Gold Creek mainstem (CR#6; Figure 3.4)

Aquatic habitat information obtained from FWMIS for three major tributaries draining into Gold Creek from the east (CR #6, Figure 3.3) are summarized below:

- Green Creek (aquatic habitat assessment conducted in 2002): Fisheries potential assessed as low due to migration barriers and high elevation gradients;
- Morin Creek (aquatic habitat assessment conducted in 2002): Numerous low water barriers and high fisheries potential with moderate spawning substrate, high rearing habitat and moderate overwintering habitat rankings;
- Caudron Creek (aquatic habitat assessment conducted in 2002): substrate in assessed areas were determined to be equal proportions of cobble and gravel, with smaller amounts of boulder and an even smaller proportion of fines; and
- Caudron Creek (aquatic habitat assessment conducted in 2010): morphology in assessed areas was determined to be primarily riffle with a small amount of pool.

The Recovery Plan designates portions of Morin and Caudron creeks as critical habitat for westslope cutthroat trout. Fish inventories have been conducted in Green, Morin, and Caudron creeks and cutthroat trout have been recovered in Morin and Caudron creeks.

Fish and fish habitat information for Blairmore Creek was obtained from habitat and fish inventory assessments conducted in August 2014, June 2015 and August 2015. For a summary of results from these field programs please refer to CR#6, Section 3.2.1.2. Some notable aquatic habitat features for Blairmore Creek include:

- Comprised primarily of riffles and runs with a predominantly cobble substrate. The creek flows over bedrock in certain areas creating plunge pools.
- Evidence of groundwater seeps along Blairmore Creek that contribute to mainstem surface flows at various locations.
- There are a set of waterfalls on the Blairmore Creek mainstem immediately upstream of tributary BCT03. Given the presence of hybrid fish recovered upstream from the falls, they are considered to be a barrier at low flow only in part due to the deep plunge pool that would allow fish at high flow to overcome the obstacle.
- Additional waterfalls and chutes occur throughout on the Blairmore Creek mainstem above the barrier described above. The status of the barriers will be re-confirmed in 2016.
- Blairmore Creek is frequently confined by steep valley walls, which have some anthropogenic disturbances in the middle portion of the drainage. Oil and gas and forestry activities occur in some of the upstream tributaries (above BCT10), but disturbance along the portion of the creek adjacent to the Project (from BCT10 to BCT01) is limited to a few ATV crossings.

Aquatic habitat information for a number of tributaries to Blairmore Creek that will not be directly affected by the Project was obtained from habitat assessments conducted in June 2015 (CR #6, Figure 3.3). Aquatic habitat in these tributaries is similar to the aquatic habitat in the Project-affected tributaries of Blairmore Creek; this is supported by the aquatic habitat information in the FWMIS that indicates these tributaries are suitable habitat for trout species. The Recovery Plan designates a portion of BCT04 as critical habitat for westslope cutthroat trout (CR #6, Figure 3.3).

Benthic invertebrate communities were sampled at three locations in the Blairmore Creek watershed and at one location in the Gold Creek watershed, on the Gold Creek mainstem, in the fall season (October) of 2014 (Figure 3.3, Appendix A1 provides a description of the field methods used for sampling benthic invertebrate communities). Metrics presenting benthic invertebrate community abundance and composition in the LSA are summarized in CR#6 including Table 3.7 and Figure 3.5 with the complete dataset obtained from these four locations presented in Appendix A2.

Total mean abundance/density ranged from 5,032 individuals/m^2 to 7,613 individuals/m^2 with the highest abundance measured at the downstream location on Blairmore Creek (BC-W01), and the lowest abundance at the location on the unnamed tributary to Blairmore Creek (UNC-W01). Benthic invertebrate communities at the Gold Creek location had an abundance of 7,052 individuals/m^2. The

standard deviations of the means ranged from 1,479 individuals/m^2 to 4,367 individuals/m^2 indicating high variability among the sample replicates collected from the same location.

Benthic invertebrate samples were also collected from two locations on the Crowsnest River, downstream (CRR-W01) and upstream Crowsnest River (CRR-W02) (relative to the Blairmore Creek/Crowsnest River confluence). Metrics presenting benthic invertebrates community abundance and composition are summarized in Table 3.8 and Figure 3.6 and the complete dataset obtained from these two locations is presented in CR#6 Appendix A2. Total mean abundance/density was almost double at the Crowsnest River downstream location (15,265 individuals/m^2) than at the upstream location (7,841 individuals/m^2). Similar to results from the LSA, high standard deviations in abundance at both locations indicate high within-location variability.

Macroinvertebrates and their habitats are important food sources for fish, because many fish species, in particular all stream-rearing salmonids, depend on drift of invertebrates from upstream areas. As part of the ongoing aquatic resources sampling, abundance and distribution of macroinvertebrates in the drift of Blairmore Creek and Gold Creek will be characterized through the use of drift samplers, which are vertically fixed nets that collect invertebrates suspended in the water column.

Periphyton was also sampled in the LSA at the same locations as the benthic invertebrate communities sample stations (Figure 3.7, Appendix A1 provides a description of the field methods used for sampling periphyton). Refer to CR#6 Sections 3.2.2.1 and 3.2.2.2 for a summary of results

Once all seasonal benthic macroinvertebrate and periphyton data has been collected and the baseline data set characterized, the data will be used as part of the final Aquatic Ecology Effects Assessment to be issued in Q1 2017.

E.6.2.3 2016 Fish and Aquatic Resources Field Program

For the 2016 fisheries and aquatic program, a number of technical studies aimed to further characterize fisheries and aquatic baseline conditions were identified to further support the assessment of potential effects as a result of the Project. These include:

Fisheries Resources

- Fish Habitat (to characterize the quality, distribution, quantity and limiting habitat in key watercourses potentially affected by the Project);
- Fish Biology (to determine/confirm fish presence, population/community composition, distribution and habitat use, population abundance/estimates, baseline fish health); and

- Instream Flow Needs (in support of conducting an instream flow study to characterize potential positive and/or adverse effects of Project-related flow change and quantify potential alterations of flow change on critical fish/aquatic habitat).

Aquatics Resources (Water Quality Focus)

- Surface Water Quality;
- Aquatic Sediments; and
- Tissue Residues (fish and lower trophic levels).

For a description of each of the technical study components listed above, please refer to CR#6 Sections 3.3.1 and 3.3.2.

E.6.2.3.1 Fisheries Resources

Additional fish habitat data has been collected in May 2016, using a modified version of British Columbia's Fish Habitat Assessment Procedures, specifically aimed at spatially characterizing important and limiting fish habitat and appropriate for assessing water withdrawal/alteration projects. Pertinent details of the methodologies are provided in CR#6, Section 3.3). The data will be organized into different spatial scales to facilitate analysis. Three scales of analysis are identified: macrohabitat (reach scale), mesohabitat (hydraulic unit scale), and microhabitat (site-specific scale).

The detailed fish habitat information will be compiled so that an assessment of existing conditions can be performed in addition to an assessment of the extent to which potential water alterations will affect fish habitat (*i.e.*, and Instream Flow Needs Study). Once all seasonal fish habitat data has been collected, it will be mapped and will form a key component of the aquatic baseline data set as well as the assessment of potential effects, which will be provide in the final AEA.

Since March 2016, the Fish Biology program has consisted of passive fish surveys (*i.e.*, snorkel surveys), which were utilized in both Gold and Blairmore creeks to gather fish information with respect to overwintering fish presence/absence, habitat use, abundance and distribution as well as spawn timing, spawning habitat preference, and distribution.

The 2016 Fish Biology Program will specifically target the following active sampling fish baseline studies:

- WSCT sub-adult and adult population assessment;
- WSCT recruitment and juvenile population assessment;
- WSCT tributary use and distribution survey; and

- Tissue Residue/Fish health.

For a description of the approach and rationale for each of these baseline studies, please refer to CR#6, Section 3.3.1.2.

The collected fish data will be generated using a suite of widely accepted standard collection methods over multiple seasons to facilitate key analyses. They currently include direct visual observation by way of snorkeling (overwintering & spawner surveys). Once all 2016 seasonal fish population data has been collected, a final analysis to characterize the fish composition, distribution, relative abundance, and general life history information of fish resources within Blairmore Creek and Gold Creek will be provided in the final Aquatic Ecology Effects Assessment report, which will be provided in Q1 2017.

The primary objectives of the IFN study are to characterize potential effects of flow change, and quantify potential effects of flow change on fish/aquatic habitat and how it relates to "Serious Harm" in the context of fisheries productivity. The study has been designed to provide a quantitative analysis of anticipated effects by predicting hydraulic conditions important for fish (*i.e.*, stream depth, width, and water velocity) during different phases of the Project and by comparing the subsequent changes in habitat quality to baseline conditions. The IFN study is multidisciplinary in nature; it will incorporate data from the fish biology and fish habitat programs (described above) as well as other baseline field programs related to hydrology, water quality, fluvial geomorphology, lower trophic organisms, and riparian/stream ecology.

The IFN study is multidisciplinary in nature; it will incorporate data from the fish biology and fish habitat programs (described above) as well as other baseline field programs related to hydrology, water quality, fluvial geomorphology, lower trophic organisms, and riparian/stream ecology.

A combination of the British Columbia Instream Flow Methodology with habitat simulation modeling (*e.g.*, PHABSIM, RHABSIM, SEFA or alternative) will be used for the assessment. These methods are similar to, and supported by, the habitat component of the Instream Flow Incremental Methodology (IFIM). Both methods assume that habitat for fish (and other aquatic species) changes as a function of flow and that predictive models can be developed to describe this relationship for a given stream. The BCIFM is a stratified-random approach to fish habitat measurement. The selection of transect sites is critical; transects will be established with primary focus on WSCT critical habitat (*i.e.*, spawning, incubation, rearing, overwintering *etc.*) and associated life stage(s). The key steps involved will include the following:

- Quantify the habitat unit composition of each Macrohabitat reach by delineating the reach into pool (slow), riffle (fast, turbulent), and glide/run (fast, non-turbulent) mesohabitats, expressed in linear distance (m) of channel occupied by the mesohabitat within the reach.
- Identify an adequate number of transect sites per reach. The number required will depend on heterogeneity of habitats within the reach. A minimum of five transects will be established per mesohabitat unit type. The number and location of transects sites will be guided by professional judgement.
- For each transect, microhabitat characteristics (depth, velocity, substrate, and cover) will be measured at a minimum of three flow levels spanning the (ideal) range of 5% to 40% naturalized mean annual discharge (NMAD); however, a greater number of flow levels may be collected in each system.

Additional physical and biological data are typically required to execute a defensible IFN. These include:

- Hydrology;
- Hydrogeology;
- Fluvial geomorphology;
- Surface water temperature; and
- Drift benthic invertebrates.

Baseline data specific to these technical areas will be collected in support of executing the IFN. Of note, water chemistry data collected for the project will be considered as part of the IFN studies.

Full details of the IFN Methodology and final assessment approach for the AEA (to be submitted in Q1 2017) are provided in CR#6, Section 3.3.1.3.

E.6.2.3.2 Aquatic Resources

Water quality sampling in 2016 will target sites established in previous 2014 and 2015 field seasons to further enhance the current baseline. The short-term target was winter (March) 2016 to enhance the winter surface water quality baseline dataset. The same field protocols and QA/QC applied during the preceding field seasons were used to ensure consistency and minimize sampling bias. An additional target was to establish an appropriate reference site. Caudron Creek was selected as a reference surface water quality site given its water quantity importance to Gold Creek as well as being uninfluenced by the proposed mine given its location (east side of Gold Creek) in the LSA.

The objective of the sediment sampling program is to characterize baseline sediment chemistry at key locations in the vicinity of the proposed mine site, with emphasis in those areas targeted for mine effluent discharge or run-off water over the course of the mine life.

Sampling locations for aquatic sediments will be coordinated with existing established locations for water quality, tissue residue, benthic invertebrates, and fish habitat to provide opportunity to examine relationships between these components of the aquatic environment; however, fine bottom sediments may not be widespread, particularly in steeper-gradient areas. While integration of these components is preferred, sampling locations for sediments will be located where fine sediments are identified. For a list of variables that will be analyzed, please refer to CR#6 Section 3.3.2.2.

Similar to sediments, tissues can absorb metal or organic contaminants discharged by operational or post-closure mines. Contaminants may be taken up directly from the water column *via* facilitated diffusion (*e.g.*, inorganic metals) or, in the case of organic selenium and methyl-mercury, may be taken up *via* dietary sources, stored in fat and proteins, and biomagnified up the food chain.

Regardless of the mode of uptake, the quantification of tissue contaminant levels is a necessary part of any baseline program, providing reference for future contaminant accumulation in aquatic organisms. Significant change from baseline concentrations may trigger additional impact assessment and/or the implementation of contingency mitigation measures that should have been developed as part of the mine review process.

Given the sensitivities around WSCT and the limited fish species diversity in both Blairmore and Gold creeks, we are proposing to utilize non-native BKTR in lower Blairmore Creek as the sentinel fish species.

Tissue specimens will be collected during the summer as part of the fish biology sampling program. Periphyton samples will be collected from select locations in both Blairmore Creek and Gold Creek following the methodology described in CR#6. Sampling of periphyton will be collected in June 2016 at select established locations in both Blairmore Creek and Gold Creek mainstems. Benthic invertebrate samples collected from previous field programs and/or those collected during the proposed 2016 drift sampling program (part of the instream flow study) will be included for tissue analysis.

Fish tissue samples will be targeted at locations downstream from the mine's proposed effluent discharge location. Given BKTR have not, historically, been documented and RNTR appear to be sparse in upper Blairmore Creek, another watercourse with known BKTR in the vicinity of the LSA, but uninfluenced by the Project (*i.e.*, lower Gold Creek or an alternative), will be targeted.

Additionally, every effort will be made to associate sampling effort in the vicinity of aquatic sediment and surface water quality stations, where feasible.

E.6.3 Potential Impacts

The primary impacts of mine development on fish resources are almost always mediated through effects to their habitat. These effects include alteration to sediment deposition and scour processes in streams, stream crossings (roads, pipelines, and powerlines), stream diversions, changes to stream flows, effluent discharge, and complete habitat loss under the project footprint. In particular, the effects of waste rock storage areas, and project footprint components (CR#6, Table 1.2) typically require more robust assessment, as they are likely to pose the most significant risks to fish and fish habitat. Fish populations respond to perturbations in numerous ways, including increased stress, disease, mortality and decreased growth, inability to reproduce, survival, recruitment, and production. The assessment of potential aquatic effects for this project is driven by the bullets listed in the AER and CEAA Terms of References summarized in CR#6, Table 1.1 and Table 1.2.

The core components of the aquatic effects assessment will focus on the potential direct habitat losses to select watercourses as a result of the project footprint, alterations to stream flow in select tributaries and mainstem watercourses, effluent discharge (*i.e.*, potential changes in water quality) and how these project activities interact with the select VCs. At this time, a complete impact assessment cannot be completed for these core components as all the required data that comprises the 2016 field program has not yet been collected. Once this data is collected, fully analyzed (*via* laboratory analysis, project footprint verification, and IFN model simulations), a final impact assessment and significance evaluation will be provided in the Aquatic Resources Effects Assessment report (to be issued in Q1 2017).

The following subsections provides an overview of the potential effects that could be associated with each phase of the Project and a summary of how each potential effect will be assessed.

E.6.3.1 Overview of Potential Design Impacts of the Project

The Project mine plan has been developed to minimize or prevent direct physical impacts to available, suitable fish habitat in both Blairmore Creek and Gold Creek mainstems. Based on the proximity of the Project footprint there is the potential for the direct removal of portions of specific upper headwater tributaries of both Blairmore Creek and Gold Creek. The activities associated with the construction, operations, and reclamation phases that may have the potential to affect aquatic resources are summarized in CR#6, Table 4.1.

E.6.3.1.1 Overview Mine Plan Design Mitigations

Water management is a key aspect of the Project from the initial site disturbance through to final reclamation; consequently, water management planning for the protection of the aquatic environment has been a main consideration and priority throughout the development of the mine plan. The following outlines the key components that will be implemented in the mine plan to protect the aquatic environment and mitigate for any potential Project effects to fish and aquatic resources. Full details of the following components are provided in full in Section C.5.3 of the application.

E.6.3.1.2 Overview Mine Plan Design Mitigations

Water management is a key aspect of the Project from the initial site disturbance through to final reclamation; consequently, water management planning for the protection of the aquatic environment has been a main consideration and priority throughout the development of the mine plan. The following outlines the key components that will be implemented in the mine plan to protect the aquatic environment and mitigate for any potential Project effects to fish and aquatic resources. Full details of the following components are provided in full in Section C.5.3 of the application and are summarized briefly in CR#6, Section 4.1.1.

E.6.3.1.3 Project Specific Potential Effects on Fish and Aquatic Resources

E.6.3.1.3.1 Potential Changes in Flow

At present, direct design (footprint) effects (*i.e.*, physical mining activities) are expected to occur to the mainsteams of either Blairmore Creek or Gold Creek. However, the current mine plan footprint may directly affect four tributaries to Blairmore Creek (Project nomenclature: BCT02; BCT05; BCT06; and BCT07), and six tributaries to Gold Creek (Project nomenclature: GCT06; GCT08; GCT09; GCT10; GCT11; and GCT14). The significance evaluation of these direct footprint effects will be provided in an addendum to the Aquatic Ecology Effects Assessment in Q1 2017.

To characterize the potential effects of predicted flow alterations on fish and aquatic habitat in the context of "Serious Harm", a project IFN study is currently being conducted. As described in Section 3.3.1.3, the IFN study has been designed to provide a quantitative analysis of anticipated effects by predicting habitat-flow relationships for fish (*i.e.*, stream depth, width, and water velocity) during different phases of the Project and by comparing the subsequent changes in flow to key indicators or effect pathways. Once sufficient data has been collected for the IFN, the assessment will proceed, predicted effects (pre-mitigation) will be generated and summarized, appropriate mitigation will be applied, and final significance evaluation will be provided in an addendum to the Aquatic Ecology Effects Assessment in Q1 2017. Depending on the outcome, the need for habitat offsetting will be discussed in the assessment.

E.6.3.1.3.2 Potential Changes in Water Quality

As the mine progresses through operations there's the potential for changes to sediment and water quality variables that may have chronic or lethal (acute) effects on aquatic biota if they have the potential to enter the aquatic ecosystem. Water quality effects on the Aquatic Health VC has been assessed in the Water Quality assessment (CR#5). Additional information collection on fish (fish tissue residue) and aquatic resources (water quality and sediment quality) forms part of the 2016 sampling program (Section 3.3.2 of this report) and data has been included in CR#5. The fish tissue residue results will be included as supplementary data to CR#5 as part of the Aquatic Ecology Effects Assessment, which will be provided in Q1 2017.

E.6.3.1.3.3 Potential Changes in Angling Pressure

A majority of the Project infrastructure is located on land currently owned by Benga, with the remaining on crownland. The main access road connecting the CHPP area with Highway 3 will follow the route of the proposed overland conveyor, which will transport the clean steelmaking coal product to the rail load out where it will be loaded into train cars. Mine pit and waste rock storage area haul roads, along with water management facility roads will branch out from the CHPP area. These roads will vary in location over the course of the mine life. Public use of these roads will be prohibited by Benga during the construction and operation phases for public safety reasons. At closure, the haul roads will be reclaimed as part of the Conservation and Reclamation Plan (C&R Plan). As part of the C&R Plan, access to some of the water management facilities (specifically the surge ponds) will still be required for a number of years after the end of mining (EOM). These roads as well as the main access road will be on Benga private land and will be closed to the public. At final closure, all water management facility structures will be reclaimed, as well as the associated access roads. The main access road will also be reclaimed from the CHPP area to the Golf and Country Club.

Benga has also been consulting with recreational users such as the Crowsnest Pass Quad Squad, the United Riders of Crowsnest and the Crow Snow Riders in order to gain further understanding on recreational use of the proposed mining area. A majority of the known trails in the area are along the north and west sides of the proposed development. Benga will continue to work with these groups in order to develop measures to mitigate potential impacts of the Project on outdoor recreation in the area.

In addition, at the completion of mining, the area will be reclaimed to a land use equivalent to what existed prior to development including recreational use. As the public will not be allowed to use any private mine related roads, and with Benga's commitment to adopt an employee policy where angling is not allowed. Angling pressure on local fish populations is not anticipated to be a concern.

A final significance evaluation will be provided along in the final Aquatic Ecology Effects Assessment report in Q1 2017.

E.6.3.2 Potential Monitoring

Monitoring plans for the Project will be finalized in 2017 once all aquatic significance evaluations have been compiled; the framework for monitoring could potentially include a number of components, some of which may include (but not limited to):

- implementation of a water quality monitoring program for the life of the project, which will include regular compliance monitoring of sedimentation ponds, which will include but not limited to monitoring of flows and total suspended solids (TSS);
- effects monitoring for surface water quality in natural watercourses, both upstream and downstream of Project activities on both Blairmore Creek and Gold Creek;
- development and implementation of a benthic invertebrate biomonitoring program to assess the effectiveness of the surface water management;
- fish population, habitat and seasonal use monitoring;
- design and implementation of a monitoring program to monitor sedimentation and stream "embeddedness" patterns in Blairmore Creek and Gold Creek to assess the effectiveness of surface water management;
- at the EOM, the evaluation of the end pit lake system through a monitoring program to assess water quantity and water quality; and
- specific monitoring requirements on Blairmore Creek and Gold Creek mainstems and/or tributaries based on results from the IFN study, as necessary.

If deemed necessary as a result of the outcome(s) from the Aquatic Ecology Effects Assessment a habitat offset plan will be developed. The offset planning will consider the results of the impact assessment findings (*e.g.* footprint effects, flow alteration effects resulting from IFN study) to aid in the determination of quantity and nature of required offsets, identification of locations where offsets could be implemented, and the development a formal habitat offset plan. The offset plan would initially be considered conceptual and would be finalized in consultation with the AER and DFO. Once agreed upon, the associated approvals and authorizations from regulatory agencies would be applied for. The implementation of the offsets and monitoring to assess effectiveness of the plan would be determined as part of the plan development and approval/authorization terms and conditions. It is expected that the final implementation plan would be prepared with regulators and stakeholders prior to Project approval at the Project permitting level.

E.6.4 Cumulative Effects Assessment

Of the proposed projects forming the Planned Development Case:

- The proposed Michel Creek Coal Mine by Teck Coal Ltd. is not located in the Crowsnest River drainage and any effects of this project would likely be *via* changes in air quality.
- Future timber operations on Crown Land are likely to proceed at the same rate as they are currently.
- It is assumed that Alberta Transportation's re-alignment of Highway No. 3 will be done in an environmentally-sustainable manner and not adversely affect the water quality or aquatic resources of the Crowsnest River.

The list of proposed projects included as part of any Cumulative Effects Assessment (CEA) will be re-evaluated as the assessment of effects proceeds. Once a tabulation of residual effects is generated and after mitigation has been applied, the need for conducting a CEA on Aquatic Resources will be confirmed. If residual effects remain post-mitigation, the Aquatic Ecology Effects Assessment issued in Q1 2017 will include an assessment and discussion of cumulative effects.

E.6.5 Summary

Benga has been collecting fish and aquatic baseline data for the Project in 2014 to 2015 and are continuing with additional baseline data collection in 2016 in both Blairmore Creek and Gold Creek. The information collected in 2014 and 2015 provides some baseline background data; however, additional data collection in 2016 will provide the foundation of a more detailed and comprehensive aquatic effects assessment for Blaimore Creek and Gold Creek watersheds.

This more focused assessment will support previously collected fish and aquatic resources data, and will also use data generated from the hydrogeological assessment (CR#3), the hydrology assessment (CR#4), and the water quality assessment (CR#5) to fully address the AER TOR and CEAA guidelines developed for the Project.

As part of ongoing discussions with the AER, CEAA, DFO, and DFO SARA specialists, it was agreed that as seasonal data is required for the complete 2016 data collection to complete the IFN study, the more comprehensive and completed Aquatic Ecology Effects Assessment will be provided to the AER and CEAA as an addendum to the EIA in Q1, 2017.

E.7 TERRAIN AND SOILS

E.7.1 Introduction and Terms of Reference

Riversdale conducted a soil and terrain assessment for the proposed Project. The following section is a summary of the Baseline Terrain and Soils Survey and Effects Assessment that was prepared by Millennium EMS Solutions Ltd. and included as Consultant Report #7 (CR #7).

The final Terms of Reference (ToR) for the Project (AER 2015) are provided in the Project Application (Appendix 1). The specific requirements for the soil and terrain component are provided in Section 3.9, 8, 9 and 10, and are as follows

3.9 Terrain and Soils

3.9.1 Baseline Information

[A] Provide Descriptions and maps of the Terrain and soils conditions, including:

- *Surficial geology and topography;*
- *Soil types and their distribution. Provide an ecological context to the soil resource by supplying a soil survey report and maps to Survey Intensity Level 2 for the Project Area;*
- *Suitability and availability of soils within the Project Area for reclamation;*
- *Soil types that could be affected by the Project with emphasis on potential acidification (by soil type); and*
- *Descriptions and locations of erosion sensitive soils.*

3.9.2 Impact Assessment

[A] Describe Project activities and other related issues that could affect soil quality (e.g., compaction, contaminants) and:

- *indicate the amount (ha) of surface disturbance from plant, mine, overburden disposal, reclamation material stockpiles, infrastructure (pipelines, power lines, access roads), aggregate and borrow sites, construction camps, waste disposal and other construction and operation activities;*
- *provide an inventory of the pre- and post-disturbance land capability classes for the soils in both the Project Area and the Local Study Area and describe the impacts to land capability resulting from the Project. Indicate the size and location of the soil types and land capability classes that will be disturbed;*
- *discuss the relevance of any changes for the local and regional landscapes, biodiversity, productivity, ecological integrity, aesthetics, and future use resulting from disturbance during the life of the Project;*
- *describe potential sources of soil contamination;*

- *describe the impact of the Project on the soil types and reclamation suitability and the approximate volume of soil materials for reclamation. Discuss any constraints or limitations to achieving vegetation / habitat reclamation based on the anticipated soil conditions (e.g., compaction, contaminants, salinity, soil moisture, nutrient depletion, erosion, etc.); and*
- *discuss the potential for soil erosion during the life of the Project.*

[B] Discuss the potential impacts caused by the mulching and storage of woody debris considering, but not limited to vulnerability to fire, degradation of soil quality and increased footprint, etc.

8 Mitigation Measures

[A] Discuss mitigation measures to avoid, minimize or eliminate the potential impacts for all stages of the Project.
[B] Identify those mitigation measures that will be implemented for each associated impact and provide rationale for their selection.
[C] Discuss the effectiveness of the proposed mitigation.

9 Residual Impacts

[A] Describe the residual impacts of the Project following implementation of the Proponent's mitigation measures and the Proponent's plans to manage those residual impacts.

10 Monitoring

[A] Describe the Proponent's current and proposed monitoring programs.
[B] Describe the monitoring programs proposed to assess any Project impacts and to measure the effectiveness of mitigation plans.

The specific requirements for the terrain and soils assessment provided in Section 6.1.3, 6.2.3, 6.4, 6.5, 6.6.2 and 7 of the Canadian Environmental Assessment Agency (CEAA) *Guidelines for the Preparation of an Environmental Impact Statement* for the Grassy Mountain Coal Project (Appendix 2 of the Application, Benga 2015) were also considered and are as follows:

6.1.3. Topography and Soil

- *Baseline mapping and description of landforms and soils within the local and regional project area*
- *Maps depicting soil depth by horizon and soil order within the mine site area to support soil salvage and reclamation efforts, and to outline potential for soil erosion; and*
- *Suitability of topsoil and overburden for use in the rehabilitation of disturbed areas.*

6.2.3 Changes to Terrestrial Environment

overall description of changes related to landscape disturbance

6.4 Mitigation.
Terrain and soils

6.5 Significant Residual Effects
Terrain and soils

6.6.2 Cumulative Effects Assessment

- *identify and provide a rationale for the valued components that will constitute the focus of the cumulative effects assessment, emphasizing this assessment on the VCs most likely to be affected by the Project and other projects and activities.*
- *identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected.*
- *identify the sources of potential cumulative effects*
- *describe the mitigation measures that are technically and economically feasible.*
- *determine the significance of the cumulative effects*

7 SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT
a table summarising the following key information:

- *- potential environmental effects;*
- *- proposed mitigation measures to address the effects identified above; and*
- *- potential residual effects and the significance of the residual environmental effects*

The local study area (LSA) for the terrain and soils baseline study includes lands within proposed mine development areas that are expected to be disturbed during the life of the Project (CR #7, Figure 2.1-1). The regional study area (RSA) for soil and terrain for the Project encompasses the Project footprint, the mine permit boundary and some additional areas. The area selected as the RSA is deemed sufficient to evaluate cumulative effects as relating to direct disturbance of soil and terrain from other industries/operations within this selected area.

VCs related to soil and terrain include:

- soil quality (includes impacts related to soil disturbance, erosion, soil burial, and accidental releases);
- soil biodiversity and ecological integrity;
- terrain; and
- landscape capability (impact to potential capability of reclaimed soil and landscapes in comparison to baseline conditions).

E.7.2 Baseline Conditions

A total of 457 soil inspection sites have been recorded (CR #7, Figures 3.1-1 to 3.1-3) within or adjacent to the LSA and RSA, including 26 sampled soil profiles. Samples of at least one soil horizon or layer were collected at 24 of the soil inspection sites to confirm soil classification. The survey intensity achieved within the LSA was one inspection per 6.6 ha of land (230 sites over 1,520.7 ha). The survey intensity achieved within the RSA was one inspection per 11.2 ha of land (407 site inspections over 4,549.8 ha).

Soils were classified to the soil subgroup level (SCWG 1998) and to soil series level based on the AGRASID 4.0 name file (ASIC 2013, Bock *et al.* 2006).

E.7.2.1 Soil Map Units

Soil map units (SMU) combines soil patterns and associated terrain information. Soil patterns are based on the standard Soil Model adapted from ASIC 2013. Terrain information is based on standard Landform Models for surficial material, surface expression, and slope classes adapted from SCWG (1998) and Howes and Kenk (1997). Detailed mapping information, along with areal coverage and distributions of the 45 identified SMUs in the LSA and RSA are provided in CR #7, Section 3.3, Figures 3.3-2 to 3.3-5. Descriptions of the SMUs are provided in CR #7, Appendix B.

E.7.2.2 Thickness of Soil Layers

Estimating average profile layer thicknesses assists in determining suitable soil salvage and stockpiling and soil replacement requirements for reclamation purposes. All collected soil data were analyzed to determine average thicknesses of soil layers for the SMUs. Soil layers were defined as surface litter/shallow organics, deep organics, A horizons, B horizons, C horizons and upland surface soil. The estimated horizon thicknesses for each SMU are provided in CR #7, Table 4.1-1 and Figure 4.1-1. Soil volume salvageability and replacement requirements for the Project and various Project components are provided in the conceptual C&R Plan for the Project (Section F of Application).

E.7.2.3 Reclamation Suitability Ratings

Reclamation suitability assessment followed the *Soil Quality Criteria Relative to Disturbance and Reclamation* Guidelines as specified for the Eastern Slopes Region of Alberta (SQCWG 1987). Details on the application of these guidelines are provided in CR #7, Appendix C (Table C-1). Ratings parameters include: soil reaction (pH), salinity (measured by electrical conductivity (EC)), sodicity (measured by sodium adsorption ratio (SAR)), saturation percentage (sat %), coarse fragment (% volume), soil texture, consistency, and calcium carbonate equivalent (CCE). Ratings are divided

into three categories (Good, Fair, Poor) and another category for soil material that is unsuitable as a rooting medium.

Reclamation suitability ratings for all SMUs are provided in CR #7, Table 4.1-2 and Figures 4.1-2, 4.1-3, and 4.1-4. Overall, A and B horizons material are considered to be fair material for reclamation. With proper management and reclamation planning, these soils will provide a suitable growth media for reclamation and revegetation of the Project. Issues related to coarse fragment content are not seen as reclamation barriers for establishment of forested ecosystems and will likely provide for a range of microhabitats and moisture regimes post reclamation. No severe limitations on pH, salinity or sodicity were found. Organic materials were categorized as suitable for use in reclamation.

Lithic contacts occur in some map units. Through Project development and overburden removal, shallow bedrock outcrops will be removed and sufficient soil material will be replaced post reclamation such that lithic/paralithic contact (within 100 cm of surface) will be minimized.

E.7.2.4 Evaluation of Soil Erosion Potential

The rate of water erosion was estimated using the *Revised Universal Soil Loss Equation for Application in Canada* (RUSLEFAC) (Wall *et al*. 2002). The risk of water erosion for baseline conditions is typically very low as the soil surface is currently well protected by tree and understory cover that minimized exposure of surface soil material to water (CR #7, Table 4.3-1). When assessing water erosion, slope gradient is an important factor. As slope gradient increases, so does the potential risk for water erosion. If mineral soil is exposed, the risk of water erosion increases.

The majority of upland soils within the RSA occur on gentle to very strong slopes and soils in these landscapes are highly susceptible to water erosion upon complete removal of all vegetation and debris. If mitigation measures are applied to stockpiles post construction and to reclaimed lands, post reclamation water erosion risk can be reduced and managed throughout the life of the Project. Landscape conditions of special concern that are estimated to be at risk from water erosion are located on steeper slopes of class 6 (>15 to 30% slope, or >8.5 to 16.5°) and higher.

Wind erosion risk ratings were modified from the *Wind Erosion Risk, Alberta* (Coote and Pettapiece 1989), Alberta Agriculture (1985) and United States department of Agriculture (USDA) (2014). Wind erosion risk under current conditions is considered to be very low to negligible because of vegetation cover. The wind erosion ratings estimated for the soil models are based on the assumption that vegetation has been removed and bare soil is exposed (CR #7, Table 4.3-2).

Soil units in the Project would generally be at moderate to high risk of wind erosion (assuming no vegetative cover). If the vegetation is removed and the stabilizing effect of plant roots and organic

matter is removed, these soils could potentially become unstable and may become highly susceptible to erosion by wind. Upon implementation of mitigation, the wind erosion risk is expected to be low for all reclaimed landscapes within the proposed disturbance area.

E.7.2.5 Potential Soil Acidification

Soil acid sensitivity rating for mineral soils is based on the system developed by Holowaychuk and Fessenden (1987) and revised by Turchenek *et al.* (1998). Soil sensitivity ratings for Soil Models are provided in CR #7, Table 4.4-3. The majority of Soil Models were rated as having low to medium sensitivity. Based on a review of the modelled Potential Soil Acidification (PAI) isopleths, there are no PAI isopleths that contain values that trigger critical, target or monitoring load exceedances as per Alberta Acid Deposition Management Framework (AENV 2008) for the soils within the LSA or the RSA (CR #7, Figure 4.4-1).

Soil acidification via atmospheric deposition is not expected to result in an environmental effect on the soil resources within the LSA or RSA. The impact of the Project with respect to potential soil acidification is negligible at the local and regional scale for all assessment cases and is therefore not assessed as a potential impact to soil resources.

E.7.2.6 Land Capability Assessment

Land capability for the RSA has been catalogued by rating the Soil Map Units (SMUs) according to A Forest Land Capability Classification for the East Slopes Area, Alberta (Duffy and Nemeth, 1969). Details on the application of these guidelines are provided in CR #7, Section 4.5. Forest soil capabilities were determined for every SMUs for dominant and co-dominant soils.

Within the RSA, capability ratings ranged from Class 4 to Class 7. The main limitations to soils within the RSA include restriction of rooting zone by bedrock (subclass R), exposure (subclass U) and excess soil moisture (subclass W). Classes 5-6 and 5-7 are the most extensive within the RSA and LSA.

The baseline forested land capabilities for SMUs of the RSA and LSA are listed in CR #7, Table 4.5-3. Distribution of land capability classes within the RSA and LSA are provided in CR #7, Table 4.5-4 and are shown on Figure 4.5-1.

Post-reclamation suitability was evaluated for SMUs in the LSA that are expected to be disturbed over the life of the Project. CR #7, Table 4.5-5 displays the baseline and predicted reclaimed capability classes for the SMUs. All SMUs contain the same or higher final capability ratings for reclaimed landscapes than compared to pre-disturbance conditions.

E.7.2.7 Overburden Assessment

For the purpose of this assessment, overburden is defined as the material located below the soil profile (about 1 m depth in this study) and above, between, and below the coal strata that are to be mined in the Project. A total of 176 overburden samples were analyzed from seven test holes logged throughout the lease and mine permit boundaries. Various samples were analyzed for detailed salinity (pH, EC, SAR), saturation percentage, calcium carbonate equivalent, Modified Neutralization Potential (NP) and trace metals as defined by Canadian Council of Ministers of the Environment (CCME 2011). The overburden material has the potential to become part of the lower rooting zone; consequently, it was rated for reclamation suitability following SQCWG (1987) (CR #7, Table 5.3-1).

E.7.2.7.1 Salinity (EC and SAR) & Saturation Percentage

In surficial soil materials, high SAR results in poor soil structure and reduces water uptake by vegetation, thus lowering overall productivity. SAR values ranged from <0.1 – 1.03 (excluding one sample with SAR of 18.7), indicating suitability for reclamation.

The concentration of soluble salts in soil is measured as electrical conductivity on a soil paste extract. EC values >4 dS/m indicate elevated soluble salts, and hence a saline soil. EC values ranged from 0.31 - 2.85 dS/m with an average of 0.84 dS/m for all overburden data (surficial and bedrock) reviewed. No distinct spatial patterns or trends were noted. The average EC value of 0.84 dS/m indicates that the overburden material is generally non-saline.

