Attachment 2

Response to CEAA's Request for Additional Information issued December 05, 2016

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FISH AND HABITAT

1. OUTSTANDING INFORMATION REQUIREMENTS

Reference: Update EIA Consultation Report #6, Section 1.1

Preamble:

On January 13 and March 21, 2016[1][2], the Canadian Environmental Assessment Agency, in consultation with federal departments, requested that Benga Mining Limited (Benga Mining) provide additional information on aquatic resources for the Environmental Impact Application (EIA) for the Grassy Mountain Coal Project (the Project).

In response to the Agency's information requests, Benga Mining indicated that at the time of the submission of the EIA in August 2016, fish and aquatics field work was still being completed. Based on discussions between Benga Mining, the Alberta Energy Regulator (AER), the Agency, and the Department of Fisheries and Oceans, it was agreed that once the entire 2016 baseline field program was completed, a more comprehensive and complete aquatic resource assessment would be provided to the AER and the Agency as an addendum to the EIA. Benga Mining indicated the addendum would be completed for Q1 2017.

Information Required: In Benga Mining's addendum, the Agency is expecting responses to the following information requests of January 13, 2016:

- AIR #8 - Fish and Fish Habitat
- AIR #9 - Fish and Fish Habitat – Mitigation Measures
- AIR #11 - Species at Risk – Westslope Cutthroat Trout

And information requests of March 21, 2016:

- AIR #1 – Baseline Information
- AIR #2 – Regional Study Area
- AIR #3 – Mapping Fish Habitat
- AIR #4 – Geomorphological Changes
- AIR #5 – Gold Creek and Blairmore Creek Tributaries
- AIR #6 – In-Stream Flow Needs Model
- AIR #7 – Westslope Cutthroat Trout
- AIR #8 – Conceptual Offsetting Plan
- AIR #9 – Mitigating Contaminants of Concern

[1] CEAR #33 – Canadian Environmental Assessment Agency Comments on the conformity of the Environmental Impact Statement submitted for the Proposed Grassy Mountain Coal Project.
[2] CEAR #34 – Canadian Environmental Assessment Agency's Request for Additional Information for the Environmental
Impact Statement for the Grassy Mountain Coal Project - Revised April 26, 2016.

Response:

The information required for this Additional Information Request (AIR) is provided in the Surface Water Quality Assessment Report (Consultant Report [CR] #5) issued as part of the Project's Updated Integrated Application (August 2016), and in the January 31, 2017 Addendum 1 (CR #6). The relevant information provided for each AIR is described in the following Fish and Fish Habitat Information Request concordance-style table (Table 1-1).

Table 1-1 Concordance-style table summarizing the location of relevant information addressing CEAA's information requests from January 13, 2016 and March 21, 2016.

Information Required from:	Information Provided
January 13, 2016	
AIR #8 – Fish and Fish Habitat Provide an assessment of the effects of changes to the aquatic environment and based on those predicted effects, discuss the impact to the fish resources identified by Benga Mining and its habitat in the Local Study Area (LSA) and Regional Study Area (RSA). In providing its analysis and conclusions Benga Mining will make it clear what project activity or project component is causing the effect.	CR #6, Section 3.0 Assessment Approach CR #6, Section 4.0 Effects Assessment CR #6, Section 5.0 Conclusions
AIR #9 – Fish and Fish Habitat – Mitigation Measures For all impacts to fish and fish habitat Benga Mining is required to: a. identify the technically and economically feasible mitigation measures that will be undertaken to mitigate the significant adverse effects predicted on the biological conditions of Blairmore Creek and Gold Creek and their tributaries in the LSA; b. explain how the mitigation measures are meant to reduce significance; and c. discuss the anticipated effectiveness of the mitigation measures; and if there is some question as to the effectiveness of the mitigation measure or if mitigation of the effect is not feasible, provide a rational and discuss the potential risks and effects to the environment including to the fish species identified as Valued Components (VCs) before and after contingency measures, such as offsetting and/or compensation, will be applied.	CR #6, Section 4.2 Pathways Analysis (mitigation is described in each pathway) CR #6, Section 4.2, Table 4.2 CR #6, Section 4.5 Residual Effects Classification and Determination of Significance CR #6, Section 4.6 Prediction Confidence and Uncertainty CR #6, Section 6.0 Proposed Monitoring and Follow-Up
AIR #11 – Species at Risk – Westslope Cutthroat Trout a. a detailed discussion on the potential for the Project to impact westslope cutthroat trout (WSCT) as a species at risk, cumulative impacts of the project in combination with threats to the species as identified in the recovery plan, as well as the potential recovery of the species, as required by the Guidelines.	CR #6, Section 3.0 Assessment Approach CR #6, Section 4.0 Effects Assessment CR #6, Appendix A4, Preliminary Habitat Offsetting Plan Attachment 3, AIR #4
March 21, 2016	
AIR #1 – Baseline Information Describe the current state of fish populations in the project area, including the distribution of pure strain WSCT.	CR #6, Section 4.1.1.1 Fisheries Aquatics Baseline CR #6, Appendix A1 Fisheries and Aquatics Technical Baseline Report, Sections 4.1.2 to 4.1.6