Saturation percentage values ranged from 20.7 – 30.3% with an average of 26.2% for all overburden data (surficial and bedrock) reviewed. Saturation percentage was not considered a limiting factor for reclamation suitability of overburden material.

E.7.2.7.2 Soil Reaction (pH)

Reaction of the overburden material ranged from strongly acidic (pH 3.69) to strongly alkaline (pH 9.07), with an average pH of 7.12. No distinct patterns or trends were displayed spatially for pH values. Soil pH was the most limiting factor for the majority of the samples; the resultant reclamation suitability rating was mainly poor.

Soil pH can influence availability of plant nutrients, thus potentially affect plant growth. It is anticipated that the alkaline pH recorded in the overburden material will not result in effects on vegetation, as the overburden material will not form a significant portion of the reclaimed rooting zone. Studies have shown that stockpiled / exposed overburden material can display a decrease in pH when carbonate-rich overburden material oxidizes, forming weak carbonic acid

(Chernipeski 2008). It is expected that overburden material excavated during the mining process will be exposed to weathering elements and the potential for a decrease in pH of this material does exist.

E.7.2.7.3 Acid Rock Drainage

Acidic drainage from the replaced overburden can be an issue at surface mines. Oxidation of sulfide minerals in the overburden will cause sulfuric acid to form, and high concentrations of trace elements may become dissolved in solution resulting in acid rock drainage. Acidity within the exposed overburden may be partially or completely neutralized in the presence of naturally occurring carbonates, either mineralized or in solution.

Results of the detailed assessment of the overburden material for acid rock drainage (ARD) potential indicate:

- ARD potential is associated with the Cadomin Formation (particularly the conglomerate), and the Mutz, Adanac, and Moose Mountain Members of the Kootenay Formation.
- Near-surface legacy spoil appears to have low ARD potential with all samples containing less than 0.1% sulphide sulphur.

Layers with higher ARD potential are relatively thin and usually surrounded by material with high neutralization potential. The acidity is completely neutralized by carbonate minerals by assuming that acid-generating materials are thoroughly mixed with acid-consuming materials.

E.7.2.7.4 Trace Elements

Sixteen trace elements were analyzed from 176 baseline overburden samples in accordance with the Canadian Soil Quality Guidelines (CSQG) (CCME 2011) guidelines. Sample collection varied from 0.6 m to 170.9 m in depth, with the bulk of samples originating from bedrock units. Mean trace metal concentrations were compared to published data in the CSQG (CCME 2011). A summary of analytical results for baseline trace metals by depth increment is provided in CR #7, Table 5.5-1.

Mean values of the 16 trace metals are generally within CSQG for parkland soils (CCME 2011). Selenium (Se) is the only element to have concentrations above the conservative CSQG with any regularity. Se concentrations slightly exceeded the CSQG for parkland soils in 92 samples. The depths of the exceedances ranged from 0 m to 170 m, with the majority of the elevated results recorded between 50 m and 90 m. The observed Se concentrations indicated that Se leaching is a consideration for the Project based on experience at other coal projects in British Columbia and Alberta.

E.7.3 Potential Impacts

The impact assessment considered each VC and assessed the impacts for the Application Case (Project only) and the Planned Development Case (Cumulative Effects).

Activities that may impact the soil resource and associated terrain as a result of the Project for the Application and Planned Development Cases include:

- Soil salvage and handling – salvage of all required soil materials in the proposed disturbance areas may result in effects to soil quality.
- Soil stockpiling – stockpiling of salvaged soil materials during the construction of the Project, both short term and long term, results in potential for soil erosion issues and effects to soil productivity.
- Development of Project infrastructure – includes creation of roads, and all related Project Infrastructure, may result in environmental effects to soil quality and terrain.
- Mining process – extraction of the coal will require removal of all soil – landscape patterns within the proposed mining pit as well as all overburden materials. Replacement of overburden materials at reclamation will result in terrain units different from baseline conditions and the potential for introduction of unsuitable overburden materials into the reclaimed soil profile.
- Operational activities – day to day operations that may result in effects to soil through accidental releases.
- Progressive reclamation – activities including recontouring, soil handling and replacement may result in effects to the reclaimed soil profiles and terrain.

E.7.3.1 Soil Quality

The analysis of soil quality considers changes that may occur in soil physical, chemical and biological properties and soil quantity due to soil profile disturbance (salvage activities, handling, and replacement), erosion, soil compaction, accidental releases, and stockpiling. Within the proposed Project footprint the available reclamation materials are estimated as follows:

- Upland surface soil – 3,019,660 m^3; and
- Deep organic material – 330,047 m^3.

The total reclamation material that is available for salvage within the project footprint is 3,349,707 m^3.

E.7.3.1.1 Soil Profile Disturbance

Disturbance of the soil profile during development of Project infrastructure, mining of the coal resource, and reclamation has the potential to impact soil quality. Soil salvage, handling, storage (long term and short term stockpiles) and replacement may impact soil quality. Soil material salvaged from disturbance areas may be chemically and physically impacted through the removal, handling and storage, and replacement during reclamation. Potential physical and /or chemical alterations may impact the quality of the soil resource. Upland surface soil thickness in the proposed disturbance area is variable and dependent on terrain types and more specifically landscape positions within discrete terrain types. Soil quality within the A horizons (includes surface litter layer) and B horizons is similar and the blending of all or portions of these layers is not expected to be detrimental, and in some instances increase soil quality depending on layer textures and nutrient levels.

The organic deposits within the proposed disturbance areas will be excavated and will form part of the soil balance salvaged for use in the reclamation program.

Based on the terrain classification for the LSA, it is estimated that approximately 379.7 ha (25.6%) of the proposed soil disturbance area will not have soil materials salvaged due to the equipment limitations because of the steep terrain. There are also approximately 185.2 ha of land that were previously disturbed by legacy mining operations in the area, where there are no soil resources available to be salvaged. It will be extremely important to salvage the upland surface soil resource when it is available for salvage to ensure there is enough to complete the reclamation.

Compaction is of particular concern during direct replacement activities when large equipment is traversing reclaimed profiles during progressive reclamation. Appropriate soil replacement strategies (*e.g.* limiting heavy traffic to certain areas) and soil de-compaction activities post-reclamation (*e.g.* rough mounding, tillage, deep ripping) will minimize impacts potentially associated with soil compaction.

With proper soil salvage, handling, storage and replacement the effects of soil profile disturbance for the Application case are rated as not significant.

E.7.3.1.2 Erosion

The potential for impacts resulting from wind and water erosion on soil quality exists throughout the life of the Project. There is potential for loss of soil via erosion during soil salvage, soil storage, and after soil replacement. The risk of erosion to surface soils is greatest during the soil salvage (construction phase) and soil replacement (reclamation phase).

Erosion of stockpiled soil material may occur by wind and water. Salvaged soil material will be stored in stockpiles. The soil stockpiles will be stabilized, and vegetated to minimize erosion. It is anticipated that the length of time over which stockpiled soil material will be at risk to soil erosion due to lack of vegetative cover will be brief and not significant with respect to the life of the Project.

Reclamation materials replaced during reclamation are at risk of erosion by wind and/or water during soil handling activities and immediately after replacement. Within the LSA, approximately 42.1% (640.5 ha) of the area has a high risk of wind erosion and 77.9% (1,185.0 ha) of the area has a severe risk of water erosion (assuming no mitigation) prior to vegetation establishment. With appropriate revegetation and erosion control activities during the Project, it is expected that the soil loss due to erosion will be minimal and not significant on the soil resource.

E.7.3.1.3 Accidental Releases

Impacts to soil quality caused by accidental releases and operational incidents within the proposed disturbance area have the potential to alter chemical and physical attributes of soils. This can include equipment failures, line failures, tank releases, and surface releases from operations activities. Accidental releases may occur as one time releases, or as cumulative releases that occur over longer periods of time. With the appropriate environmental management plans in place, accidental releases will be not significant on soil quality.

E.7.3.2 Soil Biodiversity and Ecological Integrity

The potential effect to soil biodiversity and resulting ecological integrity of vegetation communities will be discussed in terms of the effects of the Project on the spatial distribution of soil patterns and potential changes in soil diversity and ecological integrity post disturbance.

Common soils in the LSA and RSA include Brunisols, Regosols, Luvisols and Chernozems in upland and mid slope positions, Gleysols in transitional areas, and shallow to deep Organics in the poorly drained level landscapes. Based on soil information for the LSA and RSA, there were no uncommon soil profiles or patterns in the proposed disturbance area in the LSA and RSA.

Ecological integrity with respect to soil and landscapes is related to the vegetation communities and resultant habitats that are formed as a result of the relationship between soil and landscape patterns and corresponding moisture and nutrient regimes. Reclaimed soil – landscape patterns will be more homogenous than baseline conditions because reconstruction of the inherent variability associated with natural soil profiles is not possible.

Establishment of reclaimed soil and landscape patterns that are conducive to the formation of a range of desired vegetation communities will allow for the eventual formation of suitable reclaimed habitats

that meets desired end land use objectives, conforms to adjacent undisturbed soil and landscape patterns, and is self-sustaining.

No change in soil diversity or ecological integrity with respect to soil types and landscape patterns is expected from a regional perspective, and the Project is expected to be not significant.

E.7.3.3 Alteration of Terrain

Development of the Project results in disturbances to the terrain types within the LSA. Various terrain types will be removed as a result of Project development. After mining and reclamation of Project infrastructure there will be a permanent loss of organic landforms and the extreme slopes in the upland terrain will be reduced to a maximum slope angle of 23°. The natural variability and complexity of the existing terrain within the LSA will not be duplicated by creation of re-contoured landscapes. The reclaimed landscape will be more homogenous than current conditions. However, the reclaimed landscapes will contain characteristics similar to the existing upland terrain. It is expected that the creation of a range of terrain types, during contouring and reclamation will provide a reclaimed terrain that will tie into adjacent undisturbed lands, provide suitable landscapes for the development of a range of reclaimed soil types and functioning vegetation communities. The development of the project is expected to be not significant on terrain.

E.7.3.4 Land Capability Effects

Proper soil conservation, soil replacement, mine backfilling and re-contouring, soil placement and revegetation are all key to ensuring that the reclaimed landscape inclusive of reclaimed soil profiles and vegetation communities provide equivalent land capability. Reclamation success for the Project will be measured by the ability of the reclaimed landscape to achieve land capability equivalent to pre-disturbance conditions and meet the desired end land use objectives with normal land management practices. The analysis of equivalent capability is assessed by evaluation of soil and overburden materials comprising the root zone, pre-disturbance and post-reclamation land capability, comparison of the reclaimed and baseline land capability class distribution, loss of various land capabilities due to disturbance, and delay in achieving equivalent land capability post reclamation.

E.7.3.4.1 Reclaimed Overburden Materials

Overburden material will be used to backfill and re-contour completed mine blocks. The overburden material will be recontoured to a maximum slope angle of 23° and will then have reclamation material replaced, followed with vegetation establishment. Reclaimed soil profiles will provide the rooting zone in the re-constructed landscapes. In the overburden assessment the majority of the bedrock overburden is considered suitable as a rooting medium for reclamation. Benga will ensure that

sufficient suitable overburden material is placed over unsuitable overburden (1.0 m of suitable material) if it is present prior to reclamation material replacement.

An overburden sampling program will be conducted prior to soil placement to determine the soil replacement requirements at reclamation. An overburden assessment program coupled with proper soil salvage and prescriptive soil replacement plan will allow for suitable reclaimed soil profiles to be replaced after mining.

E.7.3.4.2 Pre-disturbance and Post-reclamation Land Capability

The post reclamation land capabilities will be similar or better then ratings determined for the pre-disturbance soil map units (CR #7, Table 4.5-5). CR #7, Table 7.4-1 presents a comparison of the reclaimed and baseline forest land capability class distribution within the proposed mining soil disturbance.

Differences in reclaimed and baseline land capability ratings for the Project are associated with the following changes:

- a total of 18.8 ha of organic landscapes that will be reclaimed as upland landscapes;
- the portions of the Project Footprint that were mapped as disturbed lands (ZDL) will be reclaimed to provide a suitable reclaimed landscapes to meet the end land use goals; and
- a post-closure end-pit lake that covers approximately 18.4 ha will be created.

E.7.3.4.3 Land Capability – Loss and Delays

The reclaimed landscape will contain reclaimed soil profiles, and landforms similar to what existed prior to disturbance. There will also be wetland complexes and various reclaimed drainage patterns reinstated to ensure appropriate surface water drainage post development. Reclamation goals, end land use objectives, and measures of reclamation success will dictate the length of time that the reclaimed landscape requires to reach equivalent land capability. Over time, Benga expects that the reclaimed landscape and vegetation communities will provide equivalent capability to allow for commercial forestry, wildlife habitat, and recreational uses.

E.7.4 Cumulative Effects

No planned industrial developments were identified in the RSA. The PDC is identical to the Application Case at the regional scale. It is expected that the impact assessment detailed for the Application Case will be the same for the PDC.

E.7.4.1 Soil Quality

E.7.4.1.1 Soil Profile Disturbance

It is expected that existing and potential future developments within the RSA that disturb the soil resource as a part of the development will be required to conserve soil and complete reclamation as per current regulatory and operating requirements. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize any impacts to soil quality and quantity (productivity) by ensuring appropriate conservation and reclamation planning is in place that addresses soil handling, storage, replacement, and mitigation and monitoring post reclamation.

With effective soil salvage and handling, reclamation, and mitigation and monitoring, the impacts to the RSA as a result of development of the Project and existing current and future developments are expected to be not significant with respect to reclaimed soil profiles in the reclaimed landscapes. It is expected that desired end land uses and appropriate capability will be achieved.

E.7.4.1.2 Erosion

The resultant environmental effects pertaining to soil erosion for the PDC are anticipated to be equivalent to the Application Case. It is anticipated that similar mitigative measures and monitoring described to minimize erosion for the Application Case are currently being used for existing disturbances within the RSA and will be used in potential future projects (as required to ensure soil conservation). Minimization and mitigation of soil erosion is a regulatory requirement to ensure soil conservation and to protect water bodies. The resultant residual effects to the soil resource due to potential soil erosion for the PDC are anticipated to be not significant.

E.7.4.1.3 Accidental Releases

It is anticipated that type, frequency, severity, and potential methods of accidental releases for existing developments currently within the RSA are in some instances similar to the Application Case. Forestry developments pose similar risks related to accidental releases; refuelling, equipment breakdowns, material transfers, and waste generation are all potential sources that are common to development activities related to the Project. With the appropriate environmental management plans in place, compliance with appropriate regularly requirements related to project development, and materials containment accidental releases and subsequent cleanup will result in a low impact on soil quality.

The assessment of impacts to the soil resource as a result of accidental releases for the PDC is anticipated to be not significant.

E.7.4.2 Soil Biodiversity and Ecological Integrity

The soil types and distribution of soil and landscapes within the RSA are similar to that of the LSA. The assessment of impacts to soil biodiversity for the PDC is anticipated to be equivalent to the Application Case.

E.7.4.3 Alteration of Terrain

The soil and landscape patterns within the region, the RSA and the LSA are similar. The expected impacts to terrain types disturbed by existing and future Projects in the RSA are negligible. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize the impacts to terrain types in the RSA. The evaluation of the impact to altered terrain types is the same as for the Application Case.

E.7.4.4 Land Capability Effects

Effective soil conservation, reclamation, revegetation, and mitigation and monitoring of developments or activities within the RSA will ensure that land capability will be achieved to meet desired end land uses.

The cumulative impacts to the RSA as a result of development of the Project and existing current and future developments are expected to be low impact with respect to impacts to equivalent land capability. The impact assessment for the PDC case is the same as the Application case.

E.7.5 Mitigation and Monitoring

E.7.5.1 Mitigation

Mitigation and monitoring processes provided will minimize impacts to the soil resource throughout the life of the Project. Recommendations are generalized with more detailed information related to soil conservation and reclamation procedures being provided in the C&R Plan for the Project (Section F).

- upland surface soil will be salvaged using best management practices. Supervision of salvage operations, stockpiling, and placement of materials during reclamation (including direct placement) by qualified individuals is recommended;
- soil handling activities should be suspended under wet or windy conditions when the degradation of soil quality is a potential;
- organic soil material will be salvaged for later use in reclamation;
- placement of reclamation material will require that it is stored in a manner to minimize material loss or degradation of quality and located in areas that are accessible and retrievable;

- varying thicknesses of reclamation material will be replaced, with a target of 20 cm average thickness, to assist in creating diversity in the reclaimed landscapes;
- decompaction of the replaced materials will be done to reduce potential compaction as a result of soil replacement;
- all reclaimed lands will be initially vegetated using a cover crop upon completion of soil placement to minimize soil loss *via* erosion (wind and water); target vegetation establishment will occur through natural regeneration and through seeding or planting of desired understory and tree species;
- soil erosion control measures will be implemented to minimize loss of soil materials via wind or water erosion during activities associated with soil salvage, storage and reclamation. General mitigation activities to reduce wind or water erosion potential include the following:
  - when stockpiling reclamation material, piles will be placed in strategic locations, to minimize exposure to wind or water;
  - stockpiles will be seeded with a non-invasive and weed free seed mix that establishes quickly;
  - erosion control materials (mats, netting, mulches, straw) will be used to reduce soil surface exposure, as required; and
  - reclaimed landscapes will be reseeded with a quick establishing; non-invasive cover crop to minimize the length of time bare soil is exposed to potential wind and water erosion. In addition, reclaimed landscapes that have a moderate to high water erosion risk (*i.e.*, steep side slopes) will have soil stabilizers or other measures implemented (where necessary) to minimize the potential of erosion (*i.e.*, rough mounding, check bales, silt fences, tackifiers, and/or mulch).
- implementation of appropriate soil salvage activities will ensure sufficient volumes of reclamation materials are salvaged for placement. Sufficient suitable overburden material will be available for placement over unsuitable overburden. Upon backfilling and re-contouring of mine blocks unsuitable overburden will be identified to ensure that sufficient reclamation material is replaced to meet regulatory requirements over all reclaimed lands.

E.7.5.2 Monitoring

A monitoring program will be developed and implemented to assess the success of reclamation with respect to soil quality. Success will be measured as compared to applicable reclamation criteria and the requirements set by regulatory approvals. Monitoring activities will include the following:

- direct supervision of salvage and replacement activities by a qualified individual;

- erosion of stockpiled or recently replaced soil material as well as effectiveness of erosion control activities;
- ensure reclamation material replacement coverage and depths meet required standards;
- quality of overburden material through a sampling program in order to determine material replacement requirements; and
- assessment of vegetation communities to determine if the seral communities established are appropriate for the target local common forest ecosystems and desired end land uses.
- monitoring of stockpiled soils and reclaimed areas to ensure erosion is minimized;
- develop and implement an erosion control plan as required;
- based on monitoring results of reclaimed landscapes, adaptive management will be incorporated by Benga in order to allow for continual improvement of erosion control processes;
- quality of overburden after mine backfilling and contouring to determine if overburden material located at surface is suitable or unsuitable as root zone medium;
- quantity of suitable overburden material placed over unsuitable overburden;
- reclaimed areas for reclamation material quality and quantity (depths) and suitability of overburden materials; and
- post reclamation landscapes for stability, drainage, and the interaction of the vegetation communities in the reclaimed landscapes after reclamation and revegetation.

E.7.6 Summary

Table E.7.6-1 summarizes all of the potential impacts anticipated to affect terrain and soils throughout the life of the Project.

Table E.7.6-1 Summary of Residual and Cumulative Effects on Valued Components (VCs)

Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. Soil Quality											
Soil Profile Disturbance											
Impact on soil quality - soil profile disturbance	Appropriate soil salvage, handling, storage, and reclamation	Residual	LSA	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially – Negative; Over time - Neutral	High	High	Not Significant
Impact on soil quality - soil profile disturbance	Soil salvage, handling, and reclamation as per regulatory requirements for Projects in the RSA	Cumulative	RSA	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially – Negative; Over time - Neutral	Moderate	High	Not Significant
Erosion											
Impact on soil quality – potential soil loss	Appropriate erosion control measures and monitoring throughout Project	Residual	LSA	Short	Occasional (unplanned)	Irreversible	Initially - Moderate, Low - with veg. establishment	Negative	Moderate	High during salvage and replacement at reclamation decreasing to Low after veg. establishment	Not Significant
Impact on soil quality – potential soil loss	Appropriate erosion control measures as per regulatory requirements for all stages of Projects in the RSA	Cumulative	RSA	Short	Occasional (unplanned)	Irreversible	Initially - Moderate, Low - with veg. establishment	Neutral	Moderate	High during salvage and replacement at reclamation decreasing to Low after veg. establishment	Not Significant
Accidental Releases											
Impact on soil quality – soil loss or degradation of soil quality	Appropriate environmental management plans - spill containment and spill response plan	Residual	LSA	Long	Occasional (unplanned)	Reversible – short term	Low	Neutral	High	Medium to Low	Not Significant
Impact on soil quality – soil loss or degradation of soil quality	Appropriate spill containment and spill response plan; compliant with regulatory requirements for construction, operation, and reclamation of Projects in the RSA	Cumulative	RSA	Extended	Occasional (unplanned)	Reversible – short term	Low	Neutral	Moderate	Medium to High	Not Significant
2. Soil Biodiversity & Ecological Integrity											
Impact on soil diversity (distribution of soils) and ecological integrity	Appropriate soil salvage, site re-contouring effective soil replacement, revegetation, and monitoring	Residual	LSA	Extended – diminish with time	Continuous	Partially Reversible – long term	Low	Negative	High	High	Not Significant
Impact on soil diversity (distribution of soils) and ecological integrity	Implementation of an appropriate C&R plan as per regulatory requirements for existing and planned future Projects in the RSA	Cumulative	RSA	Extended – diminish with time	Continuous	Partially Reversible – long term	Low	Negative	High	High	Not Significant

Table E.7.6-1 Summary of Residual and Cumulative Effects on Valued Components (VCs)

Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
3. Alteration of Terrain											
Removal of natural terrain and reconstruction of reclaimed terrain post development	Appropriate site construction practices and re-contouring at reclamation to meet end land use objectives	Residual	LSA	Residual	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
Removal of natural terrain and reconstruction of reclaimed terrain post development	Implementation of a C&R plan as per regulatory requirements for existing and planned future Projects in the RSA	Cumulative	RSA	Residual	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
4. Land Capability Effects											
Reclaimed Overburden Materials											
Achievement of equivalent land capability delayed or hindered through unsuitable overburden in root zone	Ensure 1.0 m of suitable overburden is placed over unsuitable during material replacement	Residual	LSA	Residual	Continuous, diminish with time	Reversible – long term	Low	Neutral	High	Low	Not Significant
Achievement of equivalent land capability delayed or hindered through unsuitable overburden in root zone – Planned Vista Phase 2	Compliance with regulatory requirements for materials placement post mining	Cumulative	RSA	Residual	Continuous, diminish with time	Reversible – long term	Low	Neutral	High	Low	Not Significant
Land Capability											
Project Development and subsequent materials placement on altered landscape may causes alteration land capability distribution and delay in achieving equivalent capability	Soil salvage, site re-contouring effective soil replacement, revegetation, and monitoring are designed to meet land use objectives for land capability	Residual	LSA	Extended – diminish with time	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
Existing and planned future development and subsequent materials placement on altered landscape may causes alteration land capability distribution and delay in achieving equivalent capability	Development and reclamation / revegetation of Projects within the RSA to ensure equivalent land capability is attained to meet end land use objectives	Cumulative	RSA	Extended – diminish with time	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Significant, Not Significant

E.8 VEGETATION & WETLANDS

E.8.1 Introduction and Terms of Reference

The following is a summary of the Project Vegetation and Wetlands Resource Assessment Report that was prepared by Millennium EMS Solutions Ltd. and included as Consultants Report #8 (CR #8).

The AER final Terms of Reference (ToR) and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to vegetation have been addressed in this report:

4.6 Vegetation

Baseline Information

[A] Describe and map vegetation communities. Identify the occurrence, relative abundance and distribution and identify any species that are:

- *listed as "At Risk, May be at Risk and Sensitive" in The Status of Alberta Species (ESRD);*
- *listed in Schedule 1 of the federal Species at Risk Act; and*
- *listed as "At Risk" by COSEWIC; and*
- *traditional and currently used species.*

[B] Describe and quantify the current extent of habitat fragmentation.

[C] Discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution. Consider their importance for local and regional habitat, sustained forest growth, rare plant habitat and the hydrologic regime.

[D] Describe the regional relevance of landscape units that are identified as rare.

[E] Provide Timber Productivity Ratings for both the Project Area and the Local Study Area, including identification of productive forested, non-productive forested and non-forested lands.

Impact Assessment

[A] Describe and assess the potential impacts of the Project on vegetation communities,

[B] Discuss any potential impacts the Project may have on rare plants or endangered species.

[C] Identify key vegetation indicators used to assess the Project impacts. Discuss the rationale for the indicator's selection.

[D] Discuss temporary (include timeframe) and permanent changes to vegetation and wetland communities and comment on:

- *the impacts and their implications for other environmental resources (e.g., habitat diversity and quantity, water quality and quantity, erosion potential);*
- *the impacts on recreation, aboriginal and other uses; and*

- *the sensitivity to disturbance (including acid deposition), as well as the techniques used to estimate sensitivity to disturbance and reclamation, of each vegetation community.*

[E] Describe the regional impact of any ecosite phase to be removed.

[F] Discuss from an ecological perspective, the expected timelines for establishment and recovery of vegetative communities and the expected differences in the resulting vegetative community structures.

[G] Provide a predicted Ecological Land Classification map that shows the reclaimed vegetation. Comment on the importance of the size, distribution and variety of the reclaimed landscape units from both a local and regional perspective.

[H] Discuss the impact of any loss of wetlands, including how the loss will affect land use.

[I] Discuss weeds and non-native invasive species and describe how these species will be assessed and controlled prior to and during operation and reclamation.

[J] Discuss the predicted changes to upland, riparian and wetland habitats resulting from increased fragmentation."

The specific requirements for the vegetation and wetlands assessment as required by the CEAA Guidelines (Appendix 2) were also considered.

The assessment of Project effects on vegetation, wetlands and vegetation biodiversity (including fragmentation), are discussed in detail in CR #8 and is based on the following nine selected VCs:

- vegetation communities;
- rare plants and rare plant communities (including species at risk);
- rangeland resources;
- forest resources (including a timber damage assessment.
- old growth forests;
- traditionally used species (TEK vegetation);
- wetlands; and
- biodiversity (includes assessment of fragmentation).

In addition to the eight VCs, noxious and invasive species and potential acid input were also assessed.

The LSA (4,797.6 ha) captures the entire Project Footprint (1,520.7 ha), including those components that extended close to the proposed permit boundary (CR #8, Figure 1.3-2). The proposed Project Footprint involves the power line, access and overland conveyor rights of way; a coal handling processing plant (CHPP) and infrastructure, haul road, construction camp, surface water management ponds and ditches, coal load-out and railway loop, reclamation material storage, ultimate rock disposal extent, ultimate open pit extent, proposed water pipeline /service road right of way, proposed golf course area and proposed helipad access. The proposed golf course area and

helipad access are considered "*incidental physical activities*" by Canadian Environmental Assessment Agency (CEAA 2015).

The RSA (284,0.24.8 ha) boundary is defined as the LSA plus a 25 km buffer and is primarily located in Alberta (83%) with a small portion located in British Columbia (17%) (CR #8, Figure 1.3-1).

E.8.2 Baseline Conditions

The following section provides a summary of the baseline condition for each of the ten VCs assessed. For a description of the methods used in the baseline data collection, mapping and analyses please see Sections 2.1, 2.2, and 2.3 in CR #8.

E.8.2.1 Vegetation Community Classification

The final land cover map of the LSA consisted of ecosite phases (Archibald *et al*. 1996), naturally vegetated non-forested land, previously disturbed area (including previously un-reclaimed mined areas, roads and oil and gas development), and open water (CR #8, Table 3.1-1 and Figure 3.1-1). Non-ecosite phase land classes (*e.g.*, naturally vegetated non-forested land classes) used Alberta Vegetation Inventory classes (AVI) (Alberta Sustainable Resource Development (ASRD) 2005).

The Montane and the Subalpine Natural Subregions occupy 2,618.3 ha and 2,179.3 ha of the LSA, respectively. Seventeen ecosite phases were mapped in the Montane and 10 in the Subalpine Natural Subregion. Eleven ecosite phases occupy less than 1% of the LSA and are therefore of limited distribution (CR #8, Table 3.1-1). Four hundred and eighty (480) plant species were identified in the LSA and these included 298 vascular plants, 77 mosses and liverworts, and 105 lichen species. Detailed descriptions of the ecosite phases are included in CR #8, Appendix C.

Vegetation in the RSA was classified according to AVI classes (ASRD 2005) rather than ecosite phases. Of the 51 Ecological Land Classification (ELC) AVI land description types classes identified (Section 2.3.1.2.2) and mapped in the RSA (CR #8, Section 3.14), 22 occur within the LSA (CR #8, Table 3.1-2 and Figure 3.1-2). Approximately 78% of the LSA is upland forest, 1.1% is naturally non-vegetated land, and 20.1% is disturbed land.

Approximately 49% of the RSA is forested, 16% is naturally non-vegetated land, 27% is disturbed land, 7% is barren land, and less than 1% is wetland (CR #8, Table 3.1-3 and Figure 3.1-2. Detailed descriptions of the ecological land cover classes identified in the RSA are included in CR #8, Appendix C.

E.8.2.2 Species at Risk, Rare Plants and Rare Plant Communities

E.8.2.2.1 Species at Risk and Rare Plants

Forty-one (41) species (total of 94 occurrences) identified in the LSA (CR #8, Table 3.2-1 and Figure 3.2-1) were on the Alberta Rare Plant Tracking and Watch Lists (ACIMS 2014) at the time of report submission. In total, 18 species (27 occurrences) of these 41 species were observed in the Montane Natural Subregion and 32 species (67 occurrences) were identified in the Subalpine Natural Subregion.

Two species identified in the LSA are federally listed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2015): *Pinus albicaulis* (whitebark pine) and *Pinus flexilis* (limber pine). Whitebark pine is listed as "Endangered" in Alberta and British Columbia and under *SARA* Schedule 1 (Government of Alberta 2014, Government of Canada 2015). Limber pine was designated as "Endangered" throughout its range in Alberta and British Columbia by COSEWIC in November 2014.

All but three provincially rare/watched species found in the LSA (two liverworts and one lichen) are on the *Alberta Wild Species General Status Listing - 2010* (Government of Alberta 2010). The majority have a status of "Sensitive" or "May be at Risk." However, whitebark pine and limber pine are ranked as "At Risk." Additionally, these two pine species are ranked as "Endangered" under Alberta's *Wildlife Act* (Government of Alberta 2014). All species except white bark pine are listed as globally secure under present conditions (G4 or G5); whitebark pine is listed as G3/G4. A description of the risk ranking for the federal and provincial governments (ACIMS 2014) is included in CR #8, Section 1.4.2. Locations of at-risk and rare species observed in the LSA, along with their descriptions, are provided in CR #8, Figure 3.2-1 and Appendix D.

Whitebark Pine and Limber Pine

Whitebark pine and limber pine have very similar growth forms, habitat preferences, ecological roles, and major threats to their ongoing existence. Limber pine tend to grow at lower elevations than whitebark pine, but their overlapping ranges in the LSA make it potentially difficult to distinguish the two species. These species are important components of high-mountain ecosystems. Threats to whitebark pine and limber pine are white pine blister rust (*Cronartium ribicola*) and mountain pine beetle (*Dendroctonus ponderosae*) (Murray and Krakowski 2013).

Whitebark pine and limber pine stands are scattered throughout the RSA (CR #8, Figure 3.2-2) (ASRD 2005, ACIMS 2014a, BC MFLNRO 2015). Within the LSA, whitebark pine was identified at ten locations in the Subalpine Natural Subregion and limber pine was identified at three locations in the

Subalpine Natural Subregion and one location in the Montane Natural Subregion (CR #8, Table 3.2-1 and Figure 3.2-3).

Additional aerial and ground survey plots were used to estimate the abundance and distribution of whitebark pine and limber pine within the Project Footprint. These trees occur as individuals, sparse clusters, and stands found on both east and west aspects along crest and upper slope positions (CR #8, Figure 3.2-4) (note: this same figure includes mapped polygons of foothills rough fescue, as areas of whitebark pine and foothills rough fescue overlapped, *e.g.*, Whitebark Sparse). The Project Footprint contains approximately 245 ha of closed canopy whitebark stands (Whitebark) and open canopy grassland areas containing sparse whitebark pine (Whitebark Sparse) with a total of approximately 21,000 whitebark trees (Table E.8.2.1). White bark areas total 47.8 ha in size (1.0% of the LSA) while Whitebark Sparse areas total 196.0 ha in size (12.9% of the LSA). The number of pine is a conservative over-estimate as it is based on ground calibration plots extrapolated to entire mapped areas and includes understory and juvenile trees. Table E.8.2-1 indicates the amount of area, and approximate number of trees within the Project Footprint.

Table E.8.2-1 Whitebark Pine Distribution and Stem Count in the Project Footprint

Stand Type	Area (ha)[1]	% of LSA	Approximate Number of Trees
Whitebark – closed canopy stands or patches of whitebark pine /lodgepole pine /fir species;	47.8	1.0	15,203
Whitebark Sparse – open canopy areas with whitebark scattered infrequently across landscape or in small patches (grassland areas containing foothills rough fescue, scree slopes)	196.0	3.4	5,489
Total	**208.4**	**4.3**	**20,692**

[1] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

A few individual limber pine trees were found throughout the Project Footprint during the aerial and ground survey. As they are difficult to distinguish from whitebark pine without cones, and before the pollen season, they were included in the whitebark pine counts. Based on data from the calibration plots, limber pine was estimated to make up less than 1,000 stems across the entire Project Footprint.

Recovery plans for whitebark pine and limber pine have been established in Alberta (Alberta Whitebark and Limber Pine Recovery Team 2014a, b) and forest harvest plans (*e.g.*, C5 and R11 Forest Management Units) have included retention and management guidelines.

E.8.2.2.2 Rare Plant Potential

Ecosite phases assigned 'high' rare plant potential include the Montane b1, f1, and g1 ecosite phases; and Subalpine e1 and h1 ecosite phases. Rare plant potential in the LSA is summarized in CR #8, Table 3.2-3 and Figure 3.2-5.

E.8.2.2.3 Rare Plant Communities

There were no field observations of rare plant communities in the LSA. Approximately 100 rare plant communities are tracked or watched in the Montane and Subalpine Natural Subregions (ACIMS 2014c, d), most of which occur in both Subregions. Rare plant community potential for the LSA is provided in CR #8, Table 3.2-3 and Figure 3.2-6.

E.8.2.3 Rangeland Resources

E.8.2.3.1 Rangelands within the Local Study Area

The two range type communities identified within the LSA were the Rough Fescue-Idaho Fescue-Parry Oatgrass grassland community in the b1 ecosite phase (Montane Subregion) and the Rough Fescue-Sedge (HG) grassland community. The Rough Fescue-Idaho Fescue-Parry Oatgrass grassland community occupied 155.0 ha in the LSA while the Rough Fescue-Sedge community occupied 165.9 ha within the LSA (Table E.8.2-2). The distribution of these communities is provided in CR #8, Figure 3.1-1.

Table E.8.2-2 Range Type Communities in the LSA

Range Type Community	Baseline (ha)[3]
Montane: b1 ecosite phase[1] Rough Fescue-Idaho Fescue-Parry Oatgrass	165.9
SASMA2[2] Rough Fescue-Sedge	155.0
Total	**320.9**

[1] Willoughby *et al.* 2005.
[2] Willoughby and Alexander 2006 (SASMA - Saskatchewan Assessment Management Agency).
[3] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

Range health was assessed at five grassland sites (CR #8, Table 3.3-1 and Figure 3.3-1), all of which were situated on steep, subxeric to mesic, south to southeast facing slopes. All of these of these sites (GM200BE, GM401RE GM404BE, GM406BE, and GM005BE) fall within the Project Footprint (CR #8, Figure 3.3-1). GM200BE was the only site assigned a range health rating of "unhealthy" the rest were rated as "healthy" or "healthy with problems" (CR #8, Table 3.3-2).

E.8.2.3.2 Foothills Rough Fescue Grasslands Community within the Local Study Area

Foothills rough fescue (*Festuca campestris*) was prevalent throughout the five grassland sites assessed within the LSA, with cover at each site ranging from 20% to 40%. The plant community in site GM200BE was assessed as having minor alteration due to the steep slope of the site, with the remaining sites showing little or no alteration to the modal plant community type for the region.

The results of the fieldwork reconnaissance conducted in April 2016 to identify the distribution of range community types within the Project Footprint potentially dominated by the foothills rough fescue is presented in Table E.8.2-3 and in CR #8, Figure 3.2-4. The total area occupied by areas with foothills rough fescue is 219.9 ha. Foothills rough fescue dominant communities (Fescue) occupy approximately 3.4 ha of the Project Footprint and compose an insignificant area of the LSA. Range community types where foothills rough fescue is a sub-dominant component (Grassland Sparse) occupies approximately 18.2 ha of the Project Footprint, and open forest grassland with whitebark pine as the canopy species (Whitebark Sparse) which have foothills rough fescue as a component of the grassland, occupies 197.3 ha of the Project Footprint.

Table E.8.2-3 Foothills Rough Fescue in the Project Footprint

Range Type Community	Baseline (ha)[1]	% of LSA
Fescue – patches of foothills rough fescue dominanted grassland	3.4	<0.1
Grassland Sparse – open grasslands with sub-dominant foothills rough fescue.	18.2	0.4
Whitebark Sparse – open canopy areas with whitebark scattered infrequently across landscape or in small patches (grassland areas [containing foothills rough fescue], scree slopes).	197.3	4.1
Total	**218.9**	**4.6**

[1] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

E.8.2.4 Forest Resources

E.8.2.4.1 Timber Productivity

Timber productivity ratings (TPR) by forest cover classes (coniferous, deciduous, and mixed) in the LSA are summarized in CR #8, Table 3.4-1. Forested land, which includes any treed wetlands and regenerating forest stands, occupies 3,987.0 ha and accounts for 83.1% of the LSA. This land contains an estimated 586,903 m^3 of total timber volume.

Timber volume in the LSA was also calculated by species (CR #8, Table 3.4-2). Lodgepole pine comprised 64.9% of the total calculated volume, followed by white spruce (15.4%) and Douglas fir (12.4%).

E.8.2.5 Old Growth Forests

Old growth forest occupied 167.7 ha (3.5%) of the LSA. The forested areas within the LSA were predominantly early- (young stands) or mid- (mature stands) successional stages (CR #8, Figure 3.5-1). The total areas of old growth forests by each cover-type and canopy closure category are provided in Table E.8.2-4.

Table E.8.2-4 Area of Old Growth Forest within the Local Study Area

ELC Class[1]	Area (ha)[2]	% of LSA
Open Deciduous Forest	32.3	0.7
Open Coniferous Forest	<0.1	<0.1
Moderate Deciduous Forest	18.4	0.4
Moderate Mixed Forest	29.4	0.6
Moderate Coniferous Forest	78.8	1.6
Closed Mixed Forest	8.7	0.2
Total Old Growth Area	**167.7**	**3.5**

[1] Crown closure classes are AVI codes of canopy closure (measured in %) as follows: Dense = 71-100, Closed = 51-70, Moderate = 31-50, and open = 6-30. Cover types are based on the proportion of conifer or deciduous species in the canopy. Deciduous = >80% deciduous, mixed = 30-79% conifer / deciduous, coniferous = >80% coniferous (ASRD 2005). Age cut off for old growth is as follows: deciduous and mixed stands >100 yr., pine stands >120 yr., and coniferous (non-pine) stands >140 yr.
[2] Due to rounding of numbers, total values may not equal the sum of the individual values.

Old growth potential in a specific area is dependent on tree species composition, topography, susceptibility to stand replacing disturbance (*e.g.*, fire) and land use (*e.g.*, logging). Typically, Montane ecosite phases b2, b3, c3, c4, d3, e2, e3, f1, g1, and g2 and Subalpine ecosite phases c1, d1, e3,

e4, f2, and h1 have higher old growth potential (CR #8, Table 3.5-2). Due to the intensity of forest harvesting at the landscape level, all ecosite phases in the LSA have been adjusted to a lower ranking than typical Montane and Subalpine Natural Subregion old growth potential (CR #8, Table 3.5-2 and Figure 3.5-2).

Old growth forest occupies a small proportion (4.7%) of the RSA. Of the 13, 460 ha occupied by old growth forest in the RSA, 4,403.4 ha (1.6% of the RSA) is open coniferous and 1.5% (4,223 ha) is moderate coniferous forest (Table E.8.2-5). Old growth distribution within the RSA is illustrated in CR #8, Figure 3.5-3.

Table E.8.2-5 Area of Old Growth Forest within the Regional Study Area

ELC Class[1]	Area (ha)[2]	% of RSA
Dense Deciduous Forest	6.9	<0.1
Dense Coniferous Forest	438.5	0.2
Closed Deciduous Forest	287.3	0.1
Closed Mixed Forest	79.6	<0.1
Closed Coniferous Forest	2,774.2	1.0
Moderate Deciduous Forest	437.3	0.2
Moderate Mixed Forest	297.9	0.1
Moderate Coniferous Forest	4,223.7	1.5
Open Deciduous Forest	378.8	0.1
Open Mixed Forest	133.1	<0.1
Open Coniferous Forest	4,403.4	1.6
Total old growth in RSA	**13,460.8**	**4.7**

[1] Crown closure classes are AVI codes of canopy closure (measured in %) as follows: Dense = 71-100, Closed = 51-70, Moderate = 31-50, and open = 6-30. Cover types are based on the proportion of conifer or deciduous species in the canopy. Deciduous = >80% deciduous, mixed = 30-79% conifer / deciduous, coniferous = >80% coniferous (ASRD 2005). The age cut off for old growth is as follows: deciduous and mixed stands >100, pine stands >120, and coniferous (non-pine) stands >140.

[2] Due to rounding of numbers, total values may not equal the sum of the individual values.

Areas of old growth potential occupy a small proportion of the RSA (Table E.8.2-6; CR #8, Figure 3.5-4). Similar to the LSA, relative to what is typical for the Montane and Subalpine Natural Subregions, the old growth potential was reduced in the RSA, due to effects of logging and other development on forest communities.

Table E.8.2-6 Old Growth Potential in the Regional Study Area

Ecological Land Cover Class	Area in RSA	% of RSA	Old Growth Potential in the RSA
Dense Deciduous Forest	6.9	<0.1	Moderate
Dense Mixed Forest	105.1	<0.1	Moderate
Dense Coniferous Forest	438.5	0.2	Low
Closed Deciduous Forest	287.3	0.1	Moderate
Closed Mixed Forest	79.6	<0.1	Moderate
Closed Coniferous Forest	2,774.2	1	Low
Moderate Deciduous Forest	437.3	0.2	Moderate
Moderate Mixed Forest	297.9	0.1	Moderate
Moderate Coniferous Forest	4,223.7	1.5	Low
Open Deciduous Forest	378.8	0.1	Moderate
Open Mixed Forest	133.1	<0.1	Moderate
Open Coniferous Forest	4,403.4	1.6	Moderate
Treed Wetland	126.5	<0.1	Moderate

[1] Old growth potential was not assessed for non- forested ELCs reported in CR #8, Table 3.1-3, including shrub and graminoid wetlands, natural vegetated non-forested lands (SO, SC, HG and Rock barren), water and anthropogenic disturbances.

E.8.2.6 Traditional Ecological Knowledge Vegetation Resources

E.8.2.6.1 Traditional Use of Vegetation Resources in the Project Area

The Treaty 7 First Nation groups have traditional uses and vast knowledge of the vegetation community present in the LSA and RSA. The following quotes from their TEK reports illustrate the nature of their traditional uses and TEK:

"The area in and around Grassy Mountain has several hundred plant species that were and are used for medicinal, spiritual, and food purposes." (Kainai Nation 2015).

"Up in the mountains are all our original plants." ~ Piikani Technician (Piikani Nation 2015).

"*Multiple alpine plants found at Grassy Mountain that are crucial to Tsuut'ina Nation ceremony, healing practices, cultural identity, and spirituality are not found at lower elevations near Tsuut'ina Nation*

communities. The medicinal power of a plant can be derived from the root, flowers, leaves, and bark." (Tsuut'ina Nation 2015).

"*Medicinal and ceremonial plants were found in several locations on the project site, particularly in fertile micro-ecosystems and others on sunny slopes.*" (Siksika Consultation Office 2015).

E.8.2.6.2 Traditional Ecological Knowledge Vegetation Occurrence and Potential

Of the 60 valued species identified during the Aboriginal Consultation process and the review of TEK reports, 48 were located within the LSA. The most commonly located valued species were lodgepole pine (*Pinus contorta*), ground juniper (*Juniper communis*), prickly rose (*Rosa acicularis*), common fireweed (*Epilobium angustifolium*), and wild strawberry (*Fragaria virginiana*). TEK species (vascular and non-vascular) observed in the LSA during vegetation field surveys are summarized in CR #8, Table 3.6-1, with further details provided in CR #8, Appendix E.

Three ecosite phases in the Montane Natural Subregion (c1, c4, and g1) and one ecosite phase in the Subalpine Natural Subregion (e1) have high or very high TEK vegetation potential (CR #8, Table 3.6-2 and Figure 3.6-1).

E.8.2.7 Wetlands

In total, wetlands covered 16.9 ha (0.4%) of the LSA and 2,592 ha (0.9%) of the RSA (Tables E.8.2-7 and E.8.2-8; CR #8, Figures 3.7-1 and 3.7-2). Four wetland classes were identified within the LSA and the RSA and all are of limited distribution in both study areas.

Table E.8.2-7 Distribution of Wetland Classes in the Local Study Area

AWI Wetland Class[1]	Area in LSA (ha)[2]	% of LSA[1]
FONS – Shrubby open fen	11.2	0.2
STNN – Wooded open canopy (6-70% cover) swamp	4.8	0.1
WONN – Open water (<2 m deep)	0.5	<0.1
MONG – Open graminoid dominated marsh	0.4	<0.1
Total	**16.9**	**0.4**

[1] Based on Halsey *et al*. 2004.

[2] Due to rounding, totals may be different from sums.

Table E.8.2-8 Distribution of Wetland Classes in the Regional Study Area

Land Cover Class	Ecosite Phase/AVI Equivalent	AWIS Wetland Class Equivalent[1]	Total Area (ha)[2]	% of RSA
Graminoid Wetland	NA	FONG/MONG	158.5	0.1
Shrubby Wetland	Subalpine g1, h2	FONS	762.7	0.3
Open Water	NWF	WONN	1,544.0	0.5
Treed Wetland	Subalpine h1	FTNN & STNN	126.5	<0.1
Total Wetlands	**-**	**-**	**2,591.7**	**0.9**

[1] Based on Halsey *et al*. 2004.

[2] Due to rounding, totals may be different from sums.

- and NA are not applicable.

E.8.2.8 Biodiversity and Fragmentation

E.8.2.8.1 Baseline Biodiversity and Biodiversity Potential in the Local Study Area

Within the LSA, elven Montane and six Subalpine ecosite phases were sampled for biodiversity. Baseline species level and community level biodiversity indicators for these sampled ecosite phases are summarised in CR #8, Tables 3.8-1 and 3.8-2. A total of 37 ecosite phases and 10 naturally occurring non-ecosite units were mapped within the LSA. Twenty-one of the naturally occurring mapped units each occupied <1% of the LSA. Twenty of the naturally occurring mapped units occupied <1% of the LSA each. Subalpine ecosite phase e1 was the most common occupying 20.8% of the LSA followed by Montane ecosite phase d2 (12.4%) and e1 (6.0%). All other mapped ecosite phases occupied <5% each.

In the Montane Subregion the c4 ecosite phase had the highest number of species (163), the c3 ecosite phase had the highest Shannon Diversity Index (2.69), and the a1 and d2 ecosite phases had the highest species evenness (0.76). In the Subalpine Subregion the e1 ecosite phase had the highest number of species (245), and the f1 ecosite phase had the highest Shannon Diversity Index (2.38) and species evenness (0.74).

In the Montane Subregion six ecosite phases / naturally occurring map units are ranked as having high biodiversity potential, nine are ranked as moderate, and eight are ranked as low. In the Subalpine Subregion four ecosite phases / naturally occurring map units are ranked as having high biodiversity potential, eight are ranked as moderate, and one is ranked as very low. The biodiversity potential for all ecosite phases and naturally occurring map units are provided in CR #8, Table 3.8-3.

Areas of potentially high and moderate biodiversity comprise 36.6% and 31.9%, respectively, of the LSA (Table E.8.2-6; CR #8, Figure 3.8-1). Unnatural and disturbed areas not assigned a biodiversity rating comprise 16.1% of the LSA.

E.8.2.8.2 Baseline Fragmentation in the Local Study Area

Within the LSA, large homogeneous patches are found only where the terrain is more subdued. The largest mean natural patch types in the Montane Natural Subregion of the LSA are e1 and e3 ecosite phases. The largest mean patch types in the Subalpine Natural Subregion are e4, e1, and a1 ecosite phases (CR #8, Table 3.8-5). In terms of landscape level fragmentation, existing disturbance in 339 anthropogenic patches cover 16.3% of the LSA, which includes 185.2 ha of previous mining disturbance within the Project Footprint. The mean size of anthropogenic patches is 2.3 ha, and the mean size of natural patches is 5.9 ha (CR #8, Table 3.8-6).

E.8.2.8.3 Baseline Fragmentation in the Regional Study Area

Of the natural ELC classes in the RSA, 26 are rare. Mature closed coniferous forest (12.1%), mature open conifer forest (9.4%), and natural upland herb (13.6%) are the most abundant natural ELC classes within the RSA. Mature dense mixed forest had the greatest mean distance to its nearest neighbour (5,440.6 m), barren land had the highest core index (90.9%), and mature open conifer forest had the highest patch density (99.9/km^2). Young dense mixed forest has the lowest mean patch area (0.9 ha) and comprised <0.01% of the RSA, while barren lands had the lowest mean perimeter area (96.4 m/ha). The baseline condition and fragmentation measures for ELC classes mapped in the vegetation RSA are presented in CR #8, Table 3.8-7.

E.8.2.9 Noxious and Invasive Species

The baseline field surveys identified nine noxious weeds and 20 invasive vegetation species within the LSA (CR #8, Table 3.9-1, Figure 3.9-2, and Appendices E and G). The majority of the noxious and invasive species were observed in areas with existing disturbance (*i.e.*, pipelines, well sites, clearings, pastures, cutblocks, and along roads).

E.8.2.10 Potential Acid Input and Nitrogen Deposition

The modelled baseline levels of PAI within the LSA and RSA ranged from 0.11 to less than 0.025 keq H^+/ha/yr. Modelled baseline levels for nitrogen deposition within the LSA and RSA ranged from 6.5 to less than 2.5 kg/ha/yr.

Baseline values of PAI were not found to exceed the critical values of soils with high sensitivity (0.25 keq H^+/ha/yr) and the Baseline Case for nitrogen deposition may exceed critical loads in isolated locations. Areas of exceedance are related to the settlements and transportation infrastructure

currently in the study area. Details on models and results can be found in CR #1, Air Quality & Climate.

E.8.3 Potential Impacts

The assessment approach to determine Project effects / impacts involved completing impact analyses related to abundance, distribution and quality of vegetation and wetland resources.

E.8.3.1 Vegetation Community

The Project Footprint occupies 1,520.7 ha, which equates to the physical disturbance of 31.7% of LSA (CR #8, Tables 4.1-1 and 4.1-2). All ecosite phases mapped in the LSA occur in the Project Footprint, including those of limited distribution. The Project will remove 1,042.7 ha of ecosite phases, 3.2 ha of lowlands, 195.6 ha of non-forested land, and 0.1 ha natural non-vegetated land. The remaining area occupied by the Project Footprint is already disturbed anthropogenic land.

E.8.3.2 Species at Risk, Rare Plants and Rare Plant Communities

Construction and operation of the Project would result in the removal of all 27 rare plants observed within the Project Footprint (CR #8, Figure 3.2-1 and Table 4.2-1). These species include 11 vascular plant species, 9 mosses and liverworts, and 7 lichen species. Communities of limited distribution occurring in the Footprint will also be impacted by the Project.

The Project will disturb approximately 208.4 ha of whitebark and open grassland areas containing a sparse whitebark pine canopy, for a total of approximately 21,000 whitebark pine trees and less than 1,000 limber pine trees.

Project effects on areas of high, moderate, and low rare plant potential and rare plant community potential are summarized in Tables E.8.3-1 and E.8.3-2. Within the Montane Natural Subregion, impacts on rare plant potential are greatest for areas of moderate potential, but similar across rare community potential categories (based on % lost). In the Subalpine Natural Subregion, areas of high rare plant potential and high rare community potential (based on % lost) will be impacted most.

Table E.8.3-1 Application Case Effects on Rare Plant Potential in the Local Study Area

Rare Plant Potential	Ecosite Phase / Land Class[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Montane					
High	b1, f1, g1	119.0	101.2	-17.8	-15.0
Moderate	a1, c1, c2, c4, d2 d3, e1, e2, e3, g2, HG, SC	1,761.7	1249.9	-511.9	-29.1
Low	b2, b3, c3, d1, NMR, SO	1,77.4	137.8	-39.6	-22.3
Total Montane	**-**	**2,058.1**	**1,488.8**	**-569.3**	**-27.7**
Subalpine					
High	e1, h1, HG	1,199.1	734.0	-465.2	-38.8
Moderate	a1, d1, e2, e3, f1, f2	383.1	290.0	-93.1	-24.3
Low	b1, e4, NMR, SO	222.8	131.8	-91.1	-40.9
Total Subalpine	**-**	**1,805.0**	**1,155.7**	**-649.3**	**-36.0**
Total LSA	**-**	**3,863.1**	**2,644.5**	**-1,218.6**	**-31.6**

[1] Ecosite phases / land class descriptions are as provided in CR #8, Table 4.1-1.

[2] Baseline and application case areas and rare plant potential for each ecosite / land class are provided in CR #8, Table 4.1-1. Due to rounding of numbers, total values may not equal the sum of the individual values.

- not applicable.

Table E.8.3-2 Application Case Effects on Rare Plant Community Potential in the Local Study Area

Rare Plant Community Potential	Ecosite Phase / Land Class Description[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Montane					
High / Very high	a1, HG, SC	207.8	144.3	-63.4	-30.5
Moderate	b3, c4, d3, e2, e3, g1, g2, NMR	471.5	328.8	-142.7	-30.3

Table E.8.3-2 Application Case Effects on Rare Plant Community Potential in the Local Study Area

Rare Plant Community Potential	Ecosite Phase / Land Class Description[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Low / Very low	b1, b2, c1, c2, c3, d1, d2, e1, f1, SO	1,548.3	1,185.2	-382.9	-24.7
Total Montane	**-**	**2,227.5**	**1,638.5**	**-589.0**	**-26.4**
Subalpine					
High	e2, HG	169.3	65.7	-103.6	-61.2
Moderate	a1, d1, e3, e4, f2, NMR, SO	331.9	267.0	-64.9	-19.6
Low	b1, e1, f1, h1	1,303.8	823.1	-480.8	-36.9
Total Subalpine	**-**	**1,805.0**	**1,155.7**	**-649.3**	**-36.0**
Total LSA	**-**	**4,032.6**	**2,794.2**	**-1,238.3**	**-30.7**

[1] Ecosite phases / land class are from Archibald *et.al.* 1996 and ASRD 2005.

[2] Baseline and Application Case areas and rare plant potential community for each ecosite / land class are provided in CR #8, Table 4.1-1. Due to rounding of numbers, total values may not equal the sum of the individual values.

- not applicable.

E.8.3.3 Rangeland Resources

The areas of native grasslands, including description of the specific native communities, in the LSA potentially impacted by the proposed Project are presented in Table E.8.3-3. The Project would remove 73.8 ha (44.5%) of native montane grassland and 89.8 ha (57.8%) of native subalpine grassland in the LSA. Approximately 50% of the native grasslands within the LSA would be removed.

Table E.8.3-3 Application Case - Effects on Native Grasslands in the Local Study Area

Range Type Community	Area (ha)[3]		Change from Baseline	
	Baseline	Application	Area (ha)	% Change
Montane: b1 ecosite phase[1] Rough Fescue-Idaho Fescue-Parry Oatgrass	165.9	92.1	-73.8	-44.5
SASMA2[2] Rough Fescue-Sedge	155.5	65.7	-89.8	-57.8
Total	**320.9**	**157.7**	**-163.6**	**-51.0**

[1] Willoughby *et al.* 2005.
[2] Willoughby and Alexander 2006.
[3] Due to rounding of values, totals may not equal the sum of the individual values presented in the table

The aerial reconnaissance conducted in April 2016 allows for better delineation of range community types containing foothills rough fescue grass (*Fescue campestris*), in particular those contained within lands mapped as forest units in the Project Footprint. The area occupied by these rangeland community types that will be disturbed by the Project are 218.9 ha. This includes areas identified from the air as Fescue, Grassland Sparse, and Whitebark Sparse lands based on the dominant cover (pine species or grass species).

E.8.3.4 Forest Resources

Within the LSA, Project development will result in the removal of 436,436.4 m^3 or 74.4% of the total timber volume from the LSA, including 202.1 ha (77.6%) of forest with a good timber productivity rating, 1,963.9 ha (72.8%) with a medium rating, 648.1 ha (65.4%) with a fair rating and 2.2 ha (6.0%) of unproductive forest rating (Table E.8.3-4). Of this total volume, 277,156.6 m^3 is lodgepole pine (CR #8, Table 4.4-2). The 786 m^3 of whitebark pine based on the AVI data available are outside the Footprint and are not removed by the Project.

Table E.8.3-4 Application Case Effects on Timber Productivity Rating in the Local Study Area

Cover Class	TPR	Volume (m^3)		Change in Baseline		Area (ha)[1]		Change in Baseline	
		Baseline[1]	Application Case[1]	Volume[1]	% Change[1]	Baseline[1]	Application Case[1]	Area (ha)[1]	% Change[1]
Coniferous	Good	59,053.9	9,672.3	-49,381.6	-83.6	260.5	58.4	-202.1	-77.6
Coniferous	Medium	406,683.6	102,608.2	-318,843.6	-74.5	2,698.4	734.5	-1,963.9	-72.8
Coniferous Leading		774.1	506.7						
Deciduous Leading		11,841.7	5,254.4						
Deciduous		8,434.3	520.8						
Coniferous	Fair	87,275.2	24,432.3	-68,092.1	-69.6	991.7	343.5	-648.1	-65.4
Deciduous Leading		6,632.7	4,821.9						
Deciduous		3,969.6	531.3						
Coniferous	Unproductive	2,238.3	2,119.2	-119.1	-5.3	36.4	34.2	-2.2	-6.0
Total LSA (Forested)		**586,903.4**	**150,467.0**	**-436,436.4**	**-74.4**	**3,987.0**	**1,170.6**	**-2,816.4**	**-70.6**

[1] Area occupied by non-forested lands was not rated for timber productivity and is not included in the TPR area summaries. Due to rounding of numbers, total values may not equal the sum of the individual values.

E.8.3.5 Old Growth Forests

Of the 167.7 ha of old growth forest in the LSA, only 27.4 ha (16.3% of old growth) are located within the proposed Project Footprint (located along the power line, access and overland conveyor route, and a small portion within the CHPP) (CR #8, Table 4.5-1 and Figure 3.5-1). Mixed old growth stands with a closed canopy closure (51-70% closure) would primarily be impacted, with 5.7 ha (64.7 %) of these old growth stands being removed. Moderate coniferous old growth stands will also be affected by the Project, with 18.1 ha (23.0 %) of these old growth stands being removed. Moderate mixed and moderate deciduous old growth stands do not occur in the Footprint; subsequently, they would not be directly impacted. The Project would reduce the area with potential to support old growth forests by 1,042.8 ha (28.5%) (Table E.8.3-5).

Table E.8.3-5 Application Case Effects on Old Growth Potential in the Local Study Area

Rare Plant Potential	Ecosite Phase[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Montane					
Moderate	b2, b3, c3, c4, d3, e2, e3, f1, g1, g2	530.7	386.8	-143.9	-27.1
Low	a1, b1, c1, c2, d1, d2, e1	1,532.3	1,157.4	-374.9	-24.5
Total Montane	**-**	**2,063.0**	**1,544.2**	**-518.8**	**-25.1**
Subalpine					
Moderate	d1, e1, e4, f1, h1	1,161.2	709.9	-451.3	-38.9
Low	a1, b1, e2, e3, f2	438.5	365.8	-72.6	-16.6
Total Subalpine	**-**	**1,599.6**	**1,075.7**	**-523.9**	**-32.8**
Total Potential	**-**	**3,662.7**	**2,619.9**	**-1,042.8**	**-28.5**

[1]Ecosite phases from Archibald *et al.* 1996.

[2]Baseline and application case areas and old growth potential for each ecosite / land class are provided in CR #8, Table 4.1-1. Due to rounding of numbers, total values may not equal the sum of the individual values.

- not applicable.

E.8.3.6 Traditional Ecological Knowledge Vegetation Resources

The Project would remove 1,042.8 ha (28.5%) of ecosite phases that support TEK vegetation potential (Table E.8.3-6). These include 102.4 ha and 0.8 ha of very high or high TEK potential areas in the Montane Natural Subregion and the Subalpine Natural Subregion, respectively.

Table E.8.3-6 Application Case – Effects on TEK Plant Potential in the Local Study Area

TEK Plant Potential	Ecosite Phase / Land Class Description[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Montane					
High	c1, c4, g1	374.3	271.9	-102.4	-27.3
Moderate	b1, b2, b3, c2, c3, d1, d2, d3, e1, e2, e3, f1	1600.8	1187.9	-412.9	-25.8
Low	a1, g2	88.0	84.4	-3.6	-4.1
Total Montane	**-**	**2,063.0**	**1,544.2**	**-518.8**	**-25.1**
Subalpine					
Very high	d1	0.8	0.0	-0.8	-100.0
Moderate	a1, b1, e3, e4, f2, h1	489.7	391.0	-98.7	-20.1
Low / Very low	e1, e2, f1	1,109.1	684.7	-424.5	-38.3
Total Subalpine	**-**	**1,599.6**	**1,075.7**	**-523.9**	**-32.8**
Total LSA	**-**	**3,662.7**	**2,619.9**	**-1,042.8**	**28.5**

[1] Ecosite phases are from Archibald *et al.* 1996.

[2] Due to rounding of numbers, total values may not equal the sum of the individual values.

- not applicable.

Note: For individual species or groups of species identified during the consultation process many are common and occur within a range of ecosites. For example pine, poplar, rose, raspberry, fireweed are common species with wide distributions. Other TEK species or groups of species identified, such as tree lichens and fungus, are common but occur primarily in late succession within mature and old forests. For these species, removal by the project will have an extended effect similar to that described for the assessment of the old growth forest VC (Section 4.5).

E.8.3.7 Wetlands

The area of wetlands that would potentially be impacted by the Project in the LSA is presented in Table E.8.3-7 (CR #8, Figure 3.7-1). Of the four AWIS wetland types identified in the LSA, three occur in the Project Footprint with a total of 9.7 ha (57.2%) being impacted by the Project. Shrubby open fens (FONS) would be the most impacted by the Project with 9.6 ha (85.0%) being removed. None of the AWIS wetland types would be completely removed from the LSA.

Table E.8.3-7 Application Case Effects on Wetlands in the Local Study Area

Wetland Class[1]	Area (ha)[2]		Change from Baseline (Without Mitigation)	
	Baseline	Application	Area (ha)[2]	% Change
FONS – Shrubby open fen	11.2	1.7	-9.6	-85.0
STNN – Treed swamp	4.8	4.8	0.0	0.0
WONN – Open water (<2 m deep)	0.5	0.4	-0.1	-13.7
MONG – Open graminoid dominated marsh	0.4	0.3	-<0.1	-8.8
Total LSA	**16.9**	**7.3**	**-9.7**	**-57.2**

[1] Based on Halsey *et al*. 2004.

[2] Due to rounding of numbers, total values may not equal the sum of the individual values.

E.8.3.8 Biodiversity and Fragmentation

To assess potential Project effects on biodiversity at the species, community and landscape level requires the integration of many components from CR #8. As described in CR #8, Sections 1.4.8 and 2.3.8 species level biodiversity assessment includes a wide variety of factors, as does community level biodiversity. This information is combined into a biodiversity potential as described in CR #8, Section 2.3.8.2.

As described in CR #8, Sections 1.4.8 and Sections 2.3.8.3, landscape biodiversity also incorporates communities and their distribution and abundance as well as fragmentation measures (CR #8, Table 2.3-2).

E.8.3.8.1 Application Case

Construction of the Project will impact 1,520.7 ha (31.7% of the LSA) of plant communities and other patches. This includes 274.2 ha of anthropogenic disturbance of which approximately 185.2 ha is previously unreclaimed mining disturbance that have only partially naturally revegetated (CR #8, Figure 3.0-1).

E.8.3.8.1.1 Application Case Effects on Species Diversity in the LSA

Construction and operation of the Project will result in the removal of all vegetation from the Project Footprint and a temporary reduction of native species diversity in the LSA (Section E.8.3.1; CR #8, Section 4.1, Tables 4.1-1).

After closure and initial reclamation, native species richness is expected to be lower than intact naturally developed vegetation in the LSA, except on previously disturbed areas, where species richness will increase with mitigation. The reclaimed landscape proposed for the project is included in Section F, Conservation and Reclamation Plan.

The project will have a direct effect on rare plants in the project footprint. With the exception of whitebark pine all rare species identified are considered globally secure (CR #8, Table 4.2-1). Specific mitigation for rare plant species including whitebark pine is included in CR #8, Section 4.2.6.

E.8.3.8.1.2 Application Case Effects on Community and Landscape Diversity in the LSA

Changes to the abundance of individual communities for the application case are described in Section E.8.3.1 and CR #8, Section 4.1 and provided again below with but from a perspective of a fragmentation assessment. At the community level, the impact of the Project by removal or reduction of plant communities is assessed with biodiversity potential that summarises a number of different indicators of diversity into a relative ranking from Very Low to Very High (Section E.8.2.8; CR #8, Table 2.3-3, and Section 4.8.1.2). A summary of selected biodiversity indicators by ecosite phase/land class is provided in CR #8, Table 4.8-1.

Construction and operation of the Project will result in the removal of 1,068.2 ha from the LSA of ecosite phases with moderate to high biodiversity potential (CR #8, Table 4.8-2). This includes ecosite phases of limited distribution in the LSA (<1% area) and identified with high biodiversity potential.

The Conservation and Reclamation Plan, Section F, plans for the establishment of closed conifer forest, mixed forests and open forest with grassland patches. Ecosite phases/land classes roughly corresponding to these classifications include a mix of high (*e.g.*, herb-graminoid (HG)), moderate and low biodiversity potential (*e.g.*, Montane e1).

E.8.3.8.1.3 Application Case Effects on Fragmentation in the LSA

Biodiversity decreases with increased fragmentation (Weaver and Kellman 1981, Simberloff and Gotelli 1984, Peterken and Game 1984, Webb and Vermaat 1990, Forman 1995), thus landscape fragmentation was considered in the assessment of community and landscape level biodiversity.

The Application Case presented here assumes no progressive reclamation or mitigation of any kind, and considers the entire 1,520.7 ha Project Footprint a single anthropogenic disturbance.

CR #8, Table 4.8-3 provides the Application Case results for biodiversity and fragmentation measures for the LSA based on the assumptions above. CR #8, Table 4.8-4 provides the results of Baseline – (minus) Application Case values for each ecosite phase / land class, which constitutes the Application Case effects on biodiversity and fragmentation in the LSA. CR #8, Table 4.8-5 summarises results are for natural and anthropogenic areas.

As expected, the most abundant ecosite phases and land classes in the Footprint at Baseline will experience the greatest loss in total area, core area, and perimeter area with the Project (Application Case). In this Application Case, the Project effects will result in a decrease in the total number of natural patches from 1,024 to 989 and the mean natural patch area will decrease from 5.9 ha to 4.3 ha. (Table E.8.3-8; CR #8, Table 4.8-4). Overall, landscape level fragmentation metrics demonstrate a reduction in the total number of patches (natural and anthropogenic), which is indicative of removing many smaller undisturbed natural patches that existed at Baseline Case, and replacing them with a few anthropogenic disturbed patches in the Application Case.

Table E.8.3-8 Application Case - Effects on Fragmentation Statistics for Local Study Area (Without Mitigation)

Land Cover Type	# of Patches	Mean Patch Area (ha)	Total Patch Area (ha)[1]	Core Area (ha)	Patch Density (#/100 km²)	Perimeter Length (m)	Mean Perimeter : Area (m/ha)	Core Area Index (%)
Baseline Case								
Natural	685	5.9	4,014.1	3,146.2	1,340.2	935,749.1	233.1	78.4
Anthropogenic	339	2.3	783.6	524.9	721.2	447,112.5	570.6	67.0
Combined	1,024	4.7	4,797.6	3,671.2	2,134.4	1,382,861.6	288.2	76.5
Application Case (Without Mitigation)								
Natural	643	4.3	2,788.6	2,149.6	1,340.2	700,071.9	251.0	77.1
Anthropogenic	346	5.8	2,009.0	1,744.2	721.2	394,909.4	196.6	86.8

Table E.8.3-8 Application Case - Effects on Fragmentation Statistics for Local Study Area (Without Mitigation)

Land Cover Type	# of Patches	Mean Patch Area (ha)	Total Patch Area (ha)[1]	Core Area (ha)	Patch Density (#/100 km²)	Perimeter Length (m)	Mean Perimeter : Area (m/ha)	Core Area Index (%)
Combined	989	4.9	4,797.6	3,893.8	2,061.4	1,094,981.3	228.2	81.2
Difference (Baseline Case – Application Case)								
Natural	**-7**	**-3.5**	**-1,225.4**	**-1,219.3**	**0.0**	**52,203.1**	**374.0**	**-19.8**
Anthropogenic	**42**	**1.5**	**1,225.4**	**996.6**	**0.0**	**235,677.2**	**-17.9**	**1.3**
Combined	**35**	**-0.2**	**0.0**	**-222.7**	**73.0**	**287,880.3**	**60.0**	**-4.6**

[1] Due to rounding of numbers, total values may not equal the sum of the individual values.

E.8.3.9 Noxious and Invasive Species

Eight (15 occurrences) out of the nine noxious weed species identified in the LSA occur in the Project Footprint (CR #8, Section 4.9.1). These species include *Bromus tectorum, Chrysanthemum leucanthemum, Cirsium arvense, Echium vulgare, Linaria dalmatica, Linaria vulgaris, Ranunculus acris,* and *Verbascum Thapsus* (CR #8, Figure 3.9-1). Invasive species were found throughout the LSA and noxious species were observed primarily along existing disturbances.

E.8.3.10 Potential Acid Input and Nitrogen Deposition

PAI is not likely to affect vegetation within the LSA or RSA. The predicted maximum PAI increased slightly from the Baseline case of 0.11 to 0.18 keq H+/ha/yr in the Application case when the Application Case model isopleths were overlain on the LSA and RSA maps. Refer to CR #7, Terrain and Soils for more details on Project effects on potential acid input.

The Project is predicted to increase the area affected by nitrogen deposition increased, but the extent of area is limited and is not expected to have a discernable impact on the plant communities at either a local or a regional scale (CR #8, Section 4.10.1). During operations, outside the footprint the area of nitrogen deposition expected to exceed 5 kg/ha/yr increases by only 10 ha with the application case over baseline and the maximum predicted nitrogen deposition at the mine permit boundary was 3.0 kq/ha/yr for Application and PDC cases, well below threshold levels.

E.8.4 Cumulative Effects

Based on the residual effects of the Project determined from the Application Case assessment, cumulative effects assessment (based on the Planned Development Case) was required for three VCs (CR #8, Section 5.1); vegetation community, wetlands, and fragmentation related to biodiversity.

For the remaining VCs, residual effects of the Project were assessed to be not significant, and the cumulative effects were assumed to also be not significant. A detailed description of the environmental assessment approach is included in CR #8, Section 2.4 and Section 4.0. Projects assessed in the PDC to determine cumulative effects are provided in CR #8, Table 2.4-1.

E.8.4.1 Vegetation Community

The main driver of cumulative effects in the RSA is forest harvesting. Throughout the lifetime of the Project, other planned developments/activities are expected to result in an additional 624 ha of sustainable forest harvest within the LSA and an additional 13,530.7 ha of forest harvesting within the RSA. Additional area disturbed by Teck Coal Limited is approximately 80.8 ha and the Highway 3 re-alignment will add 91.5 ha of disturbance.

Cumulative effects on the vegetation communities within the RSA were assessed for Years 14, 22, and 41 and are anticipated to be not significant (CR #8, Section 4.1.6).

E.8.4.2 Wetlands

The Project will have a positive contribution to wetlands following planned reclamation in the LSA, which increases the total area of treed swamps (STNN) from 4.8 ha to 20.3 ha. Open water (not classified as wetlands) also increases to 87.6 ha in the LSA due to ponds and the pit lake, as does potentially a shallow open water wetland (WONN) and/or marsh (MONG) potentially created around the margins of the pit lake (Conservation and Reclamation Plan, Section F). Cumulative effects in the RSA include a net loss of 18.4 ha of treed wetlands as a result of planned timber harvest and other developments. These effects are projected to not be significant (CR #8, Section 4.7.5)

E.8.4.3 Fragmentation

Cumulative and incremental effects of the Project were assessed using the ELC cover classes as they align with the planned reclamation for the Project. To assess potential cumulative effects for biodiversity and fragmentation in the RSA, two time periods were selected for the assessment; Year 14 and Year 41. Details of the methods and results are provided in CR #8, Section 4.8.2, and Tables 4.8-7 to 4.8-10.

The fragmentation statistics from the first comparison (Baseline Case [T14] and Application Case [T14]) assess the maximum amount of fragmentation effects associated with the Project in the RSA, and with mitigation included. The second comparison (Application Case [T14] and PDC [T14]) assesses the fragmentation cumulative effects from the other planned projects in the PDC but not the Project as the Project is already included in both scenarios. The fragmentation statistics from the third comparison (Baseline Case [T41] and PDC [T41]) assesses the fragmentation effects from a) the Project itself and b) the other planned projects in the PDC, when the Project disturbance is mitigated (fully reclaimed) and aged to T41 with associated structural changes to the ELC map units included. The fragmentation statistics from the fourth comparison (PDC with Project [T41] and PDC without Project [T41]) assesses the effects from the Project after mitigation and aging and structural changes to the landscape at 41 years.