Table 1-1 Concordance-style table summarizing the location of relevant information addressing CEAA's information requests from January 13, 2016 and March 21, 2016.

Information Required from:	Information Provided
AIR #2 – Regional Study Area Include Daisy Creek in the aquatic assessment or provide a rationale explaining why Daisy Creek was not included in the assessment.	Attachment 3, AIR #1
AIR #3 – Mapping Fish Habitat a. Discuss how Benga Mining has arrived at an understanding of habitat potential for the entire watercourse of Blairmore Creek based on two survey points. b. Determine and map where spawning, nursery, rearing, food supply and migration habitats and over-wintering areas are in the local study area.	CR #6, Appendix A1 Fisheries and Aquatics Technical Baseline Report, Section 3.0 and 4.0 CR #6, Appendix A2 Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek CR #6, Appendix A3 Instream Flow Assessment Attachment 3, AIR #2
AIR #4 – Geomorphological Changes a. Provide an assessment of any potential physical impacts to aquatic environments and water quality as a result of increased discharges to Blairmore Creek and other surface waters. b. Describe how any potential impacts will be mitigated.	CR #6, Section 4.2.2 Secondary Effect Pathways CR #6, Section 4.2.4.1 Changes to Hydrology in Gold and Blairmore Creek Potentially Affecting Westslope Cutthroat Trout Habitat Attachment 3, AIR #3
AIR #5 – Gold Creek and Blairmore Creek Tributaries Identify the contribution that the tributaries have (*i.e.*, habitat, water quality and quantity) with respect to fish populations in Gold and Blairmore creeks.	CR #6, Section 4.1.1.1 Fisheries Aquatics Baseline CR #6, Appendix A1 Fisheries and Aquatics Technical Baseline Report, Section 3.0 and 4.0 CR #6, Appendix A3 Instream Flow Assessment CR #5 Surface Water Quality Assessment Report
AIR #6 – In-Stream Flow Needs Model Conduct field work, if necessary, to make the IFN model specific to the fish species in Gold and Blairmore creeks. Using these results, model how changes in water quantity in watercourses could impact the availability of fish habitat.	CR #6, Appendix A3 Instream Flow Assessment
AIR #7 – Westslope Cutthroat Trout Provide an analysis of the effects of the Project, describing mitigation including offsets, on the survival and recovery of WSCT, its residences and critical habitat. Include a discussion of how population and distribution objectives set out in Recovery Strategy and Action Plans would be affected.	CR #6, Section 3.0 Assessment Approach CR #6, Section 4.0 Effects Assessment CR #6, Appendix A4 Preliminary Habitat Offsetting Plan Attachment 3, AIR #4
AIR #8 – Conceptual Offsetting Plan Identify a conceptual offsetting plan that is economically and technically feasible that would mitigate predicted impacts to fish and fish habitat, including WSCT.	CR #6, Appendix A4 Preliminary Habitat Offsetting Plan
AIR #9 – Mitigating Contaminants of Concern a. For the variables that are modelled to exceed water quality guidelines in Gold Creek, Blairmore Creek, and Crowsnest River after proposed treatment in the saturated zones, provide other potential mitigation measures to prevent potential effects to fish and fish habitat. b. Provide information as to the sources of these parameters within the mine plan and how concentrations could be controlled at source.	CR #6, Section 4.2.2.4 Changes to Water Quality Affecting the Health of Westslope Cutthroat Trout CR #5 Surface Water Quality Assessment Report

In addition to the above Fish and Fish Habitat information requests, additional information requests pertaining to the Project's January 31, 2017 Addendum 1 were issued by the Agency on March 16, 2017. Those IRs included:

- AIR #1 – Regional Study Area – Daisy Creek
- AIR #2 – Mapping Fish Habitat
- AIR #3 – Geomorphological Changes
- AIR #4 – Westslope Cutthroat Trout

Responses to these March 16, 2017 IRs are provided in Attachment 3.