A great deal of the RSA is currently fragmented and the amount of fragmentation is expected to increase over time with forest harvesting being the largest contributor. At Year 14 in the LSA, fragmentation in most habitats is expected to slightly increase because of impacts from the Project itself. By Year 41, fragmentation within the LSA will be reduced because of reclamation (Conservation and Reclamation Plan, Section F), but within the RSA fragmentation is expected to increase from projects included in the PDC. Due to the already highly fragmented condition of the Project Footprint, the Project contribution to the increase in fragmentation cumulative effects is minimal and positive compared to other projects included in the PDC, especially compared to forest harvesting in the RSA. Establishing large contiguous forest patches, during reclamation, on the landscape will somewhat offset the unnaturally small patches created by harvesting.

Overall, the cumulative effects on fragmentation are projected to be not significant. The Project will have a positive effect on landscape level fragmentation due to the already highly fragmented condition of the Project Footprint that will be reclaimed. With reclamation, the Project will contribute large patches of closed conifer forest to the landscape providing an improved patch size distribution by offsetting the numerous small patches and linear disturbances caused by historical and ongoing human activities (Conservation and Reclamation Plan, Section F). Having a distribution of patch sizes is beneficial and has been identified as a forest management goal for the region.

E.8.5 Mitigation and Monitoring

E.8.5.1 Mitigation

Progressive reclamation of the Project Footprint to equivalent land capability provides the primary measure required to mitigate the impacts on vegetation and wetland VCs. Project mitigation will aim to reclaim not only the new disturbances from the Project but also areas previously disturbed from historic mining operations and from roads and oil and gas developments. The reclamation of the

185.2 ha of the Project Footprint left un-reclaimed from previous mining operations is a positive outcome of the Project, especially as the previous mining operations are over 55 years old and have only partially revegetated by natural processes. Mitigation measures will include, but are not limited to, the following (further details in CR #8, Section 5.2):

- a re-vegetation program which aims to establish diverse native vegetation communities (closed conifer forests, grassland open forests, mixed forests, and treed wetlands) with equivalent pre-disturbance capability;
- a Conservation and Reclamation Plan (Section F)which aims to establish communities that are locally and regionally limited in distribution where conditions allow;
- preservation of adjacent vegetation communities by minimizing the area required for construction and operation of the Project;
- provision of appropriate soil substrate where re-vegetated areas can establish;
- seeding of stockpiled reclamation material with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment;
- use of coarse woody debris and direct soil placement techniques to augment mycorrhizal and microbial inoculums;
- use direct placement of soil for provision of propagules to enhance opportunity for re-establishment of native species composition and enhanced species richness;
- planting of multiple layers of native vegetation (*e.g.*, trees, shrubs and graminoids) to provide initial structure for wildlife habitat and to enhance biodiversity;
- based on the described selection criteria implement the seed collection, propagation and/or relocation plan for rare species; and
- establish disease-resistant whitebark pine.

In addition to the strategies noted above, the preferred primary mitigation strategy for native foothills rough fescue grasslands is avoidance. Until disturbance is unavoidable, the following mitigation strategies will be implemented to preserve the resource:

- construct, or undertake assessments and surveys, during the dormant period for rough fescue (August to March); and
- avoid soil disturbance (Desserud 2006; Government of Alberta 2010a) by:
  - minimizing topsoil stripping and grading;
  - utilizing existing trails; and
  - potential implementation of seed collection and propagation plan and/or direct placement of sod.

Where disturbance is unavoidable, where feasible, mitigation strategies will include direct placement of reclamation material (including potential transplantation of rare plants or of foothills rough fescue sod), collection of native seed from areas with foothills rough fescue and rare plants that will be disturbed, seeding of wild harvest seed, as part of a certified, weed-free native seed mixes in re-vegetation plan, and the potential seeding and growing of plugs grown in a greenhouse to be transplanted onto the site.

For old growth forests, additional mitigation measures should include reclamation with tree species capable of achieving of old growth conditions. As a rare tree species with a specific conservation plan, whitebark pine mitigation will focus on the goals of introducing white pine blister rust resistant strains and conserving genetic diversity during reclamation. To preserve genetic diversity, clusters of whitebark pine will be investigated for suitability for cone/seed collection prior to disturbance and seed collection would include selection of trees showing evidence of white pine blister rust resistance. Conditions and strategies for establishing whitebark pine during reclamation include:

- identification of high light, low competition sites;
- planting in pure stands or patches to avoid competition from other trees;
- avoiding planting in swales and frost pockets;
- creation of microsites for seedling establishment (rocks, stumps or other coarse woody debris);
- use of recommended spacing to avoid interspecies competition; and
- planting seedlings in the fall to avoid hot dry summer conditions.

Given that various wetland classes are rare in the Project Footprint and in the region, added mitigation measures for wetland impacts should include the following:

- use of best practices to maintain the hydrologic regime of mineral soil wetlands;
- creation of transition areas between re-vegetated ELCs as outlined in the reclamation plan to the treed swamps, where it is possible and/or appropriate to do so; and
- placement of culverts within wetlands that will be divided by roads to ensure that water flow between wetlands will not be affected.

At closure with reclamation, an additional 18.2 ha of treed wetlands (STNN) will be added to the Project Footprint, and potentially another 1.8 ha of shallow open water (WONN) and/or open graminoid marsh will be added in the littoral zone around the end pit lake. This approach to wetland mitigation for the Project is consistent with the *Alberta Wetland Policy* (Government of Alberta 2013b) which focuses on the following outcomes: wetlands and their benefits are restored if removed by a project; wetlands are managed by avoiding, minimizing, and if necessary, replacing lost wetland

value due to project activities, and wetland management of a project considers wetlands in a regional context. For the Project, wetlands have been avoided or disturbance minimized where possible and any removed wetlands will be replaced / restored during reclamation activities.

Supplementary mitigation measures for TEK vegetation impacts include the following:

- consult with and involve First Nations in designing mitigation measures for sustainable management of TEK vegetation;
- implement a re-vegetation program that aims to re-establish vegetation communities that are common to the pre-disturbed landscape and that will support TEK vegetation; and
- where practicable utilize locally collected seed to preserve the legacy of species and of place.

Measures taken to mitigate the loss of vegetation and wetlands and to attenuate the spread of non-native and invasive species will also mitigate overall loss of biodiversity. Project impacts related to fragmentation will decrease, following the implementation of mitigation measures. The Project will reduce the amount of historical fragmentation present from existing disturbances (primarily previous mining operations), as well, through tree planting programs on previously disturbed areas.

E.8.5.2 Monitoring

Re-vegetation monitoring will include, but not be limited to, the following:

- periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation; and
- survival, growth and health assessments of re-vegetated areas to monitor the effectiveness of reclamation efforts relative to re-vegetation targets (including noxious and invasive species and effectiveness of control methods).

Wetland monitoring will include, but not be limited to, the following:

- monitoring and maintenance of drainage control structures should be conducted regularly to ensure water flow and flow patterns are maintained in wetlands adjacent to the Project Footprint;
- monitoring road removal at Project closure ensure restoration of the hydrologic regime;
- continue monitoring for a minimum of ten years to ensure composition, structure, and key wetland functions are consistent with those prior to the Project disturbance; and
- include the use of sub-emergent vegetation species as indicators of wetland health and integrity in the monitoring program.

Ongoing reclamation and re-vegetation of disturbed areas no longer required for Project-related activities will be maintained throughout the life of the Project. Reclaimed plant communities, wetlands, aquatic ,and riparian environments will be designed to support wildlife habitats, forest resources, TEK vegetation, old growth forests, rare plants, and rare plant communities. Detailed rare plant mitigation strategies, including whitebark pine, are included in, Section 4.2.6. Overall detailed reclamation and re-vegetation strategies and goals are provided in the proposed Reclamation Plan for the Project (Section F).

E.8.6 Summary

A summary of the Project impact on the assessed VCs is provided in Table E.8.6-1. With mitigation and monitoring, overall Project residual impacts in the LSA are characterised as being not significant for all assessed VCs. Similarly, cumulative impacts assessed for the vegetation community, wetlands, and biodiversity fragmentation VCs are anticipated to be not significant.

Table E.8.6-1 Summary of Impacts on Vegetation Components

VC Potential Impact or Effect	Mitigation / Protection Plan	Type of Impact	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence – Ecological Context[8]	Significance
1. Terrestrial Vegetation/Plant Communities or Ecosite Phases											
Reduction in Plant Community Types & Area	Yes	Application	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant
2. Rare Plants, Rare Plant Communities and Rare Plant Potential											
Removal of rare plant potential	Yes	Application	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant
Removal of Rare Plants	Yes	Application	Local	Extended	Continuous	Reversible Long Term	High	Negative	High	High	Not Significant
Removal of whitebark (and limber pine)	Yes	Application	Regional	Extended	Continuous	Reversible Long Term	High	Positive (Neutral)	High	High	Not Significant
3. Rangeland Resources											
Removal of Rangelands	Yes	Application	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant
4. Forest Resources											
Removal of Forested stands	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Not Significant

Table E.8.6-1 Summary of Impacts on Vegetation Components

VC Potential Impact or Effect	Mitigation / Protection Plan	Type of Impact	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence – Ecological Context[8]	Significance
5. Old Growth Forests											
Removal of Old Growth Forests	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Positive	High	High	Not Significant
6. Traditionally Used Plants											
Removal of TEK species	Yes	Application	Local	Extended	Continuous	Reversible	High	Neutral	High	High	Not Significant
7. Wetlands											
Reduction in Types & Area	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Moderate	Positive	High	High	Not Significant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Moderate	Positive	High	High	Not Significant
8. Biodiversity											
Reduction in Species Diversity	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Moderate	Negative	Moderate	High	Not Significant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Moderate	Negative	Moderate	High	Not Significant
Reduction of Community Diversity	Yes	Application	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	High	Neutral	High	High	Not Significant

Table E.8.6-1 Summary of Impacts on Vegetation Components

VC Potential Impact or Effect	Mitigation / Protection Plan	Type of Impact	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence – Ecological Context[8]	Significance
Reduction of Landscape Diversity	Yes	Application	Regional	Residual	Continuous	Irreversible	Moderate	Positive	High	High	Not Significant
		Cumulative	Regional	Residual	Continuous	Irreversible	Moderate	Positive	High	High	Not Significant
9. Noxious Vegetation Species											
Spread of Invasive & Noxious Species	Yes	Application	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Not Significant
10. Potential Acid Input and Nitrogen Deposition											
Potential Acid Input and Nitrogen deposition	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Not Significant

[1] Local, Regional, Provincial, National, Global
[2] Short, Long, Extended, Residual
[3] Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
[4] Reversible in short term, Reversible in long term, Irreversible – rare
[5] No Impact, Low Impact, Moderate Impact, High Impact
[6] Neutral, Positive, Negative
[7] Low, Moderate, High
[8] Low, Medium, High
[9] Significant, In-significant

E.9 WILDLIFE

E.9.1 Introduction

Benga conducted a Wildlife Assessment for the proposed Project. The following section is a summary of the Wildlife Assessment that was prepared by Millennium EMS Solutions Ltd., included as Consultant Report #9 (CR #9).

The wildlife assessment was prepared in accordance with the Project TOR that were issued by AER (Appendix 1) and with the guidelines set out by the Canadian Environmental Assessment Agency's (CEA Agency) *Guidelines for the Preparation of an Environmental Impact Statement* (Appendix 2). The AER Final TOR related to wildlife are as follows:

1. *4.7 Wildlife*
2. *4.7.1 Baseline Information*

[A] Describe and map existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals). Describe species composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, general life history including habitat disturbances and their use and potential use of habitats. Also, identify any species that are:

- *a) listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (ESRD);*
- *b) listed in Schedule 1 of the federal Species at Risk Act;*
- *c) listed as "at risk" by COSEWIC; and*
- *d) species of traditional and current use, and cultural keystone species.*

[B] Describe, quantify and map all existing habitat disturbance (including exploration activities) and identify those habitat disturbances that are related to existing and approved Project operations.

4.7.2 Impact Assessment

[A] Describe and assess the potential impacts of the Project to wildlife populations and wildlife habitats, considering:

- *a) how the Project will affect wildlife relative abundance, movement patterns, and distribution for all stages of the Project;*
- *b) how improved or altered access may affect wildlife including potential obstruction of movements, increased vehicle-wildlife collisions, and increased hunting pressures;*
- *c) how increased habitat fragmentation may affect wildlife considering edge effects, the availability of core habitat, and the influence of linear features and infrastructure on wildlife movements;*

d) the spatial and temporal changes to habitat availability and habitat effectiveness (types, quality, quantity, diversity, and distribution);
e) potential impacts on wildlife resulting from changes to air and water quality, including both acute and chronic effects to animal health;
f) the resilience and recovery capabilities of wildlife populations and habitats to disturbance; and
g) the potential for the Project Area to be returned to its existing state with respect to wildlife populations and their habitats.

[B] Identify key indicator species and discuss the rationale for their selection.

[C] Comment on the availability of species for traditional use considering habitat loss, habitat avoidance, vehicle-wildlife collisions, increased non-aboriginal hunting pressure and other Project related impacts on wildlife populations.

The CEAA Guidelines for wildlife are:

6.1.6. Migratory Birds and their Habitat

- the various ecosystems found in the project area likely to be affected based on existing information;

- wetlands, including classification, location, size, and function (biochemical, hydrological, and ecological) based on existing information and surveys, if existing information is insufficient;

- migratory and non-migratory birds (including waterfowl, raptors, shorebirds, marsh birds, and other land birds) based on existing information and surveys, if existing information is insufficient;

- year-round migratory bird use of the area (e.g., winter, spring migration, breeding season, fall migration) using existing data and literature as well as surveys to provide current field data; and,

- exposure to relevant contaminants of concern (see section 6.1.2) based on data from existing sources.

6.1.7. Species at Risk

- a list of all potential or known federally listed species at risk that may be affected by the Project (fauna and flora), using existing data, literature, and surveys to provide current field data;

- a list of all federal species designated by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) for listing on Schedule 1 of the Species at Risk Act. This will include those species in the risk categories of extirpated, endangered, threatened, and special concern;

- any published studies that describe the regional importance, abundance, and distribution of species at risk;

- residences, seasonal movements, movement corridors, habitat requirements, key habitat areas, identified critical habitat and/or recovery habitat, and general life history of species at risk that will occur in the project area or be affected by the Project; and

- exposure to relevant contaminants of concern based on data from existing sources.

6.3.2 Predicted Effects to Migratory Birds

- direct migratory bird mortality from project activities, such as clearing of sites, or birds and nests being in contact with contaminated waters (e.g., surface water drainage ponds);

- collision risk of migratory birds with any project components or activities;

- changes to relative abundance, movements and use of habitats, including wetlands, by migratory birds due to increased disturbance (e.g., noise, light, presence of workers); and

- direct and indirect effects to migratory birds resulting from increased exposure to contaminants of concern.

6.3.3 Species at Risk

- direct and indirect effects of the Project on federally listed species at risk and those species listed by COSEWIC classified as extirpated, endangered, threatened, or of special concern (flora and fauna) and their critical habitat including:

- direct and indirect effects resulting from increased exposure to contaminants of concern; and

- the direct and indirect impacts to existing Recovery Strategy and Action Plans including a discussion of how population and distribution objectives set out in those documents would be affected.

The Wildlife Local Study Area (WLSA) and Regional Study Areas (RSAs) are shown in CR #9, Figure 1.2-2 and Figure 1.2-3. The LSA covers an area of 5,646 ha and was established to account for potential disturbance effects of Project development on wildlife that may extend beyond the Mine Permit Boundary. Regional Study Areas (RSA) encompass an area within which Project-specific effects on wildlife can be assessed in a broad spatial context. For the wildlife assessment, two RSAs were defined (CR #9, Figure 1.2-3). The Wildlife RSA (WRSA) was defined as the area within 10 km of the WLSA boundary (73,547 ha), and the Grizzly Bear RSA (GBRSA) was defined as the area within 25 km of the WLSA boundary (284,025 ha). The WRSA was selected to reflect the approximate

average size of two elk winter home ranges, while the GBRSA was selected to represent the average area of an adult female grizzly bear home range.

Key regulatory issues with respect to wildlife are related to species at risk, species of management concern, and migratory birds, which occur, or have the potential to occur, in the Project footprint and WLSA. In addition to determining the presence and distribution of species at risk, this wildlife assessment addresses the following four key wildlife issues:

- potential direct and indirect losses of habitat;
- habitat fragmentation and potential reductions in regional habitat connectivity and the subsequent effects on wildlife movements within and beyond Project boundaries;
- potential impacts of the Project on regional wildlife mortality and wildlife health; and
- potential effects on regional wildlife diversity.

To address these key issues in the LSA and RSAs, information was obtained from various sources of existing information (CR #9, Section 2.2) and from field surveys (CR #9, Section 2.3), and habitat suitability modeling was conducted for a set of ten valued components (VCs). The modeling approach for each VC is described in CR #9, Appendix C. Habitat modeling was applied to three assessment scenarios – Baseline Case, Application Case, and Planned Development Case.

Wildlife species that were selected as VCs include two species that are federally protected under SARA (olive-sided flycatcher and little brown myotis), one species listed by COSEWIC (western toad), one COSEWIC species that is also provincially threatened (grizzly bear), four species rated as Sensitive in Alberta (Columbia spotted frog, great gray owl, American marten, and Canada lynx), and two traditional use species (elk and moose). Collectively, these species cover a breadth of taxa, habitat requirements, and sensitivities. The conservation status of each VC and the rationale for VC selection are summarized in CR #9, Table 3.2-2.

In addition to the VCs, the Project could potentially affect several other special status or highly-valued wildlife species. A set of eight wildlife species were selected as special status species: barn swallow, common nighthawk, short-eared owl, bald eagle, golden eagle, mountain goat, bighorn sheep, and wolverine. For each of these species, a high level assessment of Project effects was conducted in the context of change in habitat availability, movement, mortality risk, and abundance from the Baseline Case to the Application Case (CR #9, Section 5.4).

E.9.2 Baseline Conditions

The primary objective of the baseline wildlife surveys was to describe and map existing wildlife resources in the Project WLSA, and to evaluate their use and potential use of habitats. Special

attention was paid to SARA-listed (Schedule1) and COSEWIC-listed species, as well as those that are at-risk or sensitive in Alberta (CR #9, Table 2.4-2). Species of management concern (*i.e.* those that may be hunted or trapped), and species used and/or valued by First Nations (CR #9, Table 2.2-1) were also considered.

Field surveys were conducted for amphibians, songbirds, raptors, and mammals. Wildlife cameras were used to determine the occurrence and distribution of mammals and large ground birds (such as grouse and wild turkey) in the WLSA. Incidental observations of wildlife species were also recorded during the field surveys. All field surveys were based on standard survey protocols currently in use in Alberta (*e.g.*, AEP 2013a).

E.9.2.1 Wildlife Habitat Availability

E.9.2.1.1 Local Study Area

The WLSA at baseline contained 16 habitat types comprised of 17 ecosite phases in the Montane Natural Subregion (2,716.1 ha, 48.1% of the WLSA), 10 ecosite phases in the Subalpine Natural Subregion (1,790.5 ha, 31.7%), and 17 anthropogenic disturbances and non-vegetated lands (1,027.3 ha, 18.2%) (CR #9, Table 2.4-1). Most of the WLSA was characterized by coniferous forest (2,837 ha; 50.2%) or mixed coniferous and mixed deciduous forest (1,282 ha; 22.7%). Deciduous forests accounted for 79.2 ha (1.4 %) of the WLSA. Rock/barren areas and waterbodies comprised 48.6 ha (0.9%) and 61.8 ha (1.1%) of the WLSA, respectively. The diversity of landscape and habitat types in the WLSA provides suitable habitat for a wide range of wildlife species.

E.9.2.1.2 Regional Study Areas

The predominant habitat type in the WRSA at baseline was mature conifer forest habitat (52.2%) composed of four ELC categories: closed conifer mature (19.3%), moderate conifer mature (12.2%), open conifer mature (12.2%), and dense conifer mature forest habitats (8.6%) (CR #9, Table 4.2-2). Herbaceous habitats (14.4%) and barren land (6.0%) were also common habitat features at this landscape scale. Forest harvest blocks and other regenerating clearings were the most common anthropogenic disturbance (13.3%). Other important anthropogenic disturbances at the WRSA scale included agricultural land (5.4%) and linear anthropogenic disturbances (3.4%). Industry, including other mine operations, accounted for 0.6% of the WRSA. Old-growth forest comprised 2.1% of the WRSA.

Similarly, the GBRSA was predominantly characterized by mature conifer forest (34.3%) and herbaceous habitats (19.9%) (CR #9, Table 4.2-2). Old-growth forest accounted for 4.7% of the GBRSA. Forest harvest blocks and other regenerating clearings were the most common anthropogenic disturbance (13.3%), with agriculture accounting for 9.5% of the landscape. Linear anthropogenic

disturbances and industrial developments (including mines) accounted for 2.7% and 1.1% of the GBRSA, respectively.

E.9.2.1.3 Critical Habitat for Species at Risk

Critical habitat has not yet been identified for three of the four SARA-listed species known to be present in the WLSA: olive-sided flycatcher, common nighthawk, and short-eared owl. Therefore, it is not possible to determine the amount of critical habitat available to these species in the WLSA or GBRSA. Critical habitat was not considered further in the assessment of these species.

In December 2015, critical habitat for little brown myotis was partially identified for hibernacula (Environment Canada 2015c). Potential hibernacula in the WLSA include abandoned mines, which are too unsafe to enter to verify suitability based on temperature (2°C - 10°C) and relative humidity (>80%).

E.9.2.2 Wildlife Diversity

Based on field data and a range distribution maps, 219 and 268 wildlife species could potentially occur in the WLSA and GBRSA, respectively (CR #9, Appendix D). Wildlife surveys, incidental observations, and other available information sources (*e.g.*, FWMIS, North American BBS) collectively indicate that 61 wildlife species with special status at either the federal or provincial level may exist within the GBRSA (CR #9, Table 2.4-2). Of the 156 bird species with potential to occur in the WLSA, field surveys found 87 species of birds (CR #9, Section 2.4.3.5), of which 67 species are protected under the *Migratory Birds Convention Act* and two species (olive-sided flycatcher and common nighthawk) are protected under SARA Schedule 1. Five herptile species (out of a potential of 10 species), including COSEWIC-listed western toad, were detected during field surveys (CR #9, Section 2.4.3.1). Additionally, 28 species or species groups of mammals (out of a potential of 53 species) were detected during field surveys, including SARA-listed little brown myotis and provincially-threatened grizzly bear (CR #9, Section 2.4.3.3).

The WLSA and GBRSA were dominated by moderate-high and high diversity habitats based on the total number of species that could occur within each habitat type (Table E.9.2-1; CR #9, Figures 4.3-1 and 4.3-2). Wildlife habitats with high numbers of species were composed of primarily open mixedwood, open deciduous, open mixed coniferous, closed mixedwood, shrubby wetland, and treed wetland habitats in the WLSA (CR #9, Table 4.3-2). Mature forest, old growth forest, shrub lands, wetlands, and herbaceous habitats had high potential for wildlife diversity in the GBRSA (CR #9, Table 4.3-3). Disturbances represent the largest portion of the low and moderate-low wildlife biodiversity habitat rankings.

Table E.9.2-1 Baseline Wildlife Diversity in the Wildlife Local Study Area and Grizzly Bear Regional Study Area					
Diversity Rating	**No. of Species**	**Wildlife LSA**		**Grizzly Bear RSA**	
		Area (ha)	**% of WLSA**	**Area (ha)**	**% of GBRSA**
Low	0 - 19	165.4	2.9	3,183.6	1.1
Moderate-Low	20 - 44	238.6	4.2	26,276.5	9.3
Moderate	45 - 70	340.9	6.0	3,232.9	1.1
Moderate-High	71 - 90	3,069.8	54.4	112,817.4	39.7
High	≥ 91	1,831.7	32.4	138,514.2	48.8
Total[1]		**5,646.4**	**100.0**	**284,024.7**	**100.0**

[1]Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

E.9.2.3 Wildlife VCs

Effective habitat availability in the WLSA was estimated for the 10 selected VCs (Table E.9.2-2; CR #9, Section 4.4) and based on the availability of limiting habitat (*e.g.*, breeding, foraging, winter). The scarcity of suitability breeding ponds/wetlands in the WLSA results in very limited habitat availability for amphibians (CR #9, Sections 4.4.1.2 and 4.4.2.2). Other VCs with limited habitat availability in the WLSA are little brown myotis (20.7% of WLSA provides effective roosting habitat) and elk (27.7% of WLSA provides effective winter habitat). Effective habitat for the remaining seven VCs was relatively abundant in the WLSA.

Table E.9.2-2 Baseline Effective Habitat Availability for Valued Components in the Wildlife Local Study Area			
Valued Component	**Effective Habitat Type**	**Area (ha)**	**% of WLSA**
Columbia spotted frog	Breeding	172.9	3.1
Western toad	Breeding	269.7	4.8
Olive-sided flycatcher	Breeding/Nesting	3,001.2	53.2
Great grey owl	Nesting and Foraging	3,312.7	58.7
Little brown myotis	Roosting	1,166.5	20.7
American marten	Winter	3,740.3	66.2
Canada lynx	Winter	2,569.6	45.5
Grizzly bear	Foraging	2,721.0	50.0
Moose	Winter	2,769.0	49.0
Elk	Winter	1,563.5	27.7

Under baseline conditions in the WLSA, Highway 3 is likely the greatest barrier to movement of wildlife, including American marten, Columbia spotted frog, western toad, Canada lynx, grizzly bear, and elk (CR #9, Section 4.4). Other potential barriers to wildlife movement include forest fragmentation, access roads, barren/rocky areas, and residential and industrial developments.

Within the WLSA, the primary sources of mortality for the VCs are natural predation, hunting/trapping and illegal take (American marten, Canada lynx, moose, elk, and grizzly bear), and collisions along anthropogenic features such as transmission lines and roads (CR #9, Section 4.4).

E.9.3 Potential Impacts

Potential Project impacts to wildlife include loss of habitat availability, habitat fragmentation and reduced habitat connectivity, increased mortality risk, and reduced abundance. These potential impacts were assessed for all VCs and were evaluated at a high level for the additional special status species. The consequential impacts to wildlife biodiversity were also assessed. Detailed descriptions of potential impacts are presented in CR #9, Section 5.

E.9.3.1 Wildlife Habitat

Habitat availability will be altered by the Project, either directly through habitat loss within the Project footprint, or indirectly through sensory disturbance which may result in some wildlife species avoiding areas they previously occupied or used. Land clearing during Project construction creates a direct loss of habitat, which for some species may represent the greatest single effect of the Project. Wildlife with small home ranges and highly specific habitat requirements may be affected at the local level, depending on population size and Project location. Other species with different seasonal requirements, such as toads which require aquatic habitat in spring and summer and upland habitat in winter, may reduce their use of an area if one seasonal habitat is lost. The effects of habitat loss can continue long after the habitat loss has occurred. Habitat loss is considered to be the leading cause of biodiversity loss by many authorities (Pimm and Raven 2000, Brooks *et al.* 2002, Fahrig 2003).

Sensory disturbance associated with Project development (*e.g.*, noise, artificial lighting, blasting, and human activity) will also result in indirect habitat loss. These sensory disturbances, which can be ongoing or periodic, may result in wildlife avoiding otherwise suitable habitat, reduced reproductive success, reduced foraging ability, or increased mortality (CR #9, Section 3.1.1).

The Project footprint will occupy 1,502.7 ha of land over the lifetime of the Project, comprising 26.9% of the WLSA, 2.1% of the WRSA, and 0.5% of the GBRSA (CR #9, Section 5.1). Wildlife habitat maps for the WLSA at Year 14 (maximum extent of disturbance) and Year 27 (end of mine) are provided in CR #9, Figures 5.1-1 and 5.1-2, and those for the GBRSA are in CR #9, Figures 5.1-3 and 5.1-4. In the WLSA, the habitats incurring the greatest areal losses by Year 14 are moderate mixed coniferous

(387 ha), closed mixed wood (309 ha), closed mixed coniferous (148 ha), and grasslands (151 ha) (CR #9, Table 5.1-1). In the GBRSA at Year 14, the greatest areal losses will be for closed conifer mature forest (310 ha), moderate conifer mature forest (262 ha), dense conifer mature forest (202 ha), and open conifer mature forest (168 ha) (CR #9, Table 5.1-2). Collectively, these losses of mature conifer forests comprise 0.3% of the GBRSA.

E.9.3.2 Habitat Fragmentation and Connectivity

The Project has the potential to disrupt movement patterns of wildlife species and reduce their access to seasonally important habitats (CR #9, Section 3.1.2). For most species, the ability to move across a landscape is crucial. Inability to access high quality habitats may result in species using lower quality habitats with sub-optimal forage and shelter, leading to impaired health and lower reproduction rates.

Open pit coal mines, access roads, coal conveyors, and utility corridors can function as physical barriers to the movement of certain animals, while sensory disturbance associated with use of access roads and construction and operation of Project facilities may prevent animals from effectively moving across the landscape. The effects of these physical and sensory barriers, together with effects of habitat loss through vegetation clearing, can lead to habitat fragmentation and loss of connectivity within a species' home range. Increased fragmentation and reduced movements can lead to, for example, reduced gene flow and population health of sensitive species, insufficient patch sizes to support home ranges and territories required for reproductive success, and reduced habitat quality.

E.9.3.3 Wildlife Mortality

The Project has the potential to increase mortality risk for wildlife species through several mechanisms (CR #9, Section 3.1.3). Clearing/removal of natural habitat may result in direct mortality of individuals, particularly chicks located in nests and other animals with limited mobility. Mortality can also result from wildlife-vehicle collisions during Project construction and operation, particularly along access roads/utility corridors that provide access to Project facilities. Indirectly, seismic lines, roads, and other rights-of-way, can increase access to the area, potentially leading to increased levels of hunting, trapping, and predation. Increased mortality rates are a particular concern for species that occur at very low densities and are therefore vulnerable to relatively small population declines. Additionally, contamination of water or forage can lead to decreased fitness, and in extreme cases, reduced survival.

E.9.3.4 Wildlife Abundance

Changes in habitat availability, habitat fragmentation and movement, and wildlife health and mortality rates can affect the abundance of wildlife (CR #9, Section 3.1.4). Reduced abundance may

result from increased mortality, reduced reproductive rates, or displacement of animals from the WLSA. Sustained reductions in abundance at the local population level can ultimately lead to changes in population processes at the landscape level, and survival of species at a broader geographic scale. As with mortality risk and health, changes in wildlife abundance related to Project development are difficult to predict quantitatively at both the WLSA and WRSA scales.

E.9.3.5 Wildlife Health

Wildlife health was assessed on the basis of the air quality assessment (CR #1 – Air Quality & Climate) and a screening level wildlife risk assessment (CR #12 – Human & Wildlife Health, Appendix H) conducted for the Project. The screening level wildlife risk assessment evaluated potential risks to wildlife associated with chemicals of potential concern emitted from the Project into the air and deposited on soil and/or surface water within the GBRSA. The results of the wildlife risk assessment indicated that wildlife health effects were likely to be highly localized, Project-related contributions to emissions in the GBRSA would be negligible to small, and the risk of adverse effects associated with Project emissions on the health of wildlife in the study areas would be minimal. It was concluded that the Project will not pose a threat to wildlife health; therefore, health effects for the wildlife VCs in the WLSA, WRSA, and GBRSA were not considered further (CR #9, Section 4.1).

E.9.3.6 Wildlife Diversity

Included in the WLSA habitat losses are 423 ha of habitat hosting a high number of wildlife species (≥91 species) and 834 ha of moderate-high wildlife diversity (71-90 species) (Table E.9.3-1). With the expected loss in habitat availability at Year 14 and consequential change in habitat diversity arising from the Project, there is potential for the WLSA to no longer be able to support the wildlife community present under baseline conditions. At Year 27, a trend towards increased biodiversity potential is evident (Table E.9.3-1). In the GBRSA, there is not expected to be sufficient change in habitat availabilities to significantly impact wildlife diversity at Year 14 (CR #9, Table 5.2-2).

Table E.9.3-1 Change in Wildlife Diversity Potential Between the Baseline and Years 14 and 27 in the Wildlife Local Study Area

Diversity Rating	Potential No. of Species	Baseline (ha)	Year 14			Year 27		
			Application (ha)	Change		Application (ha)	Change	
				ha	%		ha	%
Low	0-19	165.4	1,068.1	902.7	545.8	9.3	-156.1	-94.4
Moderate-Low	20-44	238.6	230.5	-8.1	-3.4	197.9	-40.7	-17.0

Table E.9.3-1 Change in Wildlife Diversity Potential Between the Baseline and Years 14 and 27 in the Wildlife Local Study Area

Diversity Rating	Potential No. of Species	Baseline (ha)	Year 14			Year 27		
			Application (ha)	Change		Application (ha)	Change	
				ha	%		ha	%
Moderate	45-70	340.9	703.2	362.3	106.3	1,646.7	1,305.8	383.0
Moderate-High	71-90	3,069.8	2,235.6	-834.2	-27.2	2,383.5	-686.3	-22.4
High	≥91	1,831.7	1,409.0	-422.7	-23.1	1,409.0	-422.7	-23.1

E.9.3.7 Valued Components and Special Status Species

The Project will affect the 10 wildlife VCs (CR #9, Section 5.3) and eight special status species (CR #9, Section 5.4) through changes in habitat availability, habitat fragmentation/connectivity, and mortality risk, all of which will affect local populations to some degree. Most of the Project-related effects on wildlife will be confined primarily to the Project footprint although sensory disturbances associated with mine construction and operations will, for the most part, be limited to the WLSA.

Project-related losses of effective habitat for the VCs relative to baseline conditions were estimated for Years 14 and 27 of the Project, to assess losses at the time of maximum disturbance and after mine-closure and reclamation (Table E.9.3-2). At Year 14, effective habitat availability in the WLSA for all VCs is estimated to be 27% (Columbia spotted frog) to 40% (grizzly bear) lower relative to baseline conditions. At Year 27, the effects of reclamation are expected to result in greater availability of effective habitat relative to baseline for great grey owl, grizzly bear, moose, and elk. The remaining VCs are dependent on wetland habitat (amphibians) and mature and old-growth forests (olive-sided flycatcher, little brown myotis, American marten, and Canada lynx). Wetland habitat is expected to increase with reclamation of the selenium management ponds at closure. It will take decades for mature forests to return to the reclaimed landscape, and at that point effective habitat availability for species dependent on them is expected to be greater than at baseline.

Table E.9.3-2 Change in Effective Habitat Availability for Valued Components in the Wildlife Local Study Area

Valued Component	Baseline - Year 14		Baseline – Year 27	
	Area (ha)	% of WLSA	Area (ha)	% of WLSA
Columbia spotted frog	-46.0	--26.6	-18.2	-10.5
Western toad	-53.4	-19.8	-22.5	-8.3
Olive-sided flycatcher	-832.9	-27.8	-729.1	-24.3
Great grey owl	-1,146.7	-34.6	404.2	12.2
Little brown myotis	-325.8	-27.9	-238.1	-20.4
American marten	-927.5	-24.8	-925.1	-24.7
Canada lynx	-772.8	-30.1	-798.0	-31.1
Grizzly bear	-648.90	-40.1	767.4	92.9
Moose	-757.7	-27.4	541.4	19.6
Elk	-572.5	-36.6	928.4	59.4

With successful application of mitigation and reclamation, the residual effects of the Project on the VCs and special status species are summarized in Table E.9.3-3 and CR #9, Table 5.4-1, respectively. Residual effects are predicted to be not significant.

Table E.9.3-3 Summary of Residual Project Effects Ratings for Wildlife Valued Components

Wildlife VC / Potential Effects	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Columbia Spotted Frog									
Habitat Availability	Local	Long	Continuous	Short-term	Low	Negative	Moderate	High	Not Significant
Movement	Local	Long	Continuous	Short-term	Low	Negative	Moderate	High	Not Significant
Mortality Risk	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Abundance	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	High	Not Significant
Western Toad									
Habitat Availability	Local	Long	Continuous	Short-term	Low	Negative	Moderate	High	Not Significant
Movement	Local	Long	Continuous	Short-term	Low	Negative	Moderate	High	Not Significant
Mortality Risk	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Abundance	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	High	Not Significant
Olive-sided Flycatcher									
Habitat Availability	Local	Extended	Continuous	Long-term	Moderate	Negative	High	High	Not Significant
Movement	Local	Long	Continuous	Short-term	Low	Negative	High	High	Not Significant
Mortality Risk	Local	Long	Isolated	Short-term	Low	Neutral	High	High	Not Significant

Table E.9.3-3 Summary of Residual Project Effects Ratings for Wildlife Valued Components

Wildlife VC / Potential Effects	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Abundance	Local	Long	Continuous	Long-term	Low	Negative	High	High	Not Significant
Great Gray Owl									
Habitat Availability	Local	Long	Continuous	Long-term	Low	Neutral	High	High	Not Significant
Movement	Local	Long	Continuous	Short-term	Low	Neutral	High	High	Not Significant
Mortality Risk	Local	Long	Occasional	Short-term	Low	Neutral	High	High	Not Significant
Abundance	Local	Long	Continuous	Short-term	Low	Negative	Moderate	Moderate	Not Significant
Little Brown Myotis									
Habitat Availability	Local	Extended	Continuous	Long-term	Moderate	Negative	High	High	Not Significant
Movement	Local	Long	Continuous	Short-term	Low	Neutral	High	Moderate	Not Significant
Mortality Risk	Local	Long	Occasional	Short-term	Low	Neutral	High	Low	Not Significant
Abundance	Local	Long	Continuous	Long-term	Low	Negative	High	Moderate	Not Significant
American Marten									
Habitat Availability	Local	Extended	Continuous	Long-term	Moderate	Negative	High	High	Not Significant
Movement	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	Low	Not Significant
Mortality	Local	Short	Occasional	Short-term	Low	Negative	Moderate	Low	Not Significant

Table E.9.3-3 Summary of Residual Project Effects Ratings for Wildlife Valued Components

Wildlife VC / Potential Effects	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Risk									
Abundance	Local	Extended	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Canada Lynx									
Habitat Availability	Regional	Extended	Continuous	Long-term	Moderate	Negative	High	High	Not Significant
Movement	Regional	Long	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Mortality Risk	Local	Long	Occasional	Short-term	Low	Negative	Moderate	Low	Not Significant
Abundance	Local	Extended	Continuous	Short-term	Low	Negative	Moderate	Low	Not Significant
Grizzly Bear									
Habitat Availability	Regional	Extended	Continuous	Long-term	Low	Positive	High	Moderate	Not Significant
Movement	Regional	Long	Isolated	Long-term	Low	Negative	High	Moderate	Not Significant
Mortality Risk	Local	Residual	Occasional	Long-term	Low	Negative	High	Moderate	Not Significant
Abundance	Local	Extended	Continuous	Long-term	Low	Positive	Moderate	Moderate	Not Significant

Table E.9.3-3 Summary of Residual Project Effects Ratings for Wildlife Valued Components

Wildlife VC / Potential Effects	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Moose									
Habitat Availability	Regional	Residual	Continuous	Long-term	Low	Positive	Moderate	Moderate	Not Significant
Movement	Regional	Long	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Mortality Risk	Local	Long	Occasional	Long-term	Low	Negative	High	Moderate	Not Significant
Abundance	Local	Residual	Continuous	Long-term	Low	Neutral	Moderate	Moderate	Not Significant
Elk									
Habitat Availability	Regional	Residual	Continuous	Long-term	Low	Positive	High	High	Not Significant
Movement	Regional	Long	Continuous	Long-term	Low	Negative	Moderate	Moderate	Not Significant
Mortality Risk	Local	Long	Occasional	Long-term	Low	Negative	High	Moderate	Not Significant
Abundance	Local	Residual	Continuous	Long-term	Low	Positive	Moderate	Moderate	Not Significant

[1] Local, Regional, Provincial, National, Global
[2] Short, Long, Extended, Residual
[3] Continuous, Isolated, Periodic, Occasional
[4] Reversible in short term, Reversible in long term, Irreversible – rare
[5] Nil, Low, Moderate, High
[6] Neutral, Positive, Negative
[7] Low, Moderate, High
[8] Low, Medium, High
[9] Not Significant, Significant.

E.9.3.8 Migratory Birds

As with wildlife in general, VCs, and special status species, there is potential for the Project to impact migratory birds through changes in habitat availability, habitat fragmentation/connectivity, mortality risk, and abundance, and result in altered bird diversity (CR #9, Section 5.5). The greatest effect of Project development on migratory birds will be direct habitat loss, most of which is expected to be temporary as disturbed habitats will be reclaimed progressively during Project operations and following Project closure. The full community of migratory birds in the WLSA occupies the full breadth of available habitat types, as different species of migratory birds utilize different habitats or combinations of habitats. Most of the migratory birds confirmed to occur in the WLSA have habitat requirements that are similar to wildlife species selected as VCs (CR #9, Table 4.6-1). Forest-dwelling migratory bird species, particularly those that nest in coniferous and mixedwood forests, will likely be the most affected by Project development. Based on the assessment of all wildlife VCs, it is expected that the longest lasting impacts will be experienced by those bird species requiring old-growth forests for breeding and foraging habitats.

E.9.4 Cumulative Effects

The cumulative effects assessment was conducted quantitatively where possible, and to provide a context for assessing potential effects on selected wildlife populations (CR #9, Section 6.3). A conservative 20% habitat change threshold was established for the wildlife VCs. Where sufficient quantitative information did not exist, effects ratings were based on existing literature and professional judgement. Cumulative wildlife effects related to the PDC scenario were rated using the same key wildlife issues, spatial and temporal boundaries, and effects prediction criteria used in the Application Case assessment for residual effects.

Significant residual Project effects were not predicted for any of the wildlife VCs (CR #9, Section 5.3), but five VCs were selected for cumulative effects assessment due to their requirements for mature and old-growth forests or their potential for increased mortality because of increased access from forestry activities in the GBRSA. Selection rationale is discussed in CR#9, Section 6.3.1. Of the ten wildlife VCs, olive-sided flycatcher, little brown myotis, American marten, and Canada lynx were selected because of their sensitivity to losses of effective habitat (mature and old-growth forests) and their known susceptibilities to some degree of habitat fragmentation, especially from activities such as timber harvest. Grizzly bear was selected for cumulative effects assessment because of the potential for increased mortality risk resulting from increased access at the local and regional levels. With the exception of marten, the selected VCs for the cumulative effects assessment are federally-listed species at risk and/or have a special status designation in Alberta. The primary driver for the cumulative effects in the GBRSA over the next 30 years is related to forestry activity, which can negatively affect habitat availability and mortality risk for these VCs.

The cumulative effects ratings are summarized in Table E.9.4-1. After mitigating potential Project effects on wildlife habitat loss and fragmentation, movement, mortality risk, and abundance, no significant cumulative effects are predicted. Benga is committed to mitigating Project effects throughout the construction, operation, and reclamation phases of the Project and collaboratively participating in any regional initiatives with regulators, stakeholders, and other industry partners to minimize the effects of resource development on wildlife on the regional scale.

Table E.9.4-1 Summary of Residual Cumulative Effects Ratings for the Planned Development Case

Wildlife VC	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Direction[6]	Confidence Rating[7]	Probability of Occurence[8]	Significance[9]
Change in Habitat Availability									
Olive-sided flycatcher	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not Significant
Little brown myotis	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not Significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not Significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not Significant
Grizzly bear	Regional	Long	Continuous	N/A[11]	Low	Positive	High	High	Not Significant
Change in Habitat Fragmentation/Connectivity									
Olive-sided flycatcher	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not Significant
Little brown myotis	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not Significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not Significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not Significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	Low	Not Significant
Change in Mortality Risk									
Olive-sided flycatcher	Regional	Long	Continuous	Long term	Low	Negative	Moderate	Moderate	Not Significant
Little brown myotis	Regional	Short	Occasional	Short term	Low	Negative	Moderate	Low	Not Significant
American marten	Regional	Short	Isolated	Short term	Low	Negative	High	Low	Not Significant
Canada lynx	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not Significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	Moderate	Low	Not Significant

Table E.9.4-1 Summary of Residual Cumulative Effects Ratings for the Planned Development Case

Wildlife VC	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Direction[6]	Confidence Rating[7]	Probability of Occurence[8]	Significance[9]
Change in Abundance									
Olive-sided flycatcher	Regional	Long	Continuous	Long term	Low	Negative	Moderate	Moderate	Not Significant
Little brown myotis	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not Significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not Significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	Moderate	Not Significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neural	Moderate	Low	Not Significant

[1] Local, Regional, Provincial, National, Global

[2] Short, Long, Extended, Residual

[3] Continuous, Isolated, Periodic, Occasional

[4] Reversible in short term, Reversible in long term, Irreversible – rare

[5] Nil, Low, Moderate, High

[6] Neutral, Positive, Negative

[7] Low, Moderate, High

[8] Low, Medium, High

[9] Not Significant, Significant.

[10] No effects are predicted to occur.

[11] Predicted effects are positive in magnitude

E.9.5 Mitigation and Monitoring

The Project has the potential to affect wildlife through a number of mechanisms such as direct and indirect habitat loss, habitat fragmentation/connectivity, changes in movement patterns, and increased mortality risk. The proposed mitigation measures and wildlife monitoring program described in CR #9, Section 7 were designed to reduce or minimize the effects of the Project on wildlife and to monitor the effects of the Project to ensure the efficacy of the implemented mitigation measures.

E.9.5.1 Mitigation

Benga will implement a number of best management practices, Project design features, a Conservation & Reclamation Plan (Section F), and other wildlife-specific mitigation measures to avoid or minimize effects on wildlife (CR #9, Section 7.1). These mitigation measures broadly fit into the categories of species at risk, migratory birds, habitat availability and fragmentation, and mortality risk.

E.9.5.1.1 Species at Risk

To prevent or minimize Project effects on federally-listed (SARA) species at risk, Benga will work in consultation with Environment Canada to develop species-specific mitigation and monitoring plans for species at risk known to occur in the WLSA. Currently, these species include olive-sided flycatcher, common nighthawk, short-eared owl, and little brown myotis. Benga acknowledges that over the duration of the Project, other species at risk may be found in the WLSA or added to SARA's list of protected species.

At the time of submission, federal recovery strategies exist for three species at risk in the WLSA – olive-sided flycatcher (Environment Canada 2016a), common nighthawk (Environment Canada 2016b), and little brown myotis (proposed) (Environment Canada 2015). The short-term and long-term objectives outlined in these recovery strategies, and any future federal action plans that may be developed from these proposed recovery strategies, will form the basis for Project mitigation and monitoring plans for these three species. Additionally, a proposed federal management plan for short-eared owl was also released (Environment Canada 2016c). Should recovery strategies, action plans, or management plans be developed by Environment Canada for any other species at risk found in the WLSA, the Project mitigation and monitoring plans will be adapted accordingly.

E.9.5.1.2 Migratory Birds

Mitigation measures to prevent or minimize Project effects on migratory birds and their habitats are incorporated into CR#9 Section 7.1.3 (habitat availability), CR#9 Section 7.1.4 (habitat connectivity and movement), and CR#9 Section 7.1.5 (mortality risk). Key measures include planning vegetation

clearing outside of the breeding bird period (April 15 to August 31) characteristic of the region, conducting pre-disturbance nest searches, and implementing an effective conservation and reclamation plan (see Section F - C&R Plan) that promotes the development of habitats required for migratory birds. Benga also acknowledges that Environment Canada encourages industry to develop Beneficial Management Practices guides to minimize potential Project-specific impacts on migratory birds and their habitat.

E.9.5.1.3 Habitat Availability

The majority of Project-related wildlife habitat loss will result from land clearing, surface mining, and construction of infrastructure and roads. In addition to direct physical loss of habitat, indirect habitat loss may arise from sensory disturbances (*e.g.*, artificial light and increased noise from equipment and blasting, and vehicles) that cause wildlife species to avoid the area and from dust accumulation on vegetation and in wetlands.

Many of the Project effects associated with wildlife habitat loss will be minimized through implementation of the Project's reclamation plan. The summary of the reclamation plan mitigation recommendations for wildlife and wildlife habitat reclamation include:

- minimize the overall disturbance footprint through the mine planning process to avoid critical breeding habitats, nesting and denning sites, and movement corridors to the extent possible;
- preserve remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and hide cover for wildlife species;
- remnant patches should protect known essential raptor habitat features by incorporating these habitat features (*i.e.*, mature balsam poplar and aspen) where possible;
- maximize the direct placement of salvaged soil to enhance native plant development;
- retain slash and large woody debris in the salvaged soil to provide microsites for native plant and hide cover for wildlife;
- establish a variety of vegetation species and communities suitable for wildlife, and encourage structural complexity within the forests;
- encourage understory complexity in reclaimed forests by planting native shrubs such as alder and willow;
- ensure that core security areas are provided for wildlife;
- provide water management program that ensures the surface water quality is maintained; and
- limit sight lines by maintaining mature forest stands as buffers between roads and reclamation areas.

To support the reclamation plan mitigation measures, the following will be implemented to mitigate potential direct and indirect Project effects on wildlife habitat availability:

- Incorporate the existing legacy mining disturbances into the development and reclamation plans for the project, and other proposed land use activities to the best extent possible so that habitat loss, habitat fragmentation, linear disturbance features, and cumulative habitat loss are minimized.
- Pre-disturbance surveys (wildlife sweeps) will be conducted in the development area prior to any construction activities during Project development to determine the occurrence of any important wildlife habitat features such as migratory bird nests, mineral licks, active dens, bat habitat and hibernacula, active raptor nest sites, and essential raptor habitat features (*i.e.*, mature balsam poplar, platform/stick nests) that could indicate the presence of species at risk.
- Protect all important wildlife habitat features in areas of suitable wildlife habitat (on the edge of the Project footprint boundary) appropriate setback distances (or buffer zones) will be considered.
- Clearing and equipment use/storage/cleaning in undisturbed areas within and adjacent to the Project footprint will be avoided.
- Vegetation adjacent to high-activity linear corridors (*e.g.*, access roads, coal conveyor) will be retained to reduce the extent of noise and visual sensory disturbances to the extent possible.
- The overland coal conveyor system was designed in such a manner to prevent any deposition of coal product along the route from the CHPP to the rail load-out area (Section C.3). This includes a cover for the length of the conveyor to reduce dust, and motor specifications to reduce industrial noise levels.
- Where appropriate, vegetated buffer zones (100 m or minimum of 30 m; pending topography constraints) will be maintained between Project infrastructure and wetlands, creeks, and streams to the best extent possible.
- As required by the *Weed Control Act and Regulations*, all identified noxious and invasive weed species populations will be controlled prior to any site disturbance and mine operation to prevent the further spread of weeds. Noxious weed management will occur in compliance with R&R/03-4 *Weeds on Industrial Development Sites* (Alberta Environment 2003b).
- As the presence of artificial lighting can potentially affect bird and bat use of nearby habitats, Benga has developed a visual impact mitigation plan that reduces stray and non-essential artificial lighting to minimize wildlife effects and that will comply with OH&S safety requirements.

- To mitigate the potential effects of sensory disturbance (acoustic and visual) on effective habitat availability in the southeast portion of the Gold Creek valley, Benga will install and maintain a 15-m tall earth berm along the eastern edge of the south disposal area. The earth berm will be constructed/maintained during the daytime when required and will grow in elevation as the height of the disposal area increases.
- Sensory disturbance from the active mine site will be further mitigated through the use of mufflers on all internal combustion engines, utilizing mine pit topography to shield noise generated from haul trucks, and conducting blasting during daylight hours.

E.9.5.1.4 Habitat Connectivity and Movement

Habitat loss and fragmentation reduce habitat connectivity and thereby can affect daily and seasonal movements and dispersal of wildlife species. Wildlife may move into or through habitats that are physically disturbed but are unlikely to reside there, and they are also prone to sensory disturbances (acoustic or visual). As identified in the Project Assessment Case (CR#9, Section 5), the potential barriers to wildlife movement associated with the Project include:

- loss of vegetation and landscape alteration from construction of surface mine, infrastructure and roads;
- vehicular traffic activity associated with the mine access road and other mining activities;
- coal conveyor infrastructure; and
- the railway loop.

The reclamation plan outlines mitigation measures that will be implemented during progressive reclamation (*i.e.*, reclamation that will occur over the life of the mine operations and into closure) that will minimize the impact of the Project on wildlife movement during reclamation and after mine closure.

The following general wildlife mitigation measures will be implemented to minimize potential disruption to daily and seasonal wildlife movements:

- a minimum of six wildlife crossings (underpasses and overpasses) will be incorporated into the design of the coal conveyor (the conveyor route is approximately 5.4 km in length);
- these will be strategically placed in locations that will maximize wildlife use (*e.g.*, presence of well used trails, suitable habitats, and terrain features such as valleys and depressions that act as natural crossings);
- additional pre-disturbance surveys will be conducted to identify important wildlife habitats and trails along the access road and conveyor corridor;

- natural underpasses using topography are preferred;
- above ground crossings may be required when topography isn't favourable, conveyor will likely be raised higher above the ground to allow wildlife movement under it;
- surface water management ponds and ditches located in undisturbed areas of the Project footprint will be designed to allow wildlife to move around or cross safely;
- road plowing and grading will be conducted in a manner that does not restrict wildlife from crossing access roads or accessing wildlife crossings; and
- measures to control dust and other air emissions (*e.g.*, watering of roads and use of dust suppressants, minimizing engine idling, *etc.*) within the Project footprint will be implemented to minimize effects on adjacent wildlife habitats.

Project-specific mitigations targeted to carnivore species have been incorporated into the reclamation planning. Many of these will also support habitat connectivity for migratory birds and species at risk, and include:

- minimizing the overall disturbance footprint through the mine planning process;
- preserving remnant forest patches in the development areas to provide essential habitat, habitat connectivity, and hiding cover for wildlife species;
- retaining slash and large woody debris in the replaced soil landscape;
- planting native shrubs early in the reclamation process to initiate hiding cover;
- establishing mixed wood forest stands and high density coniferous tree stands;
- providing understory complexity in the reclaimed forests by planting native shrubs such as alder and willow to provide security cover for the carnivores and their prey;
- maximizing the amount of ungulate habitat;
- prioring to final reclamation, disrupt linear disturbances and sight lines by mounding surface soils, piling brush; and
- limiting sight lines by maintaining mature forest stands or by planting high density coniferous stands to act as buffers between roads, project disturbance boundaries and the reclaimed mine areas.

Additional mitigations that are specifically targeted to grizzly bears and grizzly bear habitat will also support other carnivores and migratory birds, and include:

- maintaining a 100 m undisturbed forested buffer around Blairmore Creek and other riparian corridors;
- leaving patches of residual forest within and adjacent to the mine footprint; and

- commencing reclamation early on in mine operations by seeding reclaimable areas with plant species favourable to grizzly bear forage, and by planting shrub and tree species that provide suitable cover (*e.g.*, willow, alder, coniferous trees).

For migratory birds, additional relevant mitigations include:

- retaining slash and large woody debris in the salvaged soil to provide microsites for native plant and hide cover and perches for wildlife; and
- ensuring reclaimed areas promote the re-establishment of woody species and are on a trajectory for reforestation.

For raptors, additional relevant mitigations include:

- retain residual patches of essential habitat and habitat features within and adjacent to the mine footprint (*i.e.*, mature poplar trees, tall conifer trees) to provide perches, nest sites, and hide cover;
- minimize loss of mature and old-growth forest habitat and avoid complex, multi-story mixedwood forest where possible; and,
- maintain a 100 m buffer of undisturbed forest around Blairmore Creek, Gold Creek and other riparian corridors.

Targeted mitigation measures involving amphibians and amphibian habitat include:

- conducting monitoring to identify other habitable ponds and to identify habitat requirements and constraints;
- constructing trial breeding ponds;
- reclaiming upland habitat adjacent to reconstructed breeding ponds; and
- avoiding habitat destruction and alteration outside of the defined Project footprint to the best extent possible.

E.9.5.1.5 Mortality Risk

Wildlife mortality risk may increase as a result of increased traffic, wildlife encountering equipment, or elements of the Project footprint, and wildlife being attracted to Project facilities or humans. The Grassy Mountain area currently has a considerable network of trails and roads that are heavily used. Plans are already being implemented to reduce this level of access and with the approval of this Project, the levels will be reduced considerably more. Mitigation measures that will be implemented to reduce wildlife mortality risk include:

- All access to the Mine Permit will be controlled, no uncontrolled access will be permitted. Common operational practices will include:
  - prohibiting use of snowmobiles and ATVs;
  - prohibiting hunting, harassment, or feeding of wildlife; and
  - implementing a strictly enforced zero tolerance policy on the use of firearms.
- Timing vegetation site clearing activities are to occur outside the April 15 to August 31 period to avoid disrupting nesting migratory and resident songbirds and raptors.
- In the event that vegetation clearing must occur within the restricted activity period, pre-disturbance nesting surveys will be conducted by experienced avian biologists according to established sensitive species inventory guidelines (Government of Alberta 2013b). Establish species-appropriate setback distances around confirmed active nest sites until fledging in consultation with Environment Canada and AEP. If the status of a nest cannot be confirmed, or if a nest is found outside of the breeding season, a setback distance will be implemented until such time as the nest status can be confirmed (GoA 2013b).
- Confirm the presence/absence of bats in high quality habitats located within the Project footprint prior to the initiation of any clearing activities and develop a mitigation plan if bats are found.
- Conduct pre-disturbance denning (bears, marten, *etc*.) and roosting (bats) surveys prior to vegetation clearing and other high-disturbance activities. Consult with AEP as needed to develop appropriate mitigation and management strategies.
- Conduct pre-disturbance surveys (acoustic surveys and visual searches) to identify wetlands and watercourses used by breeding Columbia spotted frogs and western toads that feed into the protection plans.
- Benga commits to supporting active bear management plans associated with the Project. If a site specific plan is required, it will be developed in consultation with AEP personnel as part of the Wildlife Mitigation and Monitoring Plan. The plan is expected to be a comprehensive document that outlines operational strategies and best practices for addressing concerns related to not only bear-human conflicts but potential risks to ungulates and other wildlife resulting from attraction of bears to the area.
- Develop a Beneficial Management Plan guide to minimize potential Project-specific impacts on migratory birds and their habitat by identifying more site-specific mitigation and monitoring measures following Project approval and in consultation with federal and provincial regulators.
- A detailed Waste Management Plan will be developed and implemented prior to construction and operational activities to minimize the attraction of wildlife. Benga will follow the Best

Management Practices for camps, fences, and barriers as described in *Bear Smart: Best Management Practices for Camps* (ASRD 2011), and ensure all waste is stored in wildlife-proof containers and disposed of properly. Some of the waste management and bear awareness/Bear Smart guidelines that will be implemented include:

- ensuring food waste, refuse, and other attractants are securely contained in enclosed and approved bear-proof containers and/or facilities (*e.g.*, hard-sided buildings, fenced compounds, and bear-proof transfer station) prior to transportation to a disposal facility to prevent access by scavenging bears;
- providing adequate signage to inform employees of the location and proper use of bear-proof storage containers/facilities;
- ensuring waste storage containers/facilities are not filled beyond capacity;
- ensuring regular inspection and maintenance of waste storage containers/facilities is carried out;
- ensuring measures contained in the bear management plan are diligently followed by all employees and contractors;
- all on-site staff will receive Bear Awareness Training; and
- bear warning signs will be installed to advise staff of locations where problem bears have been reported.

- Implement an Emergency Spill Response Plan to limit the effect of accidental spills. Spills will be minimized by restricting fuel storage and filling to designated areas that are at least 100 m from wetlands and watercourses as well as Project drainage ditches, sediment control ponds, and pit lakes.
- Store all hazardous materials, including those used for blasting, in secure areas that are inaccessible to wildlife (*e.g.*, buildings, storage areas surrounded by wildlife-proof fencing). In addition, proper handling and storage of industrial materials and debris within the Project footprint will be maintained to minimize potential risks to wildlife.
- Develop procedures to clear blasting areas of large mammals or birds prior to blasting.
- Design water management ponds and drainage ditches, and pit lakes to minimize potential entrapment of wildlife.
- Develop a strategy to minimize changes in water quality upstream of the mine in conjunction with a water-quality monitoring program.
- Enforce speed limits (≤50 km/hr) along the main access road and utility corridors, and place signs at identified wildlife crossings to increase driver diligence to minimize wildlife-vehicle collisions. Vehicles will yield to all wildlife crossing the main access road.

- Bird collisions with buildings will be mitigated by placing visual markers on windows, and collisions with the proposed power line will be mitigated by installing large 'floats' or other markers.

Mitigation measures specific to bat species include:

- avoiding direct and indirect impacts to known, primary maternity roosts and hibernacula should any such roosts or hibernacula be located/identified; and
- where possible, tree clearing to be planned to avoid the May to August bat summer season.

E.9.5.2 Preliminary Wildlife Monitoring Program

Wildlife monitoring will be used to monitor the effects of the Project on wildlife species at risk or species of management concern during construction and operation of the Project and post-closure. In particular, the effects of the Project on wildlife VCs, including disturbance, mortality, and movement will be monitored. Monitoring will consist of a systematic monitoring program along with incidental observations. The wildlife monitoring program will serve a number of important functions including:

- verifying impact predictions and monitoring the effectiveness of mitigation measures;
- improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of adaptive management practices when required; and
- ensuring compliance with the terms and conditions of the Operating Approval and Project environmental standards once the Project has been approved by AER and CEAA.

As part of the wildlife monitoring program for the Project, Benga will engage regulators (both provincial and federal), First Nations, and traditional land users in discussion regarding approaches to further minimize effects on species of special interest. Such approaches might include continued monitoring, habitat management, and participation in regional initiatives (*e.g.*, the ABMI program to assist with monitoring regional cumulative effects on biological resources).

Important considerations in selecting monitoring procedures include minimizing observer influence and ensuring that monitoring activities do not create added disturbance to sensitive wildlife species. In addition, it is important that monitoring efforts are focussed on parameters that are directly related to effects mitigation and that provide opportunities to improve mitigation performance over time. For these reasons, the wildlife monitoring program will initially focus on the following, but will not be limited to:

- Continuing with and expanding the use of wildlife camera monitoring as a low-disturbance, passive monitoring approach to quantitatively measure changes in use of preferred habitat types by larger species such as grizzly bear, moose, and elk and elusive species of concern such as marten, lynx, and wolverine in the vicinity of the Project footprint.
- Monitoring breeding birds, raptors, waterbirds, bats, and amphibians using sensitive species inventory guidelines (GOA 2013b) and recommendations from federal recovery strategies (olive-sided flycatcher, common nighthawk, and little brown myotis) as reclamation progresses over the landscape.
    - Targeted species will include, but not be limited to:
        - SARA schedule 1 species known to occur in the WLSA: olive-sided flycatcher, common nighthawk, short-eared owl, and little brown myotis;
        - COSEWIC-listed species known to occur in the WLSA: western toad, barn swallow, American badger, wolverine, grizzly bear, and Baird's sparrow;
        - provincially listed or protected species; and
        - species of traditional use or value.
- Implement a wildlife sighting program for Project personnel and contractors to document wildlife occurrences within the Project footprint during the construction and operations to document wildlife movements. This information can be used for monitoring wildlife use/crossings of access roads to identify major wildlife crossing areas for signage placement, improve employee/contractor wildlife awareness, and assist with monitoring the effectiveness of mitigation measures (*i.e.*, avoiding wildlife-vehicle collisions).
- Construction monitoring to ensure timing windows, setbacks, and other mitigation measures are followed.
- Monitoring wildlife use of Project-related linear features (*e.g.*, railway loop, transmission line, pipelines, drainage ditches, and ponds) during operation.
- Monitoring wildlife crossings to determine the efficiency of the structures at maintaining wildlife movements.
- Monitoring the effectiveness of any access control measures (*e.g.*, gates) on roads and other linear features.
- Monitoring and documenting all human-wildlife interactions that occur within the Project footprint.
- Post-closure wildlife monitoring linked with the reclamation monitoring program and any other related environmental monitoring programs, continuing until all permit conditions are satisfied and the AER releases the Project site.

This initial wildlife monitoring approach will enable Benga to evaluate the effectiveness of their wildlife protection, mitigation, and reclamation procedures and to ensure that the Project does not adversely affect wildlife in the region. A detailed wildlife mitigation and monitoring plan based on provincial and federal Approval Conditions will be developed following Project approval.

E.9.6 Summary

The results of the wildlife assessment indicate that the Project may have moderate local effects on habitat availability of some VCs, and increase the local mortality risk of grizzly bears. With the implementation of detailed, extensive mitigation plans, conservation and reclamation plan, and a wildlife monitoring plan, it is expected that any cumulative effects on wildlife at the regional scale will be not significant (CR #9, Section 6.4).

E.10 Land and Resource Use

E.10.1 Introduction and Terms of Reference

The following is a summary of the Project Land and Resource Use Assessment Report that was prepared by Millennium EMS Solutions Ltd. and included as Consultants Report #10 (CR #10).

The AER final ToR and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to Land and Resource Use have been considered:

> *"4.10 Land Use and Management*
>
> *4.10.1 Baseline Information*
>
> *[A] Describe the existing land and resource uses and potential conflicts, considering oil and gas development, agriculture, forestry, tourism; and outdoor recreational activities.*
>
> *[B] Describe and map all Crown land and Crown reservations (Holding Reservation, Protective Notation, Consultative Notation).*
>
> *[C] Identify and map unique sites or special features such as parks and protected areas, heritage rivers, historic sites, environmentally significant areas, culturally significant sites, and other designations (World Heritage sites, Ramsar sites, internationally important bird areas, etc.).*
>
> *[D] Describe existing access control measures.*
>
> *4.10.2 Impact Assessment*

[A] Describe access corridors needed and/or planned by other resource development stakeholders, including those responsible for forest management areas and other timber quota holders, and describe

a. *how their needs are accommodated to reduce overall environmental impact from resource development; and*
b. *opportunities for cooperation on access development.*

[B] Indicate where Crown land dispositions may be needed for roads or other infrastructure for the project.

[C] Provide a description and timing of land-clearing activities.

[D] Identify the potential impact of the project on land uses, including

a. *impacts to unique sites or special features;*
b. *the results of consultation with Parks Canada Agency on potential impacts of the project to the lands, waters, air, and natural and cultural heritage resources of national parks, national historic sites, national marine conservation areas, Canadian heritage rivers, UNESCO World Heritage sites and Ramsar Convention Wetlands of International Importance. Where impacts are predicted, provide the results of the analysis and clearly identify the impacts to the special protected area;*
c. *impacts caused by changes in public access arising from linear development, including secondary effects related to increased hunter, angler, and other recreational access; decreased access to traditional use sites; and facilitated predator movement;*
d. *the implications of relevant land-use policies and resource management initiatives for the project, including any constraints to development. Discuss how the project will be consistent with the intent of these initiatives;*
e. *potential impacts to aggregate reserves that may be located on land under the proponent's control and reserves in the region;*
f. *the impact of development and reclamation on commercial forest harvesting in the project area. Include opportunities for timber salvage, revegetation, reforestation, and harvest for the reduction of fuel hazard;*
g. *the amount of commercial and non-commercial forest land base that will be disturbed by the project. Compare the pre-disturbance and reclaimed percentages and distribution of all forested communities in the project area;*

h. how the project impacts annual allowable cuts and quotas within the forest management agreement area;

i. the potential impact on existing land uses of anticipated changes (type and extent) to the pre-disturbance topography, elevation, and drainage pattern within the project area; and

j. impacts of the project on public access, regional recreational activities, aboriginal land use, and other land uses during and after development activities.

[E] Identify any access restrictions, including, where appropriate, measures taken to control access to the project area while ensuring continued access to adjacent wildland areas.

[F] Provide a fire control plan highlighting

a. measures taken to ensure continued access for firefighters to adjacent wildland areas;

b. forest fire prevention, detection, reporting, and suppression measures, including proposed firefighting equipment;

c. measures for determining the clearing width of power line rights-of-way; and

d. required mitigative measures for areas adjacent to the project area based on the FireSmart Wildfire Assessment System."

The specific requirements for the lands and resource use assessment as provided in Section 6.1.10 of the Canadian Environmental Assessment Agency (CEAA) Guidelines for the Preparation of an Environmental Impact Statement for the Grassy Mountain Coal Project (Appendix 2) was also considered and is as follows:

"6.1.10 Human Environment

The EIS will contain baseline information on the following:

- *The rural and urban settings likely to be affected by the Project;*
- *The current use of land in the study area, including a description of hunting, recreational, and commercial fishing, trapping, gathering, outdoor recreation, use of seasonal cabins, outfitters;*
- *Current use of all waterways and water bodies that will be directly affected by the Project, including recreational uses, where available; and,*
- *Location of and proximity of any permanent, seasonal, or temporary residences or camps."*

The study areas to be utilized for the Land and Resource Use Assessment were selected based on the area of potential for direct impact due to development of the Project. The local study area (LSA) for

the Land and Resource Use Assessment includes the land contained within the proposed Mine Permit Boundary as this is the area were there will likely be surface development and the regional study area (RSA) includes the area within approximately 1.6 km of the LSA (CR #10, Figure 3.1-1).

The Land and Resource Use Assessment focusses on a number of Valued Components (VCs) that have been identified based on a review of the existing land uses within the study areas. Existing land uses were identified through:

- a review of the Public Land Standing Report (LSAS report) from Alberta Energy's Geographic Land Information Management and Planning System (GLIMPS);
- a review of dispositions included in Alberta Environment and Parks (AEP) Disposition Spatial Processing Tool;
- a review of the crown mineral dispositions from Alberta Energy's Alberta Mineral Information System (AMIS);
- a review of existing Land Title Certificates;
- a review of public information regarding land use planning initiatives; and
- Benga's public consultation program.

The land and resource use VCs chosen for the assessment include:

- Land Use Policies and Resource Management Initiatives;
- Resource Development;
- Hunting and Trapping;
- Access and Utilities;
- Tourism and Outdoor Recreation; and
- Unique Sites and Special Features.

E.10.2 Baseline Conditions

The following section provides a summary of the baseline condition for each of the VCs assessed. For a description of the methods used in the baseline data collection, mapping and analyses please see Sections 3.0 in CR #10.

E.10.2.1 Land Ownership

The Project is located within the Municipal District of Rangelands No. 66 and within the Municipality of Crowsnest Pass. The closest communities to the Project are Blairmore and Coleman. The Project in situated on both Crown and freehold land (CR #10, Figure 4.1-1). The private land with the LSA and

RSA is owned by Benga, the Municipality of Crowsnest Pass, the Crowsnest Pass Golf and Country Club and other individual private land owners.

There are seven properties within the LSA that have existing dwelling in the form of cabins. Access to these lands is currently provided by a road owned by Benga through Benga's privately owned land. The Historic Town of Lille and two additional dwellings are located just east of the LSA but within the RSA.

There are four surface dispositions found within the LSA and RSA that are in place to support activities occurring on private land. One Department Licence of Occupation (DLO) for an access road, an Easements (EZE) for a water intake, an EZE for a water pipeline (CR #10, Figure 4.1-1) and a recreational lease (REC) for portions of the Crowsnest Pass Golf & Country Club.

E.10.2.2 Land and Resource Use Planning

E.10.2.2.1 Coal Development Policy

A Coal Development Policy for Alberta was adopted in 1976 with the purpose of guiding the exploration and development of coal resources in the province (Alberta Energy 2015). Provincial lands fall into one of four categories with respect to coal exploration and development. The LSA and RSA contain areas in Category 1, Category 2, and Category 4 (CR #10, Figure 4.2-1). A description of each pertinent category, as outlined by Alberta Energy, 2015, is provided below.

Category 1, in which no exploration or commercial development will be permitted. This category includes National Parks, present or proposed parks, protected, recreation or research areas, or wildlife sanctuaries, settled urban areas and major lakes and rivers. These are areas for which it has been determined that alternative land uses have a higher priority than coal activity. Category 1 also includes most areas associated with high environmental sensitivity; these are areas for which reclamation of disturbed lands cannot be assured with existing technology and in which the watershed must be protected.

Category 2, in which limited exploration is desirable and may be permitted under strict control but in which commercial development by surface mining will not normally be considered at the present time. This category contains lands in the Rocky Mountains and Foothills for which the preferred land or resource use remains to be determined, or areas where infrastructure facilities are generally absent or considered inadequate to support major mining operations. In addition this category contains local areas of high environmental sensitivity in which neither exploration nor development activities will be permitted. Underground mining or in-situ operations may be permitted in areas within this category where the surface effects of the operation are deemed to be environmentally acceptable.

Category 4, in which exploration may be permitted under appropriate control and in which surface or underground mining or in-situ operations may be considered subject to proper assurances respecting protection of the environment and reclamation of disturbed lands. This category covers the parts of the Province not included in the other three categories.

E.10.2.2.2 Integrated Resource Planning

Integrated Resource Plans (IRPs) are put in place to assist proponents in land use planning and assessment. The LSA and RSA fall under two IRPs; the Livingstone-Porcupine Sub Regional IRP and the Crowsnest Corridor Local Sub-Regional IRP (CR #10, Figure 4.2-2). Both IRPs aim to maintain the overall integrity of natural environment and permit the exploration and extraction of coal resources within approved areas.

E.10.2.2.3 South Saskatchewan Regional Plan

The Project falls within the southwest limits of the South Saskatchewan Regional Plan (SSRP). The SSRP was established in accordance with Alberta's Land Use Framework (LUF) and came into effect on September 1, 2014 (Alberta Government 2014). The SSRP outlines the vision for the South Saskatchewan Region and identifies a number of regional outcomes and strategies for achieving these outcomes. Implementation of the strategies outlined in the SSRP is in progress and will be rolled out over time. Some of the strategies currently in place that have been considered by Benga include:

- potential impacts of the Project on the newly created Livingstone Range Wildland Provincial Park;
- the ambient air quality limits and triggers outlined in the South Saskatchewan Region Air Quality Management Framework; and
- ambient surface water quality triggers and limits outlined in the South Saskatchewan Region Surface Water Quality Management Framework.

E.10.2.2.4 South Saskatchewan River Basin Plan

The South Saskatchewan River Basin (SSRB) is comprised of four sub-basins; the Bow, Oldman, South Saskatchewan and Red Deer, inclusive of their tributaries (Alberta Environment 2006). The LSA and RSA fall within the Oldman River sub-basin. The Approved Water Management Plan for the SSRB (Alberta Environment 2006) states that no new surface water allocations are being issued from the Oldman River sub-basin but transfers of existing surface water allocations are permitted.