ATMOSPHERIC ENVIRONMENT

2. AIR QUALITY MODEL

Reference: EIS Guidelines, Section 6.2.1 & 4.2; Consultant Report #1a, Appendix B, Section 4.3; Agency's Request for Additional Information, March 21, 2016 - AIR #11.

Preamble:

The Environmental Impact Statement (EIS) Guidelines require that the assessment consider the predicted changes in air quality as a result of the Project. The Guidelines also specify that all data, models, and studies will be documented such that the analyses are transparent and reproducible.

The quality of model predictions is dependent on the quality of the input data used in the model. The selection of model options and the configuration of model domains and grids can also affect the quality of predictions. To provide confidence in the air quality model predictions presented in the EIS, all input data, including meteorological fields, and selected model options and configurations, may need to be reviewed.

Tabulated CALPUFF parameters were provided in Section 4.3, Appendix B. However, actual input files were not provided. Tabulated parameters are insufficient in allowing reviewers to evaluate the model predictions used in the EIS.

Information Required:

a. Provide input and control files in a format that can be directly used in the CALPUFF model.

Response:

All files are provided in a standalone 2 TB hard drive as requested. The provided hard drive requires 550 GB of space to incorporate 3,629 files in 39 folders/subfolders.

Files included fall under three main folders (CALMET, CALPUFF and CALPOST) and are explicitly listed in Table 2-1. Further details regarding all input/output files and processing flow

charts were listed in the spreadsheet named "GrassyEIA AQ modelling files 201701" in the main folder of the hard drive.

Table 2-1 Air Model Raw Data Formats

Main Folder Name	Files Included
CALMET	• input and control files in a format that can be directly used in the CALMET model for coarse grid (2 km) and fine grid (0.5 km); • CALMET output data for two grids setting;
CALPUFF	• input and control files in a format that can be directly used in the CALPUFF model for two emission scenarios (Project and Baseline); • Project maximum hourly and daily emissions were modelled separately under "hly" and "dly" subfolders; • all output data files in the raw CALPUFF format, including concentration outputs, wet and dry deposition outputs;
CALPOST	• input and control files in a format that can be directly used in the POSTUTIL process for three assessment scenarios (Project, Baseline and Application); • all concentration and deposition output data files from POSTUTIL process for PAI, VOCs and PAHs as well as metals; • input and control files in a format that can be directly used in the CALPOST model for three assessment scenarios (Project, Baseline and Application); • five-year (2002-2006) CALPOST output files for all three scenarios, all contaminants and all averaging periods.

b. Provide all output files in the raw CALPUFF format.

Response:

Please see response IR #2a.

3. ATMOSPHERIC ENVIRONMENT

Reference: EIS Guidelines, Section 6.2.1; Consultant Report #1, Appendix A, Section 4.7; Agency's Request for Additional Information, March 21, 2016- AIR #12.

Preamble:

The Guidelines state that the assessment should include a consideration of the predicted changes in air quality as a result of the Project. The Guidelines also specify that the EIS should provide a rationale for the information included or excluded in the assessment of Project effects on air quality.

In Appendix A, Section 4.7, it is assumed that a dust control efficiency of 80% can be achieved through frequent watering of the haul roads or application of CaCl2. The revised EIS still does not address how the assumed dust control efficiency will be achieved.

A control efficiency of 80% assumes that 80% of road dust is mitigated at a minimum and achieved continuously throughout the life of the mine.

Information Required:

a. Provide information to demonstrate that, at a minimum, 80% control efficiency is achievable at all times throughout the mine life.

Response:

Benga notes that the projected control efficiency of 80% used in the model is not a minimum value; rather it is the average value modelled for haul roads during a reasonably worst-case (from an emissions perspective) year of operations. Consultant Report (CR) #1, Appendix A, Section 4.7 presented a number of examples where the 80% efficiency value had been used in other Alberta foothills mines.