E.10.2.2.5 Environmentally Significant Areas

Environmentally Significant Areas (ESAs) have been identified throughout Alberta and are descripted in Environmentally Significant Areas in Alberta: 2014 Update Final Report (Fiera 2014). The ESAs

that have been identified provide information important to maintaining the long-term integrity of biodiversity and physical features at both the local and regional landscape scales. The identification of ESA was undertaken in order to help inform land use planning for areas identified as having high environmental sensitivity.

A number of ESAs have been identified within the LSA and RSA (CR #10, Figure 4.2-4). A majority of the ESAs in the LSA were classified as areas that contributes to water quality and quantity and as areas with ecological integrity.

E.10.2.2.6 Wildlife and Biodiversity Zones

The southern and eastern most portions of the RSA are located within a Mountain Goat and Sheep Range and the northern portion of the RSA is located within a Grizzly Bear Zone (AEP 2015) (CR #10, Figure 4.2-5). Key Wildlife and Biodiversity Zones are found within the RSA along the Crowsnest River, Pelletier Creek and a tributary to Daisy Creek and are a combination of key winter ungulate habitat and high potential for biodiversity (ESRD 2015).

E.10.2.3 Freehold Mines and Minerals

There are a number of freehold mines and mineral rights within the LSA and RSA that are held by Exxon Mobil Resources Ltd., Ember Resources Inc. and Saskatoon Lease Holder Ltd. and four Private owners (CR #10, Figure 4.3-1).

E.10.2.4 Coal Development

There is both Freehold and Crown owned coal within the LSA and RSA (CR #10, Figure 4.4-2). Leases for Crown owned coal are held by Benga, Elan Coal Ltd and Peace River Coal Ltd. Freehold coal within the LSA and RSA is owned by Benga, Carbon Development Corp. and Canpar Holdings Ltd.

Since 2013 Benga has conducted coal exploration programs to confirm the quality, quantity and delineation of the coal reserves for the Project. To access portions of Benga's private land two Licence of Occupation (LOC) dispositions that fall within the RSA and LSA, were obtained (CR #10, Figure 4.4-3).

There are four Right-of- Entry Agreements (ROEs) in the LSA and RSA that were disposed for the existing historical mining. These are currently held by Devon Canada Corp. (Devon) and are in the process of being transferred to Benga. Benga currently has an agreement with Devon to use these lands.

E.10.2.5 Oil and Gas Development

Petroleum and natural gas (PNG) licences and leases within the LSA and RSA are either wholly or partially owned by various companies such as: Direct Energy Marketing, Devon, Shell Canada Ltd. and Legacy Oil & Gas (CR #10, Figure 4.5-1). PrairieSky Royalty Ltd. holds several freehold titles for Petroleum, Natural Gas and Sulphur within the RSA.

Within the RSA there are 12 mineral surface lease (MSL) dispositions, 11 pipeline leases, 1 powerline easement, 8 licences of occupation, and 2 miscellaneous leases (MLL), all of which are in place to support oil and gas development (CR #10, Figure 4.5-2). All of the wells that are associated with the MSLs are no longer producing and are either abandoned or in the reclamation process.

E.10.2.6 Forestry and Agriculture

The LSA and RSA fall within both green and white zones of Alberta. The green zone area consists of Forest Management Unit (FMU) C5 which covers approximately 3,522 km^2 of forested land. There are currently five timber quota holders with total approved Annual Allowable Cut of 197,226 m^3.

There are five privately owned Coniferous Timber Permits within the RSA and one Coniferous Timber Licence (CTLC 050016) (CR#10, Table 4.6-1 and Figure 4.6-1). In addition, there are five grazing leases and one grazing permit within the RSA (CR#10, Table 4.6-2 and Figure 4.6-1).

AEP also holds a Consultative Notation disposition (CNT 860041) that is described as being in place to determine volumes and establish animal unit carrying capacity within the McGillivray Creek Miscellaneous Timber Use Area. This is a potential timber disposal area and does not have any restrictions.

E.10.2.7 Trapping and Fur Harvesting

There are three Trapping Area (TPA) dispositions within the northern portion of the LSA and RSA (CR#10, Figure 4.7-1). Two of these of these overlap a portion of the LSA and the third is within the RSA boundary.

E.10.2.8 Access and Utilities

Provincial Highway 3 and a main line of the Canadian Pacific Railroad are located along the southern edge of the proposed Mine Permit Boundary (CR#10, Figure 4.8-1). The southern portion of the proposed Mine Permit Area is accessible by a secondary access road off Highway 3, while the northern portion of the Mine Permit Area is accessed by an access road *via* secondary Highway 40 (Forestry Trunk Road). The railroad will be used to transport coal from the Project to the ports on the west coast. There are also a number of registered roadway dispositions held by Alberta

Transportation and the Municipality of Crowsnest Pass that run through the RSA (CR #10 Table 4.8-1).

Several surface dispositions associated with various public utilities are also found within the LSA and RSA. These include pipeline lease agreements (CR #10 Table 4.8-2) and easements for power lines (CR #10 Table 4.8-3). In addition, there are several departmental licence of occupation dispositions within the LSA and RSA, a majority of which are associated with access requirements for the power line easement (CR #10 Table 4.8-4).

E.10.2.9 Tourism and Outdoor Recreation

The Crowsnest Pass is well known for its opportunities for tourism and outdoor recreational activities. There are no provincial or national parks within the RSA. The nearest national park is Waterton Lakes which is located approximately 55 km south of the Project. There are several provincial parks and recreation areas found within 20 km of the project.

Some of the recreational areas and facilities found in the immediate vicinity (CR #10, Figure 4.9-1) include:

- Crowsnest Pass Golf and Country Club, which is located on the southern end of the proposed Project, owns land that will be impacted by development of the Project and also holds a surface disposition (REC910007) located on the east end of the rail loop;
- the Crowsnest Trail;
- All-Terrain Vehicle (ATV) trails and staging areas, including a number of recreational trails that are utilized and maintained by the Crow Snow Riders Snowmobile Club that fall under a consultative notation (CNT 980012) held by AEP; in addition an ATV club (Quad Squad) utilize a number of recreational trails in the Crowsnest Pass area;
- Lost Lemon Campground and Cabins;
- Pass Powderkeg Ski Resort, which is a family ski area located on land leased from the Municipality of Crowsnest Pass (disposition REC 830018); and
- Mountain bike trails, including those created by the United Riders of Crowsnest found throughout the Crowsnest area and the Pass Powderkeg Mountain Bike Trails.

E.10.2.10 Unique Sites and Special Features

Within the Crowsnest Pass there are historical underground mines such as the Bellevue Mine which is now used as a tourist attraction, the Grassy Mountain Mine open pits, the Greenhill Mine and the historical surface mine that was operated by the Coke and Coal Company which built the town of Coleman.

Some other unique features that occur in the area are the historic town of Lille, which is located just east of the LSA and Frank Slide which is located southeast of the Project (CR#10, Figure 4.10-1). Frank Slide was designated a Provincial Historic Resource in 1977. The slide occurred in 1903 and destroyed most of the former town of Frank. Now there are walking trails built into the rubble for tourists to visit and an interpretive centre that provides more information about the history of the slide.

The Department of Culture holds a Consultative Notation (CNT 880242) for the Green Creek Wintering site, which is described in the LSAS report as a significant historical resource. They also hold a Designated Historical Resource (DHR010001) disposition for the village of Lille and a Protective Notation (PNT900426) for the Greenhills Mine Complex.

E.10.2.11 Provincial and Federal Dispositions

There are seven Disposition Reservations (DRS) within the LSA and RSA that are held by Alberta Transportation (CR#10, Figure 4.11-1), the Department of Public Works and Government Services Canada (PWGSC), the Department of Environment and Water (now Environment and Parks), the Smoky Lake Lands Division Office (Alberta Tree Improvement and Seed Centre) and the Blairmore Land Use Area Office (AEP). These DRS' provide authorization for government use of public land for public works (SRD 1997).

In addition to the DRS', there are a number of consultative and protective notations on the lands found within the LSA and RSA. Consultative notations (CNTs) are used to show and interest in the land but do not provide any restrictions on use, while protective notations (PNTs) identify land and resources that are managed to achieve particular land use or conservation objectives (ASRD 1997). In general the CNT and PNTs denote areas with one of the following characteristics:

- Grazing Area (PNT890351, PNT890378, PNT930299, PNT940130)
- Grazing, Watershed Protection, Wildlife Habitat (PNT960092)
- Unimproved Grazing (PNT880617, PNT880619, PNT880625)
- Mountainous Terrain Rock Outcrop (PNT810769)
- No Agricultural Disposal (PNT700566, PNT776398, PNT880618)
- Potential Fescue Grassland (PNT090084, PNT090087)
- Water Disposal/Reclamation (PNT 900430)
- Registered Historic Resource (PNT900426, DHR010001)
- Firesmart Zone (CNT090027)
- Potential Timber Disposal (CNT860041)

- Green Creek Wintering Site (CNT880242)
- Snowmobile Trails (CNT980012)

E.10.3 Potential Impacts

The majority of the project components, such as the CHPP, access/conveyor corridor are located on a mix of both Crown and private land. The area that falls on Crown land will require surface dispositions in accordance with the *Public Lands Act*. Benga plans to capture all of the mining infrastructure in a single mineral surface lease (MSL), the construction camp and conveyor/access/powerline in a single miscellaneous lease (MLL) and the rail loop and loadout in a licence of occupation (LOC). Applications for these surface dispositions required in accordance with *the Public Lands Act* will be submitted under separate cover.

Access control will be undertaken to both allow and restrict access to the Project area. The appropriate level of access control will be based on the level of risk to public safety and need to protect Project infrastructure. Due to development of the Project some of the existing facilities associated with the Crowsnest Pass Golf and Country Club will need to be moved. In addition, the existing access to the helipad operated by Alberta Environment and Parks will need to be rerouted. These changes are required in order to accommodate construction of the rail loop and are shown on Figure 5.1-2 in CR #10. Although not part of the proposed Project, the development of these facilities is included in the assessment on the potential impacts of the Project on Land and Resource Use.

Reclamation activities will be undertaken throughout the life of the mine as mining in each pit is competed. During this process Benga will ensure that end land use objectives are developed in consultation with stakeholders, building on the existing consultation process and adaptive management of the Conservation & Reclamation and Closure plan will be pursued through the incorporation of the results of the site wide environmental monitoring programs and through regional research initiatives. The details of the reclamation plan are provided in Section F of the application.

E.10.3.1 Potential Effects on Private Land Owners

The potential impacts of the Project on private land owners can occur directly due to development of the Project on privately owned land or indirectly due to changes to regional socio-economic conditions. The impacts due to changes in socio-economic conditions are discussed in the Socio-Economic Impact Assessment completed for the Project (Section E.11 and CR #11). Through the Public Engagement Program (Section G), Benga will continue to consult with the land owners that may be indirectly impacted by the Project in order to identify measures required to mitigate any concerns.

A majority of the Project infrastructure is located on either crown land or land currently owned by Benga. There is a portion of the proposed rail loop is located on land owned by the Crowsnest Pass Golf & Country Club and a portion of the south rock disposal area is located on land Privately owned. Benga currently has an agreement in place with the Private landowner to access the land for mine development.

Due to development of the Project some of the existing facilities associated with the Crowsnest Pass Golf and Country Club will need to be moved. Overall impact on the current golf course infrastructure will include full or partial obstruction of Fairways #1, #2, #3, #14, #15, #16, #17 and #18, as well as the club house, car park and maintenance buildings. Benga and the Crowsnest Pass Golf & Country Club have come to an agreement to move all affected golf course infrastructures to the west of the existing golf course, onto land currently owned by Benga.

E.10.3.2 Potential Effects on Land Use Policies and Regional Planning Initiatives

Various land use policies and regional planning initiatives have been developed for the area within the LSA and RSA. The intent of these policies and planning initiatives are to help inform land use decisions. Through a review of regional policies and initiatives environmental issues and concerns have been identified and appropriate mitigation measures included in the design, construction, operation and reclamation plans for the Project. Therefore, development of the Project does not conflict with the intent of these policies and initiatives.

E.10.3.3 Potential Effects on Resource Development

Rights to develop the coal and petroleum and natural gas resources within the LSA are held by various companies. A majority of the coal leases and freehold coal located in the LSA is held by Benga (CR #10 Figure 4.4-2 and Figure 4.3-1). Although located within the proposed Mine Permit Area (and LSA), the coal owned by the Carbon Development Corporation is not within the mining area and therefore will not be impacted by development of the Project. The coal currently owned by Canpar Holdings is on the western edge of the pit area. Benga has a signed agreement with Canpar to obtain access to the coal in this area.

Mines and Minerals titles within the LSA are held by titles held by Exxon, Ember Resources, Saskatoon Lease Holders Ltd. and one Private owner (CR #10, Figure 4.3-1). Ember Resources and Exxon have both been notified of the Project and to date have not raised any concerns with the development. The title held by Saskatoon Lease Holders excludes the area within the railway right-of- way where most of the surface development in this area occurring. The re-routing of the helipad access is also proposed to occur over this Freehold title but will not impede potential development of the subsurface resource. The title held by the Private owner is from 1915, and is for a 2.1 ha area located within the existing railway right-of-way; therefore no impact from the Project is anticipated.

The rights to the Petroleum and Natural Gas resource in the LSA is held by Devon Canada and Prairiesky Royalty (CR #10, Figure 4.5-1). In addition, there are various surface dispositions held by Devon that will be directly impacted by development of the Project footprint (CR #10, Figure 4.5-2). The well sites are no longer producing and the use of all the facilities associated with these dispositions has been discontinued. Benga has been consulting with Devon on how to obtain access to these areas and Devon has provided Benga with a letter stating that they have no objection to the proposed development. Prior to development of the rock disposal area, Benga will work with Devon to ensure that the facilities are abandoned and any contamination remediated in accordance with applicable AER guidelines.

The Petroleum and Natural Gas leases were purchased by Prairiesky Royalty in January 2016. Benga has initiated contact with Prairiesky and will work with them to resolve issues as they are identified.

It is predicted that the impacts to other resource developers in the area will not be significant. Benga currently has access to all of the coal rights within the proposed mining area and there is no known subsurface resource development occurring in the area other than coal. If the holders of the other leases in the area decide to progress with development of these subsurface resources, Benga will work with the lease holders to develop plans to coordinate activities.

The Project falls within both green and white zones of Alberta, with a majority of the development footprint located within the white zone. The green zone portion of the LSA is also within Forestry Management Unit C-5, which has five timber quota holders. In addition, there is one privately owned coniferous timber permit that will be directly impacted by development of the Project. An assessment of the potential impacts of the Project on forestry resources has been undertaken (Section 4.4.1 of CR #8 [Vegetation]). It was determined that the effects on Annual Allowable Cut will be minimal because all merchantable timber salvaged from the Project will be made available to local timber rights holders and approximately 61.4% of the Project Footprint will be reclaimed to closed conifer forests with another 8.8% reclaimed to moderate mixed forest, including the historically disturbed barren land. The timber management plan for the Project is included in Conservation and Reclamation Plan located in Section F.3.3.

Within the white zone portion of the LSA there are two grazing leases and one grazing permit that will be directly impacted by development of the Project (CR #10, Figure 4.6-1). Benga has been consulting with the holders of these licences and permit and is in the process of obtaining an agreement to access these areas. A letter of consent will be provided as part of the *Public Lands Act* Application to be submitted under separate cover.

The impact to forestry and agricultural resources is also predicted to be not significant. Once mining areas are no longer required they will be reclaimed to a land use equivalent to what existed prior to

development of the Project. This includes areas for both timber production and grazing. Benga has had frequent contact with the member of the Gold Creek Grazing Co-op Ltd., and in the past has been able to come to an agreement on plans to mitigate potential impacts.

E.10.3.4 Potential Effects on Hunting and Trapping

Development of the Project has the potential to impact access to hunting and trapping areas and the potential to impact the availability of wildlife resources required to undertake these activities. The potential impacts to the availability of wildlife are discussed in the Wildlife Assessment conducted for the Project (Section E.11 and CR #9).

TPA #1677 is found along the northern portion of the proposed mining area and may be impacted later on in the life of the Project. TPA #2426 is adjacent to the northern most extent of the proposed development footprint; a small portion of this trapping area will be impacted towards the end of the life of the Project. Benga has consulted with each of the trap line holders to discuss potential concerns and opportunities to mitigate impacts of the proposed Project.

It is predicted that the impact of the Project on the access to hunting and trapping areas will not be significant as a majority of the land to be developed is privately owned. The lands will be reclaimed to an equivalent capability and Benga will continue to consult with holders of the trapping areas in order to identify further mitigation measures.

E.10.3.5 Potential Effects on Access and Utilities

The impact on access and utilities in the area due to development of the Project will not be significant. Development of the Project will encroach upon two existing power lines that are currently owned by AltaLink Management Inc. One powerline is on privately owned land and the other is on crown land and authorized by a surface disposition (CR #10, Figure 4.8-1). Benga is currently working with AltaLink to develop a strategy to ensure operation of these lines is not disrupted.

Benga has also been consulting with stakeholders on the construction of the rail loadout and associated underpass on Highway 3 in order to ensure that the final location and design takes into consideration issues raised by stakeholders therefore minimizing potential impacts. The Project will also encroach upon one departmental licence of occupation (DLO140170) for a water intake which is currently under review but not yet approved. If the DLO is approved, Benga will consult with the owner of this disposition in order to identify measures to mitigate potential impacts.

E.10.3.6 Potential Effects on Tourism & Outdoor Recreation

It is predicted that the direct impact to tourism and outdoor recreation due to development of the Project will not be significant. A majority of the land to be developed is owned by Benga. Through

their consultation activities Benga has identified potential concerns associated with recreational use of the proposed Project area. The main direct impacts to tourism and outdoor recreation due to the Project will be the development of the rail loadout within lands owned by the Crowsnest Pass Golf and Country Club and the potential disruption of trails found within the proposed development footprint. Consultation with various individuals and interest groups that may be impacted from the Project took place through one on one meetings, phone calls, open houses and emails. Private campgrounds, residents, landowners and recreational groups as well as other types of interest groups were included. The summary of these consultation activities is provided in the Project application (Section A.7 and Section G).

Benga has been working closely with the Crowsnest Pass Golf and Country Club (CPGCC) to mitigate impacts to the golf course due to development of the rail loadout. Benga and the CPGCC have agreed that the land title for the existing land owned by CPGCC, that will be impacted by the rail loop, will be amended and the southern portion transferred to Benga. The title for the portion of land to the northwest currently owned by Benga, and required for relocating the golf course facilities, will be amended and transferred to the CPGCC. The rail facilities will also encroach on a recreational lease held by the CPGCC (REC 910007), and two crown dispositions (DRS850045 and RRD8711435). The CPGCC has agreed to amend the southern portion of REC910007, once this is completed Benga will apply for a surface disposition to accommodate the rail development.

Benga has also been consulting with recreational users such as the Crowsnest Pass Quad Squad, the United Riders of Crowsnest and the Crow Snow Riders in order to gain further understanding on recreational use of the proposed mining area. A majority of the known trails in the area are along the north and west sides of the proposed development. Benga will continue to work with these groups in order to develop measures to mitigate potential impacts of the Project on outdoor recreation in the area. In addition, at the completion of mining, the area will be reclaimed to a land use equivalent to what existed prior to development including recreational use.

E.10.3.7 Potential Effects on Unique Sites & Special Features

Development of the Project has the potential to impact the historic Greenhill Mine area. The historic Town of Lille, Frank Slide, Bellevue Mine and the Green Creek Wintering site are all located outside of the proposed Project footprint and therefore will not be impacted by development of the Project. Impact to those historical resources identified within or adjacent to the Project footprint will be mitigated by undertaking additional study, where required, and obtaining clearance in accordance with the *Historical Resources Act* prior to development of the Project.

E.10.4 Cumulative Effects Assessment

There are no other planned developments within the LSA. The only planned project located in the RSA is the twinning of Highway 3, which occurs in the southwestern portion of the RSA. The potential twinning of Highway 3 has been contemplated during the discussions with Alberta Transportation and the Municipality concerning the location of the highway underpass. Therefore, the results of the Cumulative Effects Assessment will be the same as for the Application Case Assessment. Mitigation and Monitoring Recommendations

In order to minimize the potential direct impacts of the proposed Project development on other land and resource users in the area, Benga will undertake the following:

- continue to consult with local stakeholders, through the life of the Project, in order to identify concerns and proactively address issues when they arise;
- undertake progressive reclamation, and reclaim the area to a landscape that includes provisions for a variety of land uses, including forestry, wildlife habitat, grazing, recreational use, *etc.*; and
- monitor changes in land use policies and initiatives and, through adaptive management, incorporate new requirements into the ongoing development, operation, and reclamation plans.

E.10.5 Summary of Effects

The Land and Resource Use Assessment focusses on a number of VCs that have been identified based on a review of the existing land uses within the study areas. Characterization of the residual and cumulative effects of the Project on land use and management are presented in Table E.10.5-1.

Table E.10.5-1 Summary of Significance Rating on Land and Resource Use Valued Components

Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Land Use Policies and Resource Management Initiatives											
		Application	Local	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
2. Resource Development											
		Application	Local	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
3. Hunting and Trapping											
		Application	Local	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
4. Access and Utilities											
		Application	Local	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant

Table E.10.5-1 Summary of Significance Rating on Land and Resource Use Valued Components

Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent(1)	Duration(2)	Frequency(3)	Reversibility(4)	Magnitude(5)	Project Contribution(6)	Confidence Rating(7)	Probability of Occurrence(8)	Significance(9)
5. Tourism and Outdoor Recreation											
		Application	Local	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Reversible – long term	Nil	Neutral	High	High	Not Significant
6. Unique Sites and Special Features											
		Application	Local	Extended	Continuous	Irreversible – Rare	Nil	Neutral	High	High	Not Significant
		Cumulative Effects	Regional	Extended	Continuous	Irreversible – Rare	Nil	Neutral	High	High	Not Significant

(1) Local, Regional, Provincial, National, Global

(2) Short, Long, Extended, Residual

(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)

(4) Reversible in short term, Reversible in long term, Irreversible – rare

(5) Nil, Low, Moderate, High

(6) Neutral, Positive, Negative

(7) Low, Moderate, High

(8) Low, Medium, High

(9) Not Significant, Significant

E.11 SOCIO-ECONOMIC

E.11.1 Introduction and Terms of Reference

Benga conducted Socio-Economic Impact Assessment (SEIA) for the proposed Project. The following section is a summary of the SEIA that was prepared by Nichols Applied Management. The full report included as Consultant Report #11 (CR #11).

The AER final Terms of Reference (ToR) and associated concordance table for the Project (AER 2015) are provided in the Project Application (Appendix 1). The following ToR relating to air quality have been addressed in this report:

8.0 SOCIO-ECONOMIC ASSESSMENT

8.1 Baseline Information

[A] Describe the existing socio-economic conditions in the region and in the communities in the region.

[B] Describe factors that may affect existing socio-economic conditions including:

a) population changes;

b) the Proponent's policies and programs regarding the use of regional and Alberta goods and services;

c) the project schedule and a general description of the overall engineering and contracting plan for the Project;

d) the workforce requirements for the Project, including a description of when peak activity periods will occur; and

e) the planned accommodations for the workforce for all stages of the Project. Discuss the rational for their selection.

8.2 Impact Assessment

[A] Describe the socio-economic impacts of construction and operation of the Project, including:

a) impacts related to:

i. local training, employment and business opportunities,

ii. regional and provincial economic benefits,

iii. housing,

iv. recreational activities,

v. hunting, fishing, trapping and gathering, and

vi. traditional land use by aboriginal communities and groups; and

b) the need for additional Crown land to meet these needs.

[B] Discuss plans to work with Aboriginal communities and groups, other local residents and businesses regarding employment, training needs and other economic development opportunities arising from the Project; and

[C] Provide the estimated total Project cost, including a breakdown for engineering and project management, equipment and materials, and labour for both construction and operation stages. Indicate the percentage of expenditures expected to occur in the region, Alberta, Canada outside of Alberta, and outside of Canada.

The final CEAA Guidelines for the Project (CEAA 2015) and associated concordance table are provided in (Appendix 2). The CEAA Guidelines relating to the SEIA addressed in this assessment include the pertinent guidelines outlined in Section 6.1.10 – Human Environment, 6.3.4 – Aboriginal Peoples, and 6.3.5 – Other Valued Components that may be affected as a Result of a Federal Decision.

The key socio-economic valued components considered in this analysis fell into the following categories:

- employment;
- personal and business income;
- government tax and royalty income;
- population;
- regional infrastructure and services, including:
- housing, including worker housing;
- social infrastructure, including health, education, policing, emergency, recreation and social services;
- municipal infrastructure and services;
- transportation effects; and
- traditional (Aboriginal Groups) land use.

Key indicators used to assess the effects of the Project on the valued components included:

- workforce;
- income;
- population change;
- effects of population changes on service providers and physical infrastructure;

- effects of increased traffic on the regional road network;
- effects on traditional land use and culture;
- municipal taxes;
- provincial corporate tax and resource royalty income; and
- federal corporate tax.

A complete listing of the projects included in the PDC for the cumulative effects assessment is included in CR #11, Section 2.3. The RSA therefore consists of two unique parts:

- the Alberta portion which includes Ranchland and Crowsnest Pass; and
- the B.C. portion which includes only the Town of Sparwood and the portion of Highway 3 connecting the Project to the Town.

E.11.2 Baseline Conditions

E.11.2.1 Population

In 2011, the RSA was home to approximately 9,312 people, of which 5,645 resided in Alberta and 3,667 resided in B.C. The majority of the population in the Alberta portion of the RSA is distributed throughout Crowsnest Pass in the communities of Coleman (1,050 people), Blairmore (2,060 people), Bellevue (790 people), and Frank (260 people). Population change in the Alberta portion of the RSA region during the 2001 to 2011 period was negative, as the population declined at an average annual rate of 1.2%, a marked contrast to the 2.1% annual growth in the province overall.

There are no First Nation reserves or Métis settlements within the RSA. However, approximately 3% (175 people) of the Alberta portion of the RSA identify themselves as Aboriginal. Of the 175 people identifying as Aboriginal, approximately three quarters identify as Métis and the balance as First Nations. In Sparwood, 258 people identify themselves as Aboriginal of which 157 are Métis and the balance are First Nations (Statistics Canada 2011, Environics 2014).

There is a non-permanent population in the RSA that fluctuates seasonally and with the level of industrial activity. Mobile workers are accommodated primarily in rental accommodations but also in hotels and motels. The administrations of the S.M. of the Crowsnest Pass and the Town of Sparwood estimate that their non-permanent populations are approximately 1,500 to 2,000 and 400 to 1,700 respectively. These estimates were derived by examining utility usage rates, taxfiler data, and Teck employee studies.

E.11.2.2 Wage Economy

The wage economy of the RSA is driven primarily by the mining, quarrying, and oil and gas extraction industry, which accounts for approximately 22% of all jobs in the Alberta portion of the RSA and 33% of jobs in the B.C. portion of the RSA. The primary employer in the region is Teck Coal Ltd., which operates five mines in the region and directly employs 800 workers who live in Sparwood (SOCP 2015). Other large employers in Sparwood include mine service companies such as Finning Canada and Joy Global.

Other key industries in the RSA include health care and social assistance, retail trade, construction and public administration which, when taken together with the mining industry, account for more than half of all employment in the RSA (Stats Can 2011, Environics 2014). Tourism, particularly in the summer, is also a key economic driver in the Crowsnest Pass region.

E.11.2.3 Labour Force

The labour force participation rate in the Alberta portion of the RSA is 61%, well below the provincial average of 73%. This is reflective of the fact that persons aged 65 and over make up 22% of the population of Crowsnest Pass as compared to 11% in Alberta overall. The unemployment rate for the Alberta portion of the RSA is identical to the provincial rate of 5.8% (Stats Can 2011, Environics 2014).

The labour force participation rate in the B.C. portion of the RSA is 69%, which is slightly above the provincial average of 65%. The unemployment rate for the B.C. portion of the RSA (5.5%) is well below the provincial rate of 7.8%.

E.11.2.4 Income

Household incomes in the Alberta portion of the RSA in 2011 were below the provincial average by approximately 30%. This is reflective of the high number of seniors and retirees in the area (the median age in Crowsnest Pass is 51 and 43 in Ranchland as compared to 36.5 in Alberta as a whole). In contrast, the population of Sparwood is younger than the provincial average (median age of 39.5 as compared to 42 for the province of B.C.) and more likely to be in the labour force and the median household income is 32% higher than the B.C. provincial average (Stats Can 2011).

E.11.2.5 Housing

The housing market conditions in the RSA vary considerably across communities in terms of price, quality, and availability. Together, these conditions will influence the settlement patterns of new residents who relocate to the region to pursue employment opportunities related to the Project.

The number of total dwelling units in the Alberta portion of the RSA has declined at an average annual rate of 0.35% from 2,710 units in 2001 to 2,617 in 2011, a change that is roughly in line with the steady decline in the regional population. In 2011, the regional housing stock was comprised primarily of single detached homes (85%), low-rise apartment units (5%), and mobile homes (7%). The balance of homes were duplexes, semi-detached and row houses. Of these 2,617 units, approximately 81% were owned and 19% were rented (Stats Can 2011, Environics 2014).

The price of housing in the Alberta portion of the RSA has not risen as quickly or to the same heights as the province as a whole. The average real house price in 2014 in Crowsnest Pass was $216,200, nearly 50% less than the average house price in Alberta ($400,590), which may also be an indicator of lower average house quality.

E.11.2.6 Social Infrastructure

Social infrastructure includes a diverse range of human services and infrastructure including health, education, social, recreation, policing and emergency services. Social infrastructure is important to a community as a means of:

- supporting the functioning of the community by sustaining the well-being of its residents and building social cohesion; and
- sustaining economic growth by making the community more attractive to those considering investing or relocating to the region.

The RSA has a well-developed social infrastructure system. The majority of infrastructure and services are located in Sparwood and in the villages and towns located in Crowsnest Pass. CR #11, Table 7.1 presents a high-level summary of social, health and emergency services and infrastructure in the RSA along with key issues identified through stakeholder interviews and a review of relevant planning documents, studies and reports.

E.11.2.7 Municipal Infrastructure and Services

Municipalities within the RSA are responsible for the planning, construction, operations, and maintenance of municipal infrastructure within their respective boundaries.

Potable water in Crowsnest Pass is recovered from nine ground wells and treated at four treatment plants located in Coleman, Blairmore, Bellevue and Hillcrest. It is then stored in one of four concrete reservoirs and piped throughout the community (CPM 2014). Ranchland has no central water wells or treatment plants as property owners have their own water wells (Christianson 2014, pers. comm.). In Sparwood there are three water wells and two reservoirs. There is no water treatment plant as the water from these sources is exceptionally clean (Melcer 2015, pers. comm.).

Wastewater within the Crowsnest Pass is treated at two treatment facilities located in Frank and in between Bellevue and Hillcrest (CPM 2014). In Ranchland, wastewater is stored in septic tanks on individual properties and hauled out as needed (Christianson 2014, pers. comm.).

Solid waste from the Crowsnest Pass is disposed of in the Pincher Creek Sanitary Landfill while waste from Ranchland is trucked out to the landfill in Okotoks (CPM 2014; Christianson 2014, pers. comm.).

E.11.2.8 Transportation

The road network in the RSA consists of a number of primary and secondary highways, including:

- Highway 3, a two-lane undivided highway that is the main highway in the RSA.[2] It runs in an east-west direction near the southernmost boundary of the proposed mine. This highway connects the RSA with the population centres of Fort Macleod and Lethbridge to the east, and also runs west into B.C., near the U.S. border. The proposed mine access road would intersect Highway 3 near Blairmore.
- Highway 40, which runs north-south through Coleman, approximately 2 km from the western boundary of the proposed mine permit area.
- Secondary Highway 22, which is located approximately 10 km to the east of the eastern boundary of the proposed mine permit area and runs north towards Calgary. Most of the population of Ranchland lives along Highway 22 (Christianson 2014).
- Highway 3 spans the RSA from east to west and, as the main arterial road in the region, will be the road travelled by workers and material loads travelling to the Project site.

In 2014, traffic volumes on Highway 3 between Sparwood, British Columbia and Lethbridge, Alberta ranged between 4,120 and 7,880 average annual daily traffic (AADT) or two-way vehicle movements.

Collision rates along Highway 3 from the Alberta/British Columbia border to Lethbridge are generally at or below provincial averages, except for the stretch between the S.M. of Crowsnest Pass border and Pincher Creek, which was approximately 27% above the provincial average in 2012. Collision rates along the stretch of road within Crowsnest Pass which includes the Project access road were approximately 7% above the provincial average in 2012.

E.11.2.9 Traditional Land Use and Aboriginal Culture

The area surrounding the RSA has been home to Aboriginal peoples for thousands of years. Although there are no First Nation reserves in the RSA, Benga recognizes that Aboriginal people use

[2] East of Fort Macleod, Highway 3 becomes a four-lane divided highway.

lands in the RSA for traditional purposes such as hunting and plant gathering. The company has made the effort to be inclusive and engage in consultation with the following Aboriginal groups that have expressed interest in the Project:

- Piikani Nation, with reserve lands located approximately 60 km to the east of the Project on lands between Pincher Creek and Fort Macleod;
- Kainai Nation (Blood Tribe), with reserve lands located approximately 130 km to the east of the Project, near Fort Macleod and Lethbridge to the north and Cardston in the south;
- Siksika Nation, with reserve lands located approximately 240 km northeast of the Project and about 100 km east of Calgary;
- Tsuut'ina Nation, with reserve lands located approximately 200 km north of the Project to the east of Calgary; and
- Stoney Nations, with reserve lands located approximately 260 km north of the Project site (Bearspaw First Nation, Chiniki First Nation and Wesley First Nation).
- Samson Cree Nation, with reserve lands located approximately 430 km north of the Project site, near Hobbema
- Foothills Ojibway First Nation, a non-status First Nation located in and around Hinton
- Ktunaxa Nation, a small nation with five member Bands in British Columbia, including: Akiskinuk (Columbia Lake) near Windermere; Lower Kootenay near Creston; A'qam (St. Mary's) near Cranbrook; Shuswap near Invermere; and Tobacco Plains near Grasmere (Roosville Border) crossing.]
- Metis Nation of Alberta – Region 3; and
- Metis Nation of British Columbia – Region 4

Aboriginal communities often have unique socio-demographic characteristics that set them apart from the province as a whole. In general, these communities tend to be younger with a lower rate of wage employment and earnings. According to Statistics Canada's 2011 National Household Survey, First Nations with whom Benga has consulted have the following characteristics:

- the employment rate was between 27% and 46% as compared to 69% in the province as a whole;
- between 16% and 72.5% of the Aboriginal identity population had knowledge of an Aboriginal language as compared to 13% of the Aboriginal identity population in the province as a whole;
- the median age was between 21 and 29.5 years as compared to 36.5 years provincially;
- the median after-tax household income was between $26,848 and $40,846 as compared to $76,354 provincially; and

- the unemployment rate was between 9% and 40% as compared to 5.8% across Alberta (NHS 2011).

E.11.3 Potential Impacts

E.11.3.1 Fiscal Effects

Total initial capital expenditure for the Project is estimated to be $730 million. The Project contributes property taxes to both Ranchland and Crowsnest Pass, coal royalties to the provincial government, and corporate taxes to the provincial and federal government. Tax and royalty payments expand the ability of the different levels of government to fund programs and initiatives in the RSA and elsewhere.

Annual municipal tax payments to Ranchland and Crowsnest Pass are estimated at $990,000 and $490,000, respectively. Using an 8% discount rate, the present value of the municipal taxes over the life of the project is calculated to be $11.2 million ($2015).

Once the Project is fully operational, it will pay royalties to the provincial government of Alberta. Future royalty payments are subject to uncertainty as they are directly related to the prevailing market price of coal, the Canadian-US dollar exchange rate, and production costs.

E.11.3.2 Employment Effects

The economic activity associated with the Project will stimulate employment with suppliers to the Project and in the general economy as the affected workers spend their income on goods and services, hence creating employment in consumer goods and service sectors. The employment effect of the Project on suppliers is referred to as indirect employment effects and the employment generation effect in the general economy as induced employment effects. An order of magnitude estimate of these indirect and induced employment effects is derived using published multipliers from an Input-Output model of the Alberta and B.C. economies.

The direct employment effect of the construction phase of the Project on the provincial economies of Alberta and B.C., including the on- and off-site workforces and engineering contractors, is estimated to be 1,000 person years. The total direct, indirect, and induced employment effect of the construction phase is estimated to be 1,215 person years in Alberta and 810 person years in B.C. The total direct, indirect, and induced employment effect of operations is estimated to be 640 person years annually in Alberta and 410 person years annually in B.C.

Much of these employment effects will happen outside of the RSA due to the low population density and limited services within the study area. Effects will most likely be spread throughout the RSA and

nearby municipalities including Pincher Creek, Lundbreck and Brocket as well as major service centres such as Calgary and Lethbridge.

E.11.3.3 Population Effects

Any estimate of the future population of the RSA is subject to uncertainty and is linked to the pace of development in the primary resource extraction industries as well as the availability of housing and services in the RSA. For the purpose of this analysis, a Base Case, an Application Case, and a PDC were defined based on available industry plans in early 2016. The timing, size, and likelihood of future projects are subject to uncertainty as is the continued operation of existing primary resource extraction facilities.

The Project is expected to result in a net permanent population increase in the RSA comprised of in-migrants who relocate to the RSA to fill many of the jobs created as a result of the Project. The population increase associated with Project activity will begin as operations ramp up in 2019 with approximately 490 in-migrants being drawn to the Alberta portion of the RSA and 320 to Sparwood.

Over its operational life, the Project will employ, on average, 385 people per year. The population of Ranchland is expected rise by 19% above the Base Case as a result of the Project. The effect on Crowsnest Pass will be 22% above the Base Case and in Sparwood it will be 19%.

Over the construction period, the Project may increase the average number of mobile workers in the region by approximately 120 and, during peak construction activity, the increase in the number of mobile workers may reach up to 195.

E.11.3.4 Housing Effects

The in-migration anticipated to occur as a result of the Project will increase the need for housing in the RSA. This need will be the most pronounced as the Project hires workers to achieve full operations. In 2021, the anticipated need for housing related to Project-driven in-migration is approximately 277 units. An approximate geographic distribution of this housing need is shown in CR #11, Table 6.1; however, the settlement patterns of in-migrants is subject to uncertainty and may vary across the RSA as individuals respond to housing availability and affordability.

The current stock of housing and pace of development in the RSA is not adequate to accommodate the additional population; however, Sparwood has indicated they have 119 serviced lots that are currently being developed and capacity for 900 units to be built, should the demand arise.

E.11.3.5 Social Infrastructure

Demand for social infrastructure is expected to change largely in line with population effects. The population increase will begin as Project operations ramp up in 2019 with approximately 490 in-migrants being drawn to the Alberta portion of the RSA and 320 to Sparwood. Additional social infrastructure in the RSA will be required, including additional programming and staffing.

CR #11, Table 7.2 provides an overview of effects on selected social infrastructure indicators by 2021. Other indicators are possible. The social infrastructure requirements identified in CR #11, Table 7.2 are for the RSA as a whole, but will largely fall on the towns of Blairmore and Sparwood where the majority of population effects are expected to occur.

While some service providers might face challenges in meeting increased demand, future growth can also help generate opportunities to address this increased demand by:

- leading to increased funding from the federal and provincial governments (*e.g.* per capita funding support for certain programs and services);
- increasing businesses in the area that can offer support for community programs and infrastructure used by residents;
- increasing the labour pool and volunteer base on which local service providers can draw; and
- increasing revenues to local government, which can be used to increase investment in public infrastructure and services.

Growth in a community can also help increase the breadth and nature of social infrastructure services available to local residents (*e.g.* specialized health services, broader educational offerings).

E.11.3.6 Municipal Infrastructure and Services Effects Assessment

The Project will not tie in directly to municipal water or sewer lines in the region. Water will be recovered from local runoff or wells and wastewater will be treated onsite before being returned to the landscape. The Project will make use of the regional waste transfer station operated by Crowsnest Pass.

The additional demand for municipal infrastructure requirements driven by the population increase estimated under the Application Case assumptions will exceed the current and planned levels of municipal infrastructure in Crowsnest Pass but not in Sparwood.

E.11.3.7 Traffic Impact Assessment

Traffic volumes on Highway 3 are expected to increase by a similar magnitude as has been experienced in the recent past. Under these assumptions, the volume of traffic travelling along Highway 3 near the Town of Blairmore will increase to approximately 7,100 AADT in 2017 and 7,450 AADT in 2019.

Project-related traffic, as measured at the proposed mine access road to Highway 3 near Blairmore, is expected to average 50 AADT during the construction period, peaking in the range of 80 AADT in early 2018, mostly due to equipment and materials deliveries. This traffic is expected to move east and west along Highway 3 and represents an increase of approximately 1% to Base Case traffic levels in 2018.

During operations, the average contribution to traffic volumes along Highway 3 both east and west of the Project access road is estimated in the range of 130 AADT. This represents approximately a 2% increase over Base Case traffic levels in 2019.

E.11.3.8 Traditional Use Effects Assessment

There are several pathways through which resource development can affect Aboriginal culture. The type of effect experienced by a particular Aboriginal community depends on several factors including:

- size and pace of development;
- the proximity of the development to traditional and reserve lands;
- engagement strategies taken by industry and government;
- mitigations enacted by industry (w, support for capacity-building initiatives, establishment of inclusive decision-making institutions); and
- the ability of individuals and communities to cope with external disturbances.

The last point refers to the ability of Aboriginal communities and cultures to withstand strong and competing forces. While resource development can pose a challenge to community resilience by placing increased pressure on traditional land use and further exposing Aboriginal peoples to external cultural influences, mitigation and engagement strategies taken by industry can build individual and community resilience by providing support for traditional land use knowledge and studies, Aboriginal community projects, and through the negotiation of benefit agreements.

Some factors that will influence the effects of the Project on Aboriginal Groups are:

- The Project will employ approximately 385 people during operations and will peak at approximately 195 workers on-site during construction.
- First Nations reserve lands are located between 60 to over 400 km away from the Project.
- Population growth resulting from job in-migration will likely only temporarily reverse the current population decline in the area. An overall increase in the number of people living in the region is unlikely.
- Information regarding Project-specific effects on traditional land use can be found in the Aboriginal Consultation section of the EIA (Section H).

E.11.4 Cumulative Effects

The effect of additional projects considered in the PDC will be limited, as they are not expected to generate additional permanent operations jobs in the area. Specifically:

- The Altalink project will involve some activity around construction of the transmission line but this will be short-term and temporary.
- Teck's Baldy Ridge Extension project is an expansion project that aims only to replace current production in the Baldy Ridge mines and maintain current operations employment (BRE 2014).
- CanAus Coal's Michel Creek Coking Coal project is a proposed new project in the region, but its population impact is expected to be offset by the anticipated decrease associated with closure of Teck's Coal Mountain project.

E.11.4.1 Population Effects

The population effect of additional projects considered in the PDC will be limited, as they are not expected to generate additional permanent operations jobs in the area.

E.11.4.2 Housing Effects

There is no net in-migration to the region anticipated as a result of projects currently disclosed in the PDC and therefore, no significant change in the demand for housing is anticipated.

E.11.4.3 Social Infrastructure

Under the PDC, no significant population growth is anticipated and, hence, no additional effect on social infrastructure is expected to occur.

E.11.4.4 Municipal Infrastructure and Services

There is no net in-migration to the region anticipated as a result of the projects currently disclosed in the PDC and therefore, no additional municipal infrastructure is anticipated.

E.11.4.5 Traffic

There is no significant change anticipated in traffic levels as a result of additional projects currently considered in the PDC.

E.11.5 Mitigation and Monitoring

In order to ensure the local economy and people benefit from the Project, Benga will:

- support in the hiring of a municipal planner for Crowsnest Pass to assist with community planning;
- support local municipalities in discussions with the province to acquire additional funding for services and infrastructure;
- work with local governments to facilitate the timely development of residential land and dwellings;
- house construction workers in a temporary camp, which has the ancillary effect of reducing the resident population effect of the Project and the anticipated demand for housing.
- develop and implement specific policies regarding employee health and safety and emergency response;
- maintain explicit and enforced workplace policies with regards to alcohol and drug use, and illegal activities;
- provide employees with access to the company's confidential employee assistance plan, which provides support for families and individuals who may experience difficulty dealing with personal, family, or work-life issues that can affect one's health and well-being;
- continue to support local programs and initiatives through both financial and in-kind contributions, where appropriate;
- cooperate with service providers (*e.g.*, health, social, education), government, and other industrial operators in the region to assist in addressing effects of its project and resource development;
- continuous monitoring of project effects and associated mitigation measures *via* Benga's engagement with regional and provincial stakeholders; and

- working with the municipalities in the region to keep them informed of its development plans and their timing so that the affected municipalities have sufficient time to plan for changes in the demand for services.

Benga recognizes the effects of resource development on traditional land use and culture. The proponent will therefore carry out the following actions to enhance the positive and minimize the adverse effects of its Project:

- undertake progressive reclamation, giving consideration to traditional land use, where possible;
- provide access to traditional users across the lease;
- compensate trappers directly affected by the Project, according to industry standards;
- promote cultural diversity awareness to Benga's employees and contractors regarding respect for traditional resource users;
- support specific community projects, such as elder and youth programs, where appropriate; and
- continue working with Aboriginal communities in the region to ensure that their concerns with respect to traditional land use and culture are continually considered during Project planning and operation.

E.11.6 Evaluation of Significance

Table 11.6-1 provides the determination of significance for the effects of Project operations on socio-economic VCs. The determination of significance considers residual effects after mitigation and other management measures are implemented. It is consistent with the method used elsewhere in the filed application, which itself draws on guidance from both Federal and Provincial regulators.

Table E.11.6-1 Project Operations Residual Effects on Socio-Economic VCs

VC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence[8]	Significance[9]
Income	Project expenditures will generate income for businesses and workers	See Section 4.2.3	Regional/ Provincial	Long	Continuous	Reversible in long-term	Low	Positive	High	High	Not Significant
Government Revenue	The Project will generate revenue for government	N/A	Regional/ Provincial/ National	Long	Continuous	Reversible in long-term	Low to Moderate	Positive	High	High	Not Significant
Employment	Project activities will generate employment opportunities	See Section 4.2.3	Regional/ Provincial	Long	Continuous	Reversible in long-term	Low	Positive	High	High	Not Significant
Population	The operations jobs created by the Project are expected to be filled primarily by in-migrants to the region, thereby increasing the permanent population in the RSA.	See Section 5.4	Regional	Long	Continuous	Reversible in long term	Low	Mixed	High	High	Not Significant
Housing	Project-related population increases will increase demand for housing in the RSA.	See Section 6.4	Regional	Long	Continuous	Reversible in long term	Moderate	Positive	High	High	Not Significant

Table E.11.6-1 Project Operations Residual Effects on Socio-Economic VCs

VC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence[8]	Significance[9]
Social Infrastructure	Project-related activities, workers, traffic, and population effects will place demands on social infrastructure in the RSA	See Section 7.4	Regional	Long	Occasional to Periodic	Reversible in long term	Low	Negative	High	High	Not Significant
Municipal Infrastructure and Services	Project-related activities and population will place demands on municipal infrastructure in the RSA	See Section 8.4	Regional	Long	Continuous	Reversible in long term	Moderate	Negative	High	High	Not Significant
Traditional Land Use and Culture	Project-related local wage employment opportunities and land use might affect local traditional land use and associated social and cultural conditions for local Aboriginal communities.	See Section 9.4 Project-specific effects on traditional land use can be found in the Aboriginal Consultation, Traditional Ecological Knowledge and Land Use section of the EIA	Regional	Extended	Continuous	Reversible in long term	Low	Mixed	High	High	Not significant

Table E.11.6-1 Project Operations Residual Effects on Socio-Economic VCs

VC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Ability for Recovery[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence[8]	Significance[9]
Transportation	The transportation of materials, equipment and workers will increase traffic in the RSA.	See Section 10.4	Regional	Long	Continuous	Reversible in long term	Moderate	Negative	High	High	Not Significant

[1] Local, Regional, Provincial, National, Global
[2] Short, Long, Extended, Residual
[3] Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
[4] Reversible in short term, Reversible in long term, Irreversible – rare
[5] No Impact, Low Impact, Moderate Impact, High Impact
[6] Positive, Mixed, Negative
[7] Low, Moderate, High
[8] Low, Medium, High
[9] Significant, Not significant

E.11.7 Summary

The Project will create positive economic and fiscal effects on the socio-economic regional study area (RSA) consisting of Ranchland, Crowsnest Pass and Town of Sparwood (Sparwood). The Project is estimated to create:

- 90 person years of engineering employment prior to and during construction;
- 910 person years of on- and off-site employment related to the construction of the plant, facilities and infrastructure for the mine between 2018 and 2019; and
- 385 long-term operations positions to be hired by 2020.

Once fully operational, the Project will add an estimated $1.5 million annually in property taxes to Ranchland and Crowsnest Pass, which over the life of the Project has a net present value (NPV) of approximately $11.2 million (NPV 2015) assuming no change in mill rates. An estimated 67% of these taxes will be paid to Ranchland and the balance will be paid to Crowsnest Pass. The Ranchland council has acknowledged that much of the impacts of the Project will accrue to Crowsnest Pass and has indicated they would be open to negotiating a revenue-sharing agreement once the Project commences (RL 2013). The Project will also contribute an estimated $140 million (NPV 2015) and $210 million (NPV 2015) to provincial and federal corporate income taxes respectively as well as approximately $195 million (NPV 2015) in provincial royalties over the 23-year operating life of the project, assuming a $140/tonne average real price of coal.

The operations jobs created by the Project are expected to be filled primarily by in-migrants to the region, thereby increasing the permanent population in the RSA. Within Alberta, the population impact of the Project is expected to fall primarily on the S.M. of Crowsnest Pass, particularly the communities of Blairmore and Coleman as they are closest to the Project.

In addition to the impact in Alberta, the Project is also expected to result in population growth in the nearby Town of Sparwood in British Columbia (B.C.). By the year 2021, an estimated 1,100 people are expected to have re-located to the region, with approximately 430 going to Sparwood, 660 to Crowsnest Pass, and the balance (10) to Ranchland. The effects on regional services and infrastructure will largely be in line with population effects, falling primarily on Crowsnest Pass and Sparwood.

A number of service providers have indicated that they are well positioned to plan for and address future growth forecasted under both Base and Application Case assumptions, particularly in Sparwood. In Crowsnest Pass, concerns were raised about the ability of the municipality to provide sewage and water services to a larger population.

While service providers will likely face challenges in meeting the increased demand, future growth can also help generate opportunities to address this increased demand by increasing revenues to government, increasing the labour and volunteer base, and growing the number of businesses that can support local programs and infrastructure. Growth in a community can also help increase or revitalize the breadth and nature of infrastructure and services available to local residents (*e.g.*, specialized health services, broader educational offerings).

E.12 Human and Wildlife Health

E.12.1 Introduction and Terms of Reference

The potential effects of the Grassy Mountain Coal Project on human and wildlife health are discussed in Consultant Report #12 (CR #12).

The scope of the human health risk assessment (HHRA) was consistent with the final Terms of Reference (TOR) for the Project issued by the Alberta Environment Regulator (AER 2015) and the Guidelines for the Preparation of an Environmental Impact Statement issued by the Canadian Environmental Assessment Agency (CEAA 2015). The TOR and CEAA Guidelines are presented in Appendices 1 and 2, respectively. Section 7.1 of the TOR lists the public health-related requirements; those relevant to human health and addressed by the HHRA are as follows:

- *describe aspects of the Project that may have implications for public health or the delivery of regional health services. Determine quantitatively whether there may be implications for public health arising from the Project.*
- *document any health concerns raised by stakeholders during consultation on the Project.*
- *document any health concerns identified by Aboriginal communities or groups resulting from impacts of existing development and of the Project, specifically on their traditional lifestyle. Include an Aboriginal receptor type in the assessment.*

The CEAA Guidelines relevant to human health are to include consideration of the following for First Nation and other persons in the study area:

- *location of and proximity of any permanent, seasonal, or temporary residences or camps; and,*
- *effects on the health and socio-economic conditions, including the functioning and health of the socio-economic environment, encompassing a broad range of matters that affect communities in the study area in a way that recognises interrelationships, system functions and vulnerabilities.*

Human health was identified as the VC for the HHRA. The HHRA describes the nature and significance of potential health risks to the local human population, associated with exposure to

chemicals that could be released to the environment from the proposed Project. The results of the detailed quantitative health risk assessment conducted in this HHRA are the measurable parameters used to assess the potential impacts on human health.

The HHRA assessed the potential health risks associated with existing conditions, prior to development of the Project, as well as future conditions related to the Project and the Project in combination with other planned developments in the region. It was conducted using standard methods endorsed by regulatory agencies. Specifically, the risk assessment followed the Alberta Health and Wellness (2011) *Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta*. Additional guidance published by Health Canada (2010a,b) and United States Environmental Protection Agency (US EPA, 2005) was also consulted. A screening level wildlife health risk assessment was also conducted, using the same models and air concentrations as the HHRA.

The local study area (LSA) and regional study area (RSA) were the same as those used for the Air Quality Assessment (CR # 1a). The LSA is a 10 km by 15 km area centred on the proposed facility. It was selected to include key local receptors but also to exclude most regional emissions sources in order to differentiate Project impacts from the effects of regional projects. The RSA is a 30 km by 35 km area, centred near the northern boundary of the LSA, selected to include local communities such as Coleman, Blairmore, and Frank, as well as any other emissions in the area.

Chemicals of potential concern (COPCs) were identified through an inventory of expected Project air emissions, as described in the Air Quality Assessment (CR # 1a). As the Project will not release any chemicals into potential domestic use aquifers or surface water under normal operating conditions (Section C.5.3, C.6.13, and C.6.17), the COPCs were based on air emissions only.

COPCs identified for the Project included:

- criteria air contaminants (CACs) sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and fine particulate matter with diameters of 2.5 and 10 microns ($PM_{2.5}$ and PM_{10});
- metals;
- polycyclic aromatic hydrocarbons (PAHs); and
- volatile organic compounds (VOCs).

Direct inhalation of air was assumed to be the primary exposure pathway and was assessed for all identified COPCs. The HHRA evaluated both acute and chronic inhalation health risks for all of the identified COPCs for which adequate toxicological data was available. Secondary pathways were

also assessed (multimedia exposure assessment) for those COPCs meeting criteria for potential persistence or bioaccumulation in environmental media. Exposure pathways for the multimedia assessment included:

- deposition of COPCs in air onto soil in the surrounding area - potential receptor exposure by direct contact with soil, inadvertent ingestion of soil, and inhalation of dust;
- accumulation of COPC in local vegetation, through direct deposition from air or uptake from affected soils - potential receptor exposure by ingestion of local vegetation; and
- COPCs in soil, plants, and water can be ingested by local wildlife – potential receptor exposure by ingestion of local wild game.

The Project is not expected to have any effect on water quality; however, potential exposure through ingestion of surface water, contact with surface water while swimming, and ingestion of fish were considered in order to conservatively estimate total potential exposure.

E.12.2 Baseline Condition

Following Alberta Health and Wellness (2011) *Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta* and Health Canada's (2010a,b) guidelines for quantitative HHRA, review of baseline conditions was not required.

E.12.3 Potential Impacts

Potential effects arising from Project emissions and other releases include:

- reduced environmental quality;
- increased inhalation exposure; and
- increased multimedia exposure (air, water, food, soil).

Reduced environmental quality and exposure to potentially harmful concentrations of chemicals can result in a risk of potential adverse health effects.

E.12.4 Cumulative Effects

E.12.4.1 Acute Inhalation

Acute inhalation risks were evaluated by comparing maximum predicted annual average concentrations in air to toxicity limits. The majority of the hazard quotients (HQ) for the acute inhalation assessment were below 1.0 at all the receptor locations assessed. The results of the acute inhalation assessment demonstrate that Project emissions do not pose a risk of adverse health effects at the receptor locations assessed outside the Mine Project Boundary for all COPCs assessed.

Within the Mine Permit Boundary, the results of the acute inhalation risk assessment indicate that predicted HQs were below 1.0 for all COPCs with the exception of NO_2, $PM_{2.5}$ and PM_{10} at the RSA-MPOI (*i.e.*, worst-case scenario location, or maximum point of impingement) and PM_{10} at R10. As presented in the Air Quality Assessment (Consultant Report #1a), the locations of the RSA-MPOI receptors are close to key Project activities at the edge of the pit boundary within the Project footprint and the R10 location is within the Mine Permit Boundary. Access to both of these areas will be restricted to the general public during construction and operation.

Additional assessment of the R10 results indicates that although exceedances are predicted to occur, HQs are only marginally above 1.0 and occur, at the most, two days per year (an average of 0.8 times per year). Based on the conservative assumptions built into the air dispersion modelling (CR #1a, Section 2.5.3 and 2.5.5) and the exposure and hazard assessment steps, as well as the restricted access to this location, there is a low risk of potential adverse health effects occurring at this location.

Outside of the Mine Permit Boundary, HQs greater than 1.0 were predicted for PM_{10} at Coleman (R6) and Blairmore North (R8) locations. These exceedances are primarily due to baseline conditions and are thus attributed to other emission sources in the area (*e.g.*, residential, automobile traffic and rail activities) rather than the Project.

Potential risks of acute effects on humans from the Project are predicted only at the RSA-MPOI locations, which are within the Mine Permit Boundary and thus will not be accessible to the general population.

E.12.4.2 Chronic Inhalation

Chronic inhalation risks were evaluated by comparing maximum predicted annual average concentrations in air to toxicity limits. For the majority of the COPCs assessed, the results of the chronic inhalation risk assessment indicate that predicted exposure to the maximum predicted air concentrations at multiple locations yielded HQs below 1.0, and therefore do not pose a risk of adverse human health effects. Although some small exceedances were predicted for a few CACs at the RSA-MPOI, due to close proximity to proposed mining activities, it is overly conservative to assume that a person will be living at that location for long periods of time.

At the RSA-MPOI, the HQs for NO_2, $PM_{2.5}$ and PM_{10} the HQs were greater than 1.0. The locations of the MPOIs are close to key Project activities on the edge of the pit boundary. It was assumed that access to areas within the Mine Permit Boundary will be restricted to the general public during Project construction and operation. Therefore, Project emissions were not predicted to pose a risk of adverse health effects.

Exceedances predicted at R6, R8, and R14 were small and attributed to background sources in the area (*e.g.*, residential, automobile traffic and rail activities), and were not contributions from the Project.

E.12.4.3 Chronic Multimedia Exposure

Chronic risks from secondary exposure through oral and dermal pathways were evaluated using maximum predicted annual average concentrations in air and a multimedia exposure model. The multimedia HQs and ILCR quotients were less than 1.0 for all COPCs except for arsenic at the RSA-MPOI, where the ILCR quotient was equal to 1.0. The arsenic ILCR quotient of 1.0 is not considered indicative of potential risk of adverse health effects due to its occurrence only at the RSA-MPOI (*i.e.*, worst-case scenario receptor) and the conservative assumptions applied in the assessment of exposure to carcinogens.

E.12.4.4 Significant Impact Ranking

In an HHRA, there is only one VC – human health. Potential Project impacts on human health are determined through a set of measurable parameters (COPCs), and each of these parameters may be impacted by the Project, leading to impacts on human health. When a COPC's predicted HQ was below 1.0 (a magnitude rating of "nil"), the potential impact of the Project on human health was automatically defined as "not significant" and further assessment of the impact attributes (*e.g.*, extent, duration, frequency, *etc.*) was not required. HQs with a magnitude ranking of "low", "moderate", or "high" were assessed for all remaining attributes and included in Table E.12.4-1.

The results of the HHRA indicated that impacts of emissions predicted to occur due to Project activities were not significant with respect to potential risk of adverse human health effects.

Table E.12.4-1 Summary of Impact Significance on Human Health VC

Measurable Parameter	Nature of Potential Impact or Effect on VC	Type of Effect	Extent[a]	Duration [b]	Frequency[c]	Reversibility[d]	Magnitude [e]	Project Contribution [f]	Confidence Rating[g]	Probability of Occurrence [h]	Significance [j]
1. NO_2 HQ											
At the MPOI only	Potential human health effects (respiratory)	Acute	Local	Long	Periodic	Short term	Low	Negative	High	Low	Not Significant
3. $PM_{2.5}$ HQ											
MPOI only	Potential human health effects (premature mortality)	Acute	Local	Short	Periodic	Short term	Low	Negative	High	Low	Not Significant
		Chronic	Local	Long	Continuous	Irreversible	Low	Negative	High	Low	Not Significant
5. PM_{10} HQ											
MPOI only	Potential human health effects (population mortality and morbidity)	Acute	Local	Short	Periodic	Short term	Moderate	Negative	High	Low	Not Significant
		Chronic	Local	Short	Continuous	Irreversible	Low	Negative	High	Low	Not Significant
At R10 (cabin)	Potential human health effects (population mortality and morbidity)	Acute	Local	Short	Periodic	Short term	Low	Negative	High	Low	Not Significant

Table E.12.4-1 Summary of Impact Significance on Human Health VC

Measurable Parameter	Nature of Potential Impact or Effect on VC	Type of Effect	Extent[a]	Duration [b]	Frequency[c]	Reversibility[d]	Magnitude [e]	Project Contribution [f]	Confidence Rating[g]	Probability of Occurrence [h]	Significance [j]
	Potential human health effects (population mortality and morbidity)	Chronic	Local	Short	Continuous	Irreversible	Low	Negative	High	Low	Not Significant
At Coleman (R6)	Potential human health effects (population mortality and morbidity)	Chronic	Local	Long	Continuous	Irreversible	Low	Negative	High	Moderate	Not Significant
At Blairmore (R8 and R14)	Potential human health effects (population mortality and morbidity)	Chronic	Local	Long	Continuous	Irreversible	Low	Negative	High	Moderate	Not Significant

(a) Local, Regional, Provincial, National, Global

(b) Short, Long, Extended, Residual

(c) Continuous, Isolated, Periodic, Occasional

(d) Reversible in short term, Reversible in long term, Irreversible

(e) Nil, Low, Moderate, High

(f) Neutral, Positive, Negative

(g) Low, Moderate, High

(h) Low, Medium, High

(I) Not Significant, Significant

E.12.5 Mitigation and Monitoring

Assuming public access within the Mine Permit Boundary is restricted and the mitigation measures assumed by the other disciplines are implemented (Section A.10); there is no need for further mitigation of emissions based on the results of the HHRA. Due to the potential for limited acute exposure risk within the project footprint, a monitoring program is recommended to confirm that the emitted concentrations of NO_2, $PM_{2.5}$, and PM_{10} in areas accessible to the general public do not exceed the levels predicted by the air dispersion modelling and thus will not pose a risk of adverse health effects. In addition a water quality monitoring program will be implemented to monitor selenium (and other pertinent parameters) in Project affected watercourses and any end pit lakes.

E.12.6 Summary

The emissions from the Project are not predicted to pose a risk of adverse health effects at the receptor locations accessible to the general public. While risk quotients greater than 1.0 were predicted, they were identified to occur within the Mine Permit Boundary, an area assumed to be inaccessible by the public during construction and operation of the mine, or were due to existing baseline emissions with minimal contribution from the Project. Due to the conservative assumptions applied in the air dispersion modelling and HHRA, the risk results outside the RSA-MPOI were not considered great enough to be indicative of a risk of potential adverse health effects.

The results of the HHRA indicate that isolated concentrations of NO_2, $PM_{2.5}$, and PM_{10} slightly exceeded target HQs for inhalation, and that the predicted arsenic oral and dermal exposure at the RSA-MPOI was equal to the target ILCR. Due to the isolated nature of these exceedances, their marginal nature when compared to the conservativeness of the modelling assumptions, and the influence of background concentrations, the result do not suggest a need for further mitigation of emissions based on potential human health risks.

The results of the screening-level wildlife risk assessment indicates no potential risk of adverse effects associated with Project emissions on the health of wildlife in the study areas.

E.13 HISTORICAL RESOURCES

E.13.1 Introduction and Terms of Reference

The Historical Resources Assessment for Benga Mining Limited's (Benga) proposed Grassy Mountain Coal Project (Project) is summarized in this section. The full Historical Resource Assessment is provided within a separate standalone report, which will be submitted directly to Alberta Culture and Tourism. The Project is located in the Municipality of Crowsnest Pass in southwestern Alberta. Historical Resources in Alberta are regulated under the *Alberta Historical Resources Act*, and that

legislation and its regulations and guidelines are administered by Alberta Culture and Tourism. Historical Resources are defined by the *Act* as:

> *Any work of nature or of humans that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific, or esthetic interest including, but not limited to, a palaeontological, archaeological, prehistoric, historic, or natural site, structure or object (HRA, RSA 2000, Ch H-9, 1[e] p.3).*

The Alberta Energy Regulator (AER) final Terms of Reference (ToR) used for the Historical Resources Assessment was issued by the AER on March 22, 2015, indicates the following Historical Resource Assessment requirements:

Section 5 - Historic Resources:
[A] Describe consultation with Alberta Culture (AC) concerning the need for a historic resource impact assessment (HRIA) for the project, and

a) *provide a general overview of the results of any previous historic resources studies, including archaeological resources, palaeontological resources, historic period sites and other historic resources as defined within the Historical Resources Act;*
b) *summarize the results from the field program done to assess the archaeological, palaeontological and historic significance for both the project area and the local study area;*
c) *provided a summary of the result of the HRIA conducted to assess the potential impact of the project on archaeological, palaeontological and historic resources;*
d) *provide an outline of the program and schedule of field investigations that AC may require the proponent to undertake to further assess and mitigate the impacts of the project on historic resources; and*
e) *Document any concerns about historic resources raised during consultation on the project.*

For the Canadian Environmental Assessment Agency (CEAA)'s guidelines, the following requirements were requested:

Section 6.1.10. Human Environment

> *(description of) physical and cultural heritage, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance.*

Section 6.3.4. Aboriginal Peoples

> *(description of) physical and cultural heritage, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance to Aboriginal groups, including, but not limited to:*
>
> - *the loss or destruction of physical and cultural heritage;*
> - *changes to access to physical and cultural heritage; and,*
> - *changes to the cultural value or importance associated with physical and cultural heritage.*

In addition to the AER and CEAA requirements, the Project has been assessed under a *Historical Resources Act* Requirement issued by AC under file number 4560-14-001-002, which called for a HRIA of archaeological and palaeontological resources, including the assessment of historic structures and remains; subsequently, the Project's HRIA was designed, implemented, and executed to conform to the requirement.

E.13.2 Baseline Conditions

E.13.2.1 Historical Resources Ranking Overview

Historic Resources, both archaeological and paleontological, are widely distributed in Canada and have the potential to occur in a wide variety of environmental settings. In general, historical resources are considered to be largely static; subsequently, they can be potentially impacted by a variety of factors, including, but not limited to, natural erosion and deposition, chemical and mechanical decomposition, past and modern human interference, and landscape modification such as fire, industrial, commercial and residential land development, agriculture, and deforestation.

For HRIA, Alberta uses a system of ranking lands based on the presence of, and/or likelihood of, lands to contain historical resources to aid in determining requirements for historical resources. Legally described boundaries to ca. 16 hectares (ha) legal subdivisions (*i.e.* quarters of quarter sections) under the township and range system are given a ranking based on historical resources and historical resources potential. These rankings are called Historical Resource Values (HRV) and range from HRV 1 to HRV 5, where HRV 1 are considered culturally, scientifically, or historically important and HRV 5 lands are considered areas that have potential to contain unrecorded historical resources. The following provides further context on the HRV ranking order:

- HRV 1 resources are relatively rare. Within southern Alberta examples include Dinosaur Provincial Park, Head Smashed In Buffalo Jump, Writing On Stone Provincial Park, as well as Euro-Canadian era sites (*e.g.*, Fort Calgary, located in the City of Calgary).

- HRV 2 resources are restricted to municipal or registered historic resources (*e.g.*, buildings and other historically important structures from the Euro-Canadian period).
- HRV 3 resources are defined as a significant historical resources based on their scientific, historical, cultural, educational, and interpretative or other factors. Lands with this designation will likely require avoidance.
- HRV 4 resources designate other recorded historical resources that are generally not unique and are regarded as common in Alberta. Examples of HRV 4 sites are fossil bone or shell beds whose contents are not considered significant remains of an Aboriginal encampment occupied by humans at some time in the past and contains elements such as remains of stone tools or stone tool production, food remains, and related debris left behind by its occupants. An example of a HRV Euro-Canadian site is the remains from a homestead. Such remains could include machinery, dumps, and building foundations.
- HRV 5 resources denote lands thought to have the potential to contain historical resources; however, such resources have not yet been located or recorded.

There are some areas in Alberta that do not have a HRV ranking and these lands are considered to have low potential to contain historical resources, due to various factors such local topography. As examples, steep side slope areas that have been largely disturbed by agriculture and other forms of land development generally do not have an assigned HRV. There are also historical resources that have been classified as HRV 0. A HRV 0 site generally consists of a single artifact (an isolated find) or a small number of artifacts that are not considered important from a scientific, cultural, or historical perspective. HRV 0 includes sites that have been destroyed by development or other impacts. HRV 0 sites are considered in determining historical resources potential, but since they no longer exist in any measurable way, they are not subject to historical resource assessments or mitigation measures.

E.13.2.2 Historic Resources Potential

E.13.2.2.1 Local Study Area

The HRIA local study area (LSA), that is, the area that has been subject to field assessment, analysis, and reporting is coincident with the mine permit area/Project boundary (Figure E.13.2-1). The HRIA regional study area (RSA) is coincident with the Alberta portion of the Crowsnest Pass as that area is understood culturally, geologically, and geographically (Figure E.13.2-2). The Crowsnest Pass is generally a narrow east to west trending valley running through the Crowsnest Ridge. This narrow valley is located east of the Alberta-British Columbia border and it continues approximately to the community of Burmis at the east end of the culturally defined community of Crowsnest Pass. The Pass includes the north and south facing slopes of the mountains on either side of the valley and includes the south facing slopes of Bluff Mountain and the north facing slopes of Turtle Mountain.

LSA topography plays a large role in assessing whether a given area has the potential to contain historical resources related to human activity. Humans can and do travel over moderately and steeply sloping terrain; however, in these types of environments there was rare use of such lands to establish camps or to promote other activities that might result in the deposition of significant remains. Slopes are also geomorphologically unstable and any remains that are lost or abandoned on steep slopes are usually moved downslope and eroded. In general, humans tend to favour less steep or level lands near water for continued use. The steep topography within the LSA is a predominant limitation to sustained human use of many areas.

For Grassy Mountain, modern land development (*i.e.*, historical underground and open pit mining) has resulted in the disturbance of large areas of the original land surface, which likely would have impacted historical resources in these areas. With substantial pre-disturbance occurring on the upper portions of Grassy Mountain, the potential for archaeological and Euro-Canadian sites is likely limited to level and gently sloping areas associated with lower elevation lands near permanent or semi-permanent natural water sources within the LSA.

The LSA currently has HRVs of 2, 3, 4, and 5 with approximately 50 percent of the LSA having no assigned historical resource value due to factors discussed above. There is one HRV 2 site in the LSA, which is related to the Greenhill Coal Mine and its associated infrastructure. The HRV 3 sites are palaeontological locales where Mesozoic fossils are reported to occur. The HRV 4 sites are concentrated in the southern portion of the LSA, and the HRV 5 areas are primarily in the eastern and southern portions of the LSA. All historical resource values and related sites were examined and considered in the formulation and execution of the historical resources assessment for this Project.

E.13.2.2.2 Regional Study Area

For the RSA (Figure E.13.2-2), there are a large number and variety of historical resources sites and areas based on the following:

- The Crowsnest Pass has been occupied by humans since at least the end of the Pleistocene Epoch, that is, the last ice age, over 10,000 years ago and some have left remains of their occupation.
- The Crowsnest Pass was one of the first areas of Alberta to be settled by Europeans in the late 19th century and in the early 20th century, and the region was an important coal mining area.

As a result, the early 20th century Crowsnest Pass experienced rapid development of what are now considered important historical buildings and sites, such as the Lille townsite and the Greenhill Mine among others.

E.13.2.2.3 Palaeontological Potential

Palaeontological (fossil) resources of high heritage value have been found in a number of scenarios within the LSA, including areas of previous excavation within the existing mine site, predominantly pits, road and trail cuts, and railroad cuts. It is also possible that fossil material has been collected along exposures bordering creek channels. The probability that additional significant fossil material will be exposed during the proposed mining operations is quite high as there will be substantial excavations made in areas of high palaeontological potential such as pit extensions and the South Rock Disposal Area.

E.13.3 Potential Impacts

E.13.3.1 Archaeological Locales

This section contains details on all historic resources within the Project Area that are ranked HRV 4 and above and are therefore extant (Figure E.13.3-1); however, because 22 of the 32 recorded archaeological/historic sites are outside of the Project footprint, they were not subject to detailed assessment or testing and evaluation. In addition to assessing existing sites, the field survey and testing program searched for, located, assessed, and tested area(s) that were determined to offer potential to contain previously unrecorded historical resources. This section on site assessment therefore includes discussion of testing and evaluation procedures to search for sites in the Project area and more specifically the Project's footprint.

As of 2015, there are 32 recorded archaeological or historic era resources located within the LSA. These resources are considered to have potential to be relevant to further scientific studies; they may be important historically to the local or regional area; they have value as cultural heritage sites to aboriginal groups; or they may have value for the purposes of general public education or interpretation of local or regional history. Of the 32 reported sites, 10 are located within or in close proximity to the proposed Project footprint. The Project footprint is defined as the portion of the LSA that the current mine plan indicates will be developed (Figure E.13.2-1). The Project footprint includes the open pit mine, external and in pit waste rock disposal areas, a Coal Handing Processing Plant (CHPP), a covered overland conveyor, a loadout, and rail loop alignment.

Table E.13.3-1 lists the 32 recorded archaeological/historic sites located within the LSA and provides details for each site (Figure E.13.3-1). Ten of the larger sites (shaded in table) that are wholly or partially located within the Project footprint are further discussed below.

Table E.13.3-1 Archaeological Sites Within the Current Mine Permit Boundary (LSA)

Borden Site Number[1]	Precontact Period (PC) or Historic Period (H) and Site Classification[2]	Inside or Outside Project Footprint[3]	Legal Land Location[4]	Historical Resource Value[5]	Interaction[6]
DjPo-10	PC Campsite	outside	9,10-3-8-4	4	none
DjPo-37	H Blairmore dairy building remains	outside	12-3-8-4	4	none
DjPo-38	H Greenhill Mine site	inside	3,4,5-6-2-8-4	2	indirect and direct, see discussion below
DjPo-63	PC Campsite	inside	4-2-8-4	4	unknown, see discussion below
DjPo-98	PC Campsite	inside	2-23-8-4	4	direct, see discussion below
DjPo-99	H residential remains	outside	10-23-8-4	4	none
DjPo-100	PC Campsite	outside	13-19-8-3	4	none
DjPo-101	H Boisjoli mine Structures	inside	1-23-8-4	4	direct, see discussion below
DjPo-112	H Lille townsite	outside	9 to 16-18-8-3	1	none
DjPo-116	H Grassy Mountain Campsite	inside	11-24-8-4	4	direct, see discussion below
DjPo-124	H Frank to Lille Railway	partly inside	11,14-18-8-3; 3,6,7,11,13-19-8-3;4,5-30-8-3; 8-24-8-4	4	indirect, see discussion below
DjPo-130	PC Campsite	inside	2-23-8-4	4	none, but see discussion below
DjPo-133	H Cougar Valley mine remains	outside	1,2,3-14-8-4	4	none

Table E.13.3-1 Archaeological Sites Within the Current Mine Permit Boundary (LSA)

Borden Site Number[1]	Precontact Period (PC) or Historic Period (H) and Site Classification[2]	Inside or Outside Project Footprint[3]	Legal Land Location[4]	Historical Resource Value[5]	Interaction[6]
DjPo-136	H Frank to Lille wagon road	outside		4	none
DjPo-146	PC Campsite	outside	2-23-8-4	4	none
DjPo-176	H dump campsite	outside	3-19-8-3	4	none
DjPo-179	PC Campsite	outside	11-19-8-3	4	none
DjPo-180	H residential remains/ cabin	outside	11-19-8-3	4	none
DjPo-181	PC Campsite	outside	11-19-8-3	4	none
DjPo-184	PC Campsite	inside	9-24-8-4	4	direct, see discussion below
DkPo 7	PC stone feature	inside	14-24-8-4	4	direct, see discussion below
DkPo 8	PC Campsite	outside	13-19-8-3	4	none
DkPo 14	PC Campsite	outside	14-6-9-3	4	none
DkPo 30	H bridge remains	outside	3-31-8-3	4	none
DkPo 31	H bridge remains	outside	3-31-8-3	4	none
DkPo 37	PC Campsite	outside	14-19-8-3	4	none
DkPo 38	PC Campsite	outside	3,4-30-8-3	4	none

Table E.13.3-1 Archaeological Sites Within the Current Mine Permit Boundary (LSA)

Borden Site Number[1]	Precontact Period (PC) or Historic Period (H) and Site Classification[2]	Inside or Outside Project Footprint[3]	Legal Land Location[4]	Historical Resource Value[5]	Interaction[6]
DkPo 39	PC Campsite	outside	14-19-8-3	4	none
DkPo 41	H mine remains	inside	16-24-8-4	4	direct, see discussion below
DkPo 42	PC lithic scatter	outside	14-19-8-3	4	none
DkPo 43	PC Campsite	outside	13-19-8-3	4	none
DkPo 44	PC Campsite	outside	13-19-8-3	4	none

Notes:

[1] This is the official, unique identifier for archaeological/historic sites recorded in Canada, and each is assigned by the provincial historical resources regulator, in this case Alberta Culture and Tourism.

[2] A Precontact Period site dates to prior to the arrival of Europeans in the area and is therefore a First Nations site. The Precontact Period runs from the arrival of humans in Canada to the arrival of Europeans. Site classification is a general category that attempts to infer what the site is or was used for. In the case of Euro-Canadian remains, the site classification is generally more specific than for Precontact Period sites.

[3] The location of the site relative to the Project footprint as it is currently promulgated.

[4] Legal land Description: Site location

[5]The HRV of the site as assigned by the regulator, Alberta Culture and Tourism. HRVs attempt to assign a significance value based on the scientific, cultural, historic, educational, and interpretative importance or potential of a site. HRVs are discussed in detail in the Overview E.13.2.1 above.

[6] This refers to any interaction between Project development/construction/land alteration activities and the site. None means the site is outside of the Project footprint as it is currently defined and therefore the site will not be impacted. Direct means that the site lays wholly or partially inside the Project footprint. Indirect means that the site may be impacted by indirect effects related to construction such as vibration from construction or similar.

E.13.3.2 Palaeontological Locales

Palaeontological resources, primarily Mesozoic Era fossils of plants, vertebrates, and invertebrates, are comparatively widespread in mountainous areas of southwestern Alberta and they often occur in bedrock that contains exploitable coal resources. The Mist Mountain formation, which contains the targeted metallurgical coal resources, as well as the Morrissey Formations, have provided macro plant fossils and have the potential for other terrestrial fossils. Jurassic strata on the south slope of Grassy Mountain comprise a separate important, internationally known reference section with stratotypes for subdivisions within the Middle to late Bathonian age Fernie Formation as well as the

type localities for several invertebrate fossil taxa (bivalves and ammonites). Strata of the Blairmore Group, which have yielded plant fossils also lie within portions of the Project area

There are four important palaeontological locales within the LSA (Table E.13.3-2, Figure E.13.3-1), with all four known to contain Mesozoic Era fossil remains. Portions of the Project footprint, in particular areas of pit extension and the South Rock Disposal Area, are located within the boundaries of two of the palaeontological locales. The potential to encounter significant fossil resources in these areas during mining operations is quite high. The majority of the designated palaeontological locales fall outside the mine footprint area; however, there is potential for additional fossils and locales to occur within the Project footprint.

Table E.13.3-2 Palaeontological Sites Within the Current Mine Permit Boundary (LSA)

Site Name[1]	Formation/Group	Inside or Outside Project Footprint[3]	Legal Land Location[4]	Historical Resource Value[5]	Interaction[6]
Wheatcroft	Likely Kootenay Group	Partially inside	1-16-3-8-4W5M	3p	direct, see discussion below
Greenhill/Bluff Mountain	Likely Kootenay Group	Partially Inside	1-16-11-8-4W5M	3p	direct, see discussion below
Bluff Mountain	Likely Kootenay Group	Partially inside	1-16-13-8-4W5M	3p	direct, see discussion below
Grassy Mountain	Kootenay Group and Fernie Formation	Completely inside	1-16-25-8-4W5M	3p	direct, see discussion below

[1] Site name as recorded by the Royal Tyrrell Museum of Palaeontology.

[2] As determined by the International Geologic Time Scale.

[3] The location of the site relative to the Project footprint as it is currently promulgated.[4] Legal land Description: Site location

[5]The HRV of the site as assigned by the regulator, Alberta Culture and Tourism. HRVs attempt to assign a significance value based on the scientific, cultural, historic, educational, and interpretative importance or potential of a site. HRVs are discussed in detail in the Overview E.15.2.1 above.

[6] This refers to any interaction between Project development/construction/land alteration activities and the site. None means the site is outside of the Project footprint as it is currently defined and therefore the site will not be impacted. Direct means that the site lays wholly or partially inside the Project footprint. Indirect means that the site may be impacted by indirect effects related to construction such as vibration from construction or similar.

E.13.3.3 Impact Assessment and Mitigations

E.13.3.3.1 Potential Archaeological Impacts

Historic resources are generally static elements in that they are the remains of natural and/or cultural actions that have occurred in the past. These types of resources however are impacted by ongoing natural forces such as erosion and deposition, other geomorphological, geological, and biological processes, as well as other cultural factors such as land development. Natural processes acting slowly

over time can bury sites, so that they are rendered unrecoverable, and can destroy sites. Cultural processes that impact sites tend to occur over short time scales and many historical resources can be disturbed or destroyed by human activity not only in Alberta, but in Canada and the rest of North America.

As it relates to the Project, many of the historical resources within the LSA will not be impacted and may remain undisturbed by cultural processes. For those historical resources that lie partially or wholly within the Project footprint, there is the potential that they will or may be impacted. Figure E.13.3-1 indicated that there are two levels of impact to historical resources: direct or indirect. Direct impacts will occur to those sites within the Project footprint that cannot be avoided by the development. Indirect impacts may occur through indirect factors such as vibration from Project activities such as blasting and rail traffic. Indirect impacts may accumulate through time (as discussed further in the Cumulative Effects Assessment below) but are generally less onerous than direct impacts.

The following is a summary of the sites that are recorded to be wholly or partially inside the Project footprint. The nature of actual impacts to each site will vary depending upon the nature of the coal project element that will occur in the area. This section contains basic data on the site and is derived from pre-field work research and site survey, assessment, and testing.

As it relates to historical resource mitigations, these will consist of a suite of actions that are designed to reduce or eliminate the potential impact from the proposed Project's construction and operation activities. Typically, the most effective mitigations are those that are designed to be site-specific; subsequently, the following contains a description of inferred impacts and mitigation actions for the sites identified to occur within the Project footprint.

E.13.3.3.2 DjPo-38, Greenhill Mine Historic Structures and Remains

The Greenhill Mine site is located at the southern end of the LSA (Figure E.13.3-1). This site contains historic structures of a former coal mine that operated from approximately 1913 to the late 1950's and the remaining structures date to that period. The site is considered to be a provincially significant historical resource due to its uniqueness in that it represents one of the most complete groupings of early 20th century coal mining structures and remains in Alberta. It is also considered a historic resource that is important to the Euro-Canadian history of the Crowsnest Pass.

The current mine footprint includes a rail load out that will cross through the identified site. The eastern rail line loop passes through the site area but has been designed to avoid all remaining structures that are part of the mine site. The rail line loop will directly impact some of the existing non-structural remains on the site (*e.g.*, scrap metal), but these remains are not in their original context

and can be relocated outside of the project footprint. These specific remains, however, are considered non-unique and disturbance from rail construction and operation is not considered significant.

Mitigation Measures:

To mitigate potential rail yard impacts pertinent best management practices, as outlined in the *Guidelines for the New Development in Proximity to Railway Operations* (Railway Association of Canada and the Federation of Canadian Municipalities, May 2013) will be adhered to. For public access, structures on the inside of the rail loop will be fenced off and will be accessible to the public *via* request; however, for structures outside of the rail loop, a roadside interpretive pull off will be developed. Remaining structures will be fully documented and recorded in accordance with regulations of the *Alberta Historical Resources Act.*

E.13.3.3.3 DjPo-63, Unnamed Precontact Period Site

This is a multicomponent site (*i.e.*, a site containing evidence of more than one occupation) that is located within the area of the Crowsnest Golf Course (Figure E.13.3-1). The site was discovered and excavated by archaeologists in the 1980's in advance of the realignment of Highway 3 through the Crowsnest Pass. Most of the site area has been impacted by highway construction and archaeological excavation; however, a remnant of the original site area may exist between a golf course fairway and Highway 3. The site is classed as a campsite and was used multiple times over several centuries.

Mitigation Measures:

Assuming that if there are any further remains located within the proposed rail load out footprint, controlled excavations will occur at the site to remove those remains to assess and study them. It should be noted that this site has already been partly excavated during mitigative measures associated with Highway 3 through the site area in the 1980's.

E.13.3.3.4 DjPo-98, Unnamed Precontact Period Site

This is a multicomponent site located within the proposed CHPP area (Figure E.13.3-1). Testing and evaluation within the site area in 2014 and 2015 indicate that the site is ca. 120 metres (m) from east to west by 150 m north to south. The site may contain material that is up to 9,000 years old. The site is classed as a campsite and current data suggest it was used multiple times over several thousand years. Material(s) currently recovered from the site include stone tools, debitage from the production of tools, and butchered animal bones. It is anticipated that the CHPP will impact all or the majority of the surface on which the site is located. The site has been evaluated and mapped under the 2015 HRIA.

Mitigation Measure(s):

As avoidance of this site is not considered possible given the location, size, and complexity of the CHPP, a mitigation excavation will be conducted in advance of Project development. Excavation done in advance of site disturbance to remove all remaining elements of a historical resource or a representative sample is considered a standard mitigation in these situations. The excavation obtains or may obtain important scientific, cultural, and historical materials that can be assessed and preserved and which by removal and curation become part of the permanent record of the archaeology of Alberta and the people that left those remains. This site was partly evaluated and excavated when it was first recorded; however, 2015 testing and assessment indicated the presence of additional deeply buried materials; consequently, an excavation of approximately 80 m^2 is planned for this site.

E.13.3.3.5 DjPo-101 Boisjoli Mine Historic Remains

This site is made up of standing structures and debris related to the former Boisjoli Mine and the remains are located within the proposed CHPP footprint (Figure E.13.3-1). While the structures, classed as fanhouses, are located in an area to be impacted by construction, some structures may be avoidable. The Boisjoli Mine operated for less than two decades between about 1930 and 1950.

Mitigation Measure(s):

If it is not possible to avoid any structures, mitigation will include complete documentation and recording of the remaining structures and remains in compliance with Alberta Culture and Tourism's requirement for the documentation of historic structures and remains.

E.13.3.3.6 DjPo-116 Grassy Mountain Camp Historic Site

This site consists of four foundations of former buildings related to former coal mining at Grassy Mountain (Figure 14.3-1). The exact date of the foundations is unknown; however, it is likely they date to the first half of the 20th century (approximately 1940). This site has been partially disturbed by an existing road through the area in the SW of 24-8-4 W5M. This site is partly within the proposed south disposal area.

Mitigation Measure(s):

If it is not possible to avoid any structures, mitigation will include a 20 m^2 excavation plot with full documentation of the remaining building structures including mapping and related detailed recordings.

E.13.3.3.7 DjPo-124 Frank and Grassy Mountain Railroad Historic Site

This rail line ran between the town of Frank and the original Grassy Mountain mine, passing through the now abandoned coal mining town of Lille (see discussion below regarding Lille). The original rail ran for approximately 11 kilometres. Only sections of the original rail grade remain as well as some abutments at creek crossings. Most of the rail grade that remains is located east of the LSA, but the rail grade enters the mine area in Section 18-8-3 W5 and it runs due north through portions of Sections 19 and 30-8-3 W5 before entering Section 24-8-4 W5, where it terminates (Figure E.13.3-1). Most of the grade that remains intact in the mine area will not be impacted by the mine footprint; however, some of the remaining grade is located within the eastern half of Section 24-8-4 W5. This land is currently privately owned and was not accessible during the 2015 field survey, so the site has not been revisited in this area.

As stated, most of the railway grade that remains intact in the LSA will not be impacted by the mine footprint; however, some of the remaining grade in Section 24 is located within the east half of Section 24-8-4 W5.

Mitigation Measure:

Prior to any construction activities, remaining portion of the rail grade that may be impacted will be fully documented and mapped.

E.13.3.3.8 DjPo-130 Unnamed Precontact Site

This site is reported to occur within Section 2-23-8-4, which is the area of the proposed CHPP (Figure E.13.3-1). The site was originally recorded in 1974; however, it was poorly documented and no details of its contents were provided. Through Project-specific, extensive field surveying and testing, this specific site was not observed. It is likely that the site has been completely removed or was originally recorded in the wrong location.

Mitigation Measure:

As the site could not be located and as there were no historical resources that could be inferred to be related to this site, no further investigative work or mitigation is recommended. A recommendation to AC will be made to delete this site from known sites and classify it as an HRV 0 site.

E.13.3.3.9 DjPo-184 Unnamed Precontact Site

This site was recorded in 1992 during logging operations in Section 24-8-4 W5 (Figure E.13.3-1). Logging and access road construction, in addition to previous archaeological investigations, have removed approximately half of the site. Based on current data, an area of approximately 50 m x 35 m

may contain undisturbed remains. The site consists of stone tools and debitage from the production of those tools and is classed as a Precontact campsite. DjPo-184 is located on privately owned land and was not accessible during the 2015 field survey and has not yet been revisited and reassessed. The site is located partly within the planned south disposal area; consequently, it will likely be impacted.

Mitigation Measure:

Once access is obtained for the legally described lands in which this site is located a field survey will be conducted to determine if there are remaining undisturbed remains. As part of the survey, subsurface testing will be completed to develop a mitigation plan for mitigation excavation of any intact portion of the site that may or will be impacted by the south disposal area land alteration activities.

E.13.3.3.10 DkPo 7 Unnamed Precontact Site

This site was recorded in 1973 as consisting of two small rock cairns built on a rocky ridge in 14-24-8-4 W3 (Figure E.13.3-1). It was considered to be a surface site and had been partly disturbed by natural processes or human interference when recorded in 1973. During Project-specific field studies, a search of the area in which this site was recorded failed to be located and it has deemed either completely removed or it is recorded in an incorrect location and is possibly east of its originally recorded location on private lands that have not yet been accessed.

Mitigation Measure:

Once access is obtained for the legally described lands in which this site is located, field survey will be conducted to determine if there are remaining undisturbed remains. As part of the survey, subsurface testing will be completed to develop a mitigation plan for mitigation excavation of any intact portion of the site that may or will be impacted by the south disposal area land alteration activities.

E.13.3.3.11 DkPo 41 Unnamed Historic Site, structural remains related to former mining activity

This site consists of remains from two former buildings and related historic period (*i.e.*, early 20th century) debris such as glass, miscellaneous building materials, and trash (Figure E.13.3-1). This material is spread over an area of approximately 100 m x 100 m. It is likely the buildings are the remains of a small residential building and an outbuilding that were used during mining in the area. This site is located on privately owned land and was not accessible during the 2015 field survey, so the site has not yet been revisited and reassessed. The site is located within the planned south disposal area and will likely be impacted.

Mitigation Measure:

Once access is obtained for the legally described lands in which this site is located, field survey will be conducted to determine if there are remaining undisturbed remains. As part of the survey, subsurface testing will be completed to develop a mitigation plan for mitigation excavation of any intact portion of the site that may or will be impacted by the south disposal area land alteration activities.

E.13.3.3.12 DjPo-112 Lille Townsite Historic Site

The Lille Townsite is considered one of the most historically significant site areas in the Crowsnest Pass and has a HRV of 1 (Figure E.13.3-1). HRV 1 sites must be avoided by development. The northwest quarter of Section 18-8-3 W5 is located within the LSA and overlaps roughly the western half of the Lille Townsite. This quarter section has no planned development related to the mine and will not be impacted.

Mitigation Measure:

The Project footprint will not impact this site; subsequently there are no pertinent mitigation recommendations with the exception of avoidance for any future mine development activities.

E.13.3.4 Potential Palaeontological Impacts

E.13.3.4.1 Wheatcroft Palaeontological Locale

This fossil locale is located primarily to the west of the LSA; however, it extends into the LSA in Section 3-8-4 W5, which is currently a golf course location (Figure E.13.3-1). This area will be impacted by the proposed rail load out. At present, there is little potentially fossiliferous bedrock exposed in the area.

Mitigation Measure:

Construction monitoring during any excavation activities during the construction of the proposed rail line.

E.13.3.4.2 Greenhill Mountain/Bluff Mountain Palaeontological Locale

This fossil locale is located in Section 11-8-4 W5M (Figure E.13.3-1), which contains a section of the proposed access road. Little is known about the locale's contents but they may have been associated with previous mining activity. No significant fossil material was noted during site assessment although a thin layer of fossil wood was observed along the proposed access road in Section 14 to the north.

Mitigation Measure:

No significant fossil material was observed within Section 11-8-4 W5M or adjoining sections along the proposed access road or overland conveyor. Therefore, HRA clearance is recommended for the access road portion and overland conveyor of the proposed Project.

E.13.3.4.3 Bluff Mountain Palaeontological Locale

This fossil locale extends north of the Greenhill/Bluff Mountain Locale into Section 13-8-4 W5 (Figure E.13.3-1). The northern end of this locale will be impacted by the development of the south disposal area and temporarily by the location of a topsoil stock pile. Little is known of the locale's fossil content but it may have been associated with prior mining activity. No fossiliferous bedrock or fossil material was observed during limited field assessment within Section 13.

Mitigation Measure:

A limited construction monitoring program is recommended if significant fossil material is recovered from adjacent South Rock Disposal bordering on the north.

E.13.3.4.4 Grassy Mountain Palaeontological Locale

This fossil locale is located in Section 25-8-4 W5M (Figure E.13.3-1). It is recommended that Section 24 to the south be included in the Grassy Mountain locale due to the presence of pervasive fossiliferous Fernie Formation bedrock. The Grassy Mountain locale contains key Fernie Formation fossil sites located primarily along abandoned railroad and trail cuts and existing road cuts. Nearly all these sites are located within the proposed South Rock Disposal Area. In addition, a dinosaur footprint exists within an existing pit in Section 25, as does a fossil tree stump located along a footwall in another abandoned pit. Additional tree sites are located along a footwall in Section 36 in an abandoned pit to the north.

Mitigation Measure:

South Rock Disposal Area construction in Sections 24, 25, and 13 will involve an extensive soil stripping operation prior to the actual dumping of waste material within the site. The soil stripping process will likely expose several important fossil bearing intervals from the Fernie Formation. A monitoring program has been recommended that will document and salvage significant fossil material within the South Rock Disposal Area where the Fernie Formation will be exposed. This documentation and salvage procedure should be completed before dumping of waste commences as the dumping operation will render the South Rock Disposal site useless in terms of access to any

significant fossil material that exists in this part of the Project footprint. This documentation and salvage procedure can be implemented under the existing monitoring requirement.

E.13.3.4.5 HRA Recommendations by Project Component

As no, or only not significant, fossil resources were observed associated with the proposed Rail Loop or Load Out Area, Access Road, Construction Camp, Overland Conveyor, Coal Handling Processing Plant, and Infrastructure, HRA Section 31 Clearance is recommended for those components. As all other Project Components have the potential to contain significant palaeontological resources that are at risk of destruction during Project operations, especially the South Rock Disposal and Ultimate Pit Areas, the existing monitoring requirement should be utilized to document and salvage those resources.

E.13.4 Cumulative Effects Assessment

Based on the assumptions that there will be no further spatial expansion of the current mine plan, and that no other proponent will be able to access and develop undisturbed land within the LSA (excluding the Project footprint), there should be no negative cumulative effects associated with the Project on historical resources. In fact, where a project has delineated a large spatial area with a focused project footprint, it generally ensures protection of historical resources in undisturbed areas by preventing future developments from other sources or proponents.

After considering proximal direct and indirect impacts from the proposed Project developments, cumulative effects to historical resources are considered low.

E.13.5 Monitoring

Monitoring during Project development may be required at a limited number of sites in the footprint, depending upon the results of mitigative excavations. The intent of the monitoring is to search for, record, and collect historic resources materials that may be exposed by construction/land development that were not discovered during the mitigative excavations. There is a specific requirement for palaeontological monitoring and a regular monitoring program will be established after mining operations are started. A permitted palaeontologist will visit the mine area, particularly the pit area, during operations to search for any fossils that may be exposed by pit operations. If any are located, excavations and/or collection of those fossils may occur if they are deemed significant. It is anticipated that regular monitoring visits will be made annually during the first 3 years of mining. In addition, mine-operating personnel familiar with fossil identification will be asked to look for fossils during day-to-day operations.

E.13.6 Summary

Historical assessment field work including deep testing in specific locations has concluded for all those areas of high historical resource potential that could be accessed in the 2014 and 2015 field seasons. Fieldwork remains to be done in some privately owned lands, specifically the eastern half of Section 24-8-4 W5M. This fieldwork, while important, is not considered critical to the overall assessment and will be completed when access is acquired.

Palaeontological field assessment, completed in May, 2016 identified areas containing fossil resources, which may be disturbed by Project operations. The existing monitoring requirement, established by Alberta Culture and Tourism, will be utilized in these to document and salvage those fossil resources before Project operations occur.

Table E.13.6-1 Summary of Impacts on Historical Resources

VC Potential Impact or Effect	Mitigation / Protection Plan	Type of Impact	Geographical Extent of Impact[1]	Duration of Impact[2]	Frequency of Impact[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability Occurrence – Ecological Context[8]	Significance
Historical Resources											
Removal of Historical Resources	Monitoring and extraction for preservation	acute	local	long	Occasional	Irreversible	Low	Neutral	Moderate	Certain	Not Significant

[1] Local, Regional, Provincial, National, Global

[2] Short, Long, Extended, Residual

[3] Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal

[4] Reversible in short term, Reversible in long term, Irreversible – rare

[5] No Impact, Low Impact, Moderate Impact, High Impact

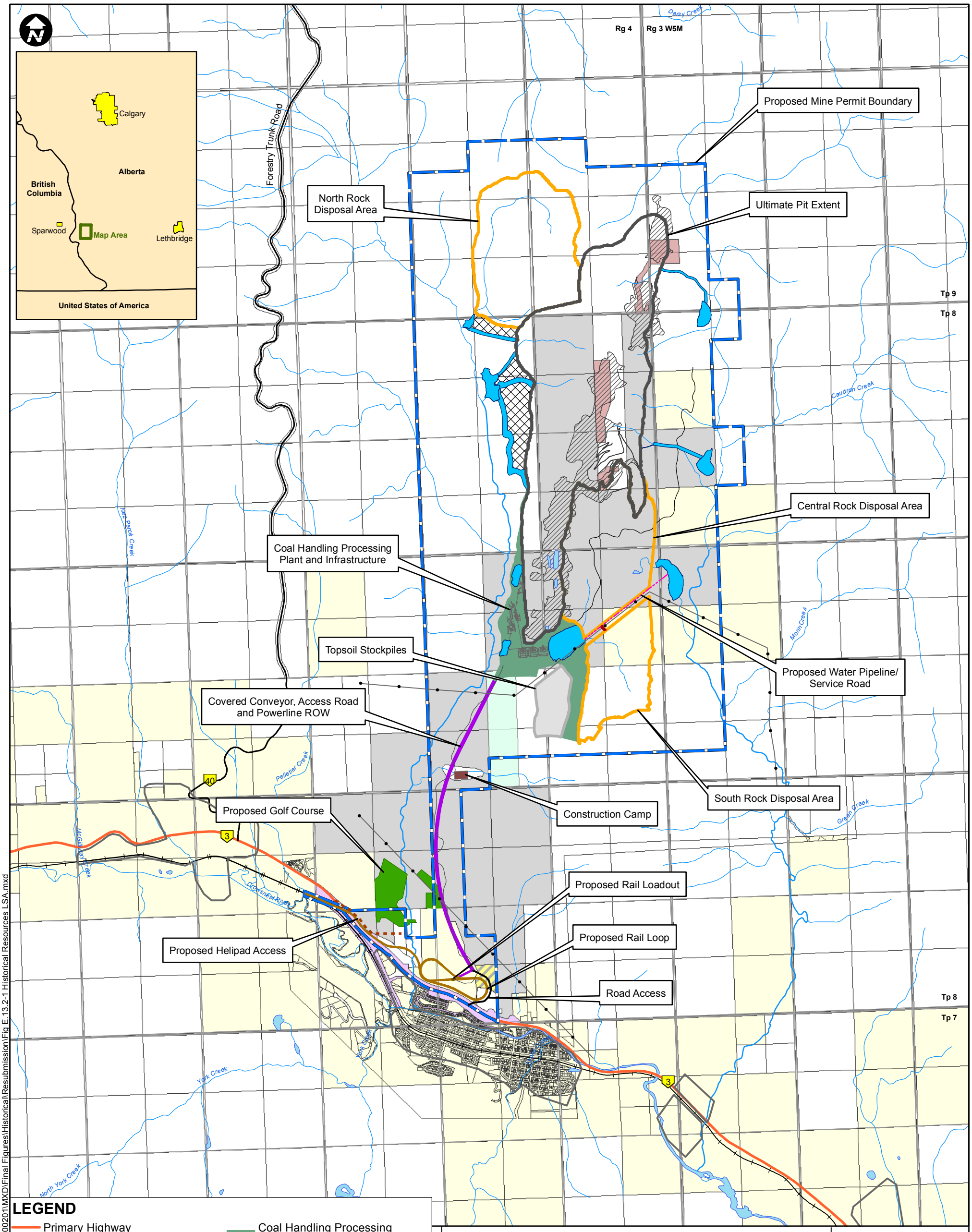
[6] Neutral, Positive, Negative

[7] Low, Moderate, High

[8] Low, Medium, High

[9] Significant, Not Significant

FIGURES


Rg 4
Rg 3 W5M
Daisy Creek
Forestry Trunk Road
Proposed Mine Permit Boundary
North Rock Disposal Area
Ultimate Pit Extent
Tp 9
Tp 8
Caudron Creek
Central Rock Disposal Area
Coal Handling Processing Plant and Infrastructure
Topsoil Stockpiles
Proposed Water Pipeline/ Service Road
Covered Conveyor, Access Road and Powerline ROW
Pelletier Creek
South Rock Disposal Area
Construction Camp
Proposed Golf Course
Green Creek
Proposed Rail Loadout
Proposed Helipad Access
Proposed Rail Loop
Road Access
Tp 8
Tp 7
York Creek
North York Creek
Calgary
Alberta
British Columbia
Sparwood
Map Area
Lethbridge
United States of America
40
3
LEGEND
Primary Highway
Secondary Highway
Existing Railway
Existing Access Road
Existing Powerline
CHPP Facilities
Proposed Water Pipeline/ Service Road
Railway Loop
Proposed Helipad Access
Proposed Mine Permit Boundary
Ultimate Pit Extent
Ultimate Rock Disposal Area Extent
Topsoil Storage
Construction Camp
Ponds and Ditches
Coal Handling Processing Plant and Infrastructure
Covered Conveyor, Access Road and Powerline ROW
Proposed Golf Course Area
Undisturbed Area
Legacy Mine Disturbance
Land Ownership
Crown (MLL Held By Benga)
Crown (ROE Held By Devon)
Crown
Freehold - Benga
Freehold - Benga 50%, CNP Golf & Country Club 50%
Freehold - Other
Registered Roadway
PROJECT
RIVERSDALE RESOURCES
GRASSY MOUNTAIN COAL PROJECT
MILLENNIUM EMS Solutions Ltd.
TITLE
HISTORICAL RESOURCES LOCAL STUDY AREA
NOTES
AltaLIS, 2016; NRCAN, 2015; Rapideye 2015 (Image Date: July 26, 2013); Riversdale, 2016
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PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: RM
DATE: JULY 13, 2016
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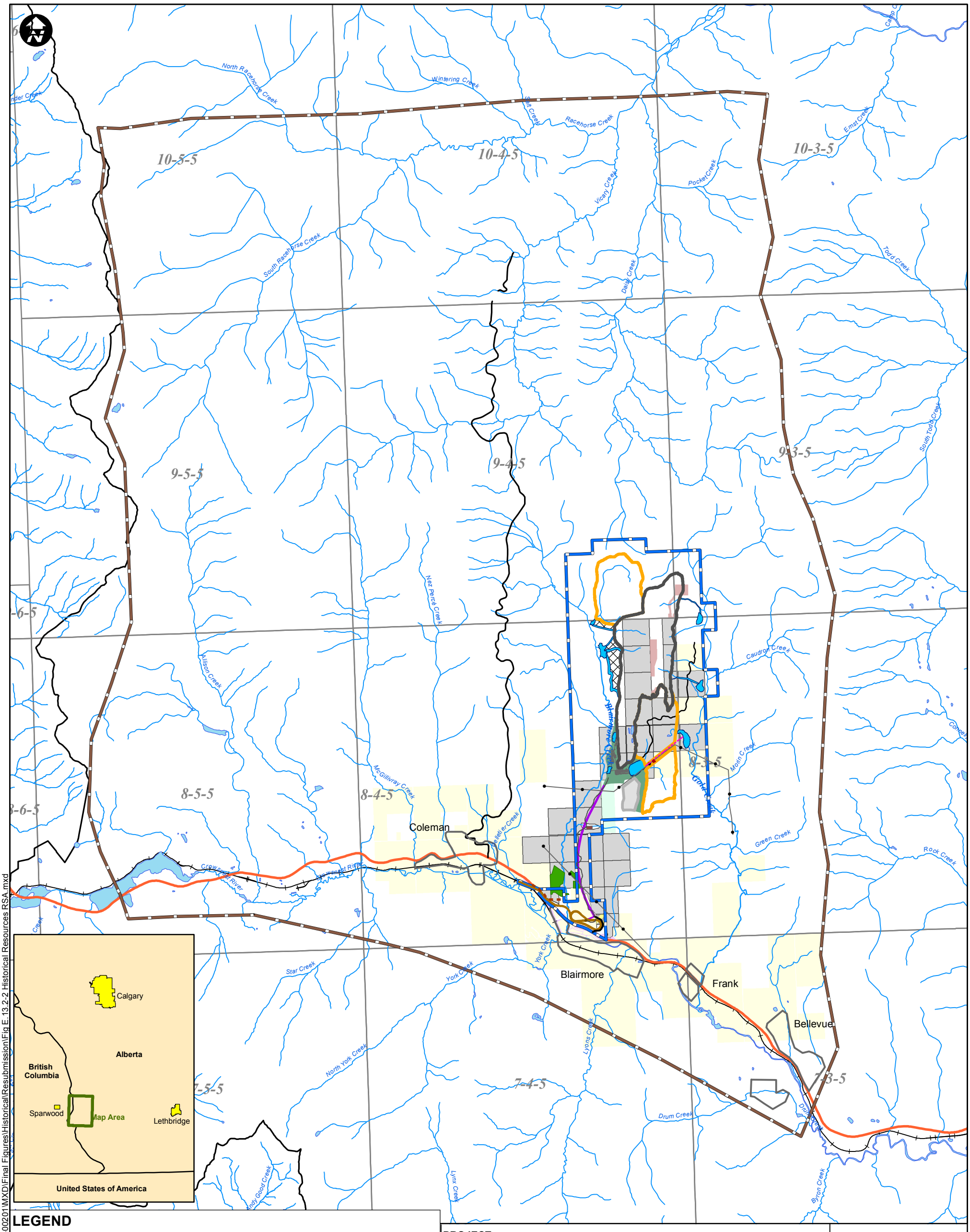

LEGEND

- Primary Highway
- Secondary Highway
- Existing Trails
- Existing Railway
- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Railway Loop
- Proposed Helipad Access
- Historical Resources Regional Study Area
- Proposed Mine Permit Boundary
- Ultimate Pit Extent
- Ultimate Rock Disposal Area Extent
- Topsoil Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Golf Course Area
- Undisturbed Area

Land Ownership

- Crown (MLL Held By Benga)
- Crown (ROE Held By Devon)
- Freehold - Benga
- Freehold - Benga 50%, CNP Golf & Country Club 50%
- Freehold - Other
- Registered Roadway

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

HISTORICAL RESOURCES REGIONAL STUDY AREA

NOTES

AltaLIS, 2016; NRCAN, 2016; Riversdale, 2016
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FIGURE

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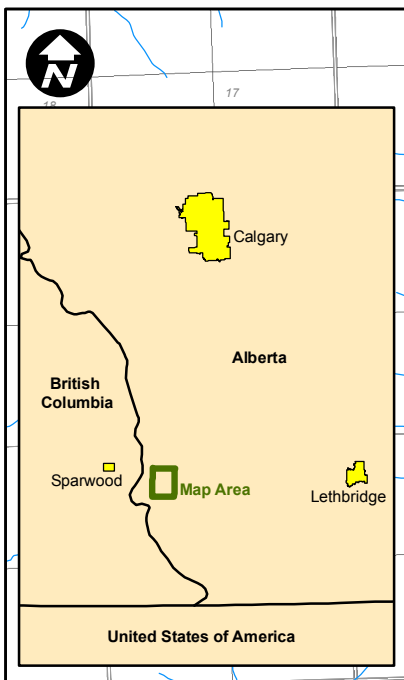

Rg 4
Rg 3 W5M
Daisy Creek
Forestry Trunk Road
Nez Perce Creek
Bluemore Creek
Caudron Creek
Morin Creek
Gold Creek
Green Creek
York Creek
North York Creek
Tp 9
Tp 8
Tp 7
ND 1
DkPo-14
Pit Tree 3
Pit Tree 2
Pit Tree 1
DkPo-30
DkPo-31
Track Site
SD A
SD B
SD C
SD D
SD S 1
SD RR
LT 1
SD E
SD LT 2
SD LT 3
SD LT 5
SD GC 6
DkPo-38
DkPo-8
DjPo-100
DkPo-37
DkPo-39
DkPo-42
DkPo-43
DjPo-181
DjPo-179
DjPo-180
DjPo-124
DkPo-41
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DkPo-7
DjPo-184
DjPo-99
SD LT 4
DjPo-116
SD LT 5
SD LT 6
SD LT 7
DjPo-98
DjPo-101
DjPo-146
DjPo-130
DjPo-176
DjPo-112
DjPo-124
GM 1
DjPo-133
4p
3p
40
3
Coleman
DjPo-10
DjPo-37
DjPo-63
DjPo-38
DjPo-124
DjPo-136
Blairmore
Frank
Bellevue

LEGEND

- Archaeological / Historic Site Not Impacted
- Archaeological / Historic Site Potentially Impacted
- Palaeontological Locale Potentially Impacted
- Archaeological / Historic Site Not Impacted
- Archaeological / Historic Site Potentially Impacted
- Primary Highway
- Secondary Highway
- Existing Trails
- Existing Railway
- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/Service Road
- Railway Loop
- Proposed Helipad Access
- Proposed Mine Permit Boundary
- Ultimate Pit Extent
- Ultimate Rock Disposal Area Extent
- Topsoil Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Golf Course Area
- Undisturbed Area
- Paleontological Resource (HRVp)

Land Ownership

- Crown (MLL Held By Benga)
- Crown (ROE Held By Devon)
- Crown
- Freehold - Benga
- Freehold - Benga 50%, CNP Golf & Country Club 50%
- Freehold - Other
- Registered Roadway

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

HISTORICAL RESOURCES STUDY SITES

NOTES

AltaLIS, 2016; Golder, 2016; NRCAN, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

Historical site symbols indicate general locations only. Not site size or other detail

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PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: RM
DATE: JULY 19, 2016

FIGURE

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