Table 3-1 has been expanded to include a larger selection of suppressants. The basis for the 80% reduction used in the assessment, as well as evidence for a consistent reduction by watering for $PM_{2.5}$, PM_{10} and Total Suspended Particulates (TSP) size ranges, is presented in the U.S. Environmental Protection Agency's (EPA) *Emission Factor Documentation for AP 42, Section 13.2.2 Unpaved Roads* (U.S. EPA 1998) as summarized in Table 3-1. In the studies on which the emission reductions are based, the median reduction for $PM_{2.5}$ was 79%, for PM_{10} 91% and for TSP 81%, comparable to the 80% used in the assessment.

In addition, while not a clear indication of the effects of road watering, Cowherd *et al*. (2006) indicates the effectiveness of vegetation on dust mitigation is similar in all three size ranges. Therefore, in the Project modelling, watering mitigated the fugitive component of all three size ranges equally and thus was an effective way of reducing $PM_{2.5}$, PM_{10} as well as TSP.

Table 3-1 Measured Emission Reduction on Haul Roads Based on U.S. EPA Tests

Place/Industry	Equipment/Control Method	Emission Reduction of $PM_{2.5}$ (%)	Emission Reduction of PM_{10} (%)	Emission Reduction of TSP (%)
California[(a)]/Road Construction	Scraper / Watering	-	79	-
Wyoming[(b)] / Coal Mines	Haul Trucks / Watering	-	54	41
North Caroline[(c)] / Stone Quarry	Haul Trucks / /Watering	-	94	-
Michigan[(d)] / Coal Yard at Power Plant	Scraper / Watering	79	80	80
Ohio[(e)] / Iron & Steel Plan	Haul Trucks / /Watering	87	-	78
Ohio[(e)] / Iron & Steel Plant	Haul Trucks / Coherex	91	-	95
Indianan[(f)] / Iron & Steel Plant	Haul Trucks / Petro-Tac	79	91	81
Missouri[(f)] / Iron & Steel Plant	Haul Trucks / /Watering	72	92	89
Missouri[(f)] / Iron & Steel Plant	Haul Trucks / Coherex	89	92	83
Wyoming, New Mexico, North Dakota[(g)] / Coal Mines	Haul Trucks / Watering	61	-	73
Wyoming, New Mexico, North Dakota[(g)] / Coal Mines	Haul Trucks / $CaCl_2$	24	-	88
Median		79	91	81

(a) South Coast Air Quality Municipal District (1996).

(b) U.S. EPA (1994).

(c) National Stone Association (1994).

(d) Midwest Research Institute (MRI) (1985).

(e) U.S. EPA (1983a), (f) U.S. EPA (1983b).

(f) U.S. EPA (1981) (poor quality data: average of controlled emissions measured at Wyoming and New Mexico over average of uncontrolled emissions measured at Wyoming, New Mexico, and North Dakota).

(g) U.S. EPA (1981) (poor quality data: average of controlled emissions measured at North Dakota over average of uncontrolled emissions measured at Wyoming, New Mexico and North Dakota.

The reduction was increased to 90% in winter due to the presence of frozen ground or snow on the ground. According to climatological data from Coleman, periods of snow cover extend from October to April. Higher (haul road) elevations would have snow on the ground longer.

Additional information in CR #1A, Appendix A, Section 4.7 from recommendations to the U.S. EPA, and in the pits and quarries guidance from Environment Canada (2012), shows that emissions would be negligible when daily rainfall exceeds 0.25 mm and when roads are covered by snow or ice. According to this approach, emissions would be negligible during winter

(roughly October to April) and in 36% (roughly 55 days) of the rest of the year. Precipitation and snow on the ground could therefore mitigate emissions on 73% of days of the year.

b. Provide details of the mitigation measures (*e.g.*, frequency of road watering or application of chemical dust suppressants) that would be necessary to achieve this control efficiency.

Response:

Apart from road watering or chemical application, other mitigation measures for reducing fugitive dust emissions include speed reduction under certain weather extremes, reduction in the number of haul vehicles, and gravelling or paving haul road surfaces where feasible to reduce the silt content of the surface material.

The following speed reduction mitigation option could be applied on very dry days, in conjunction with the aforementioned mitigations to further reduce emissions. Current vehicle speeds in the model are 25 km/h for haul trucks. Fugitive dust emissions are a linear function of vehicle speed in U.S. EPA equations (*e.g.*, Cowherd *et al*. 1988); therefore, reducing average speed on haul roads by 50% would result in a 50% reduction in particulate emissions.

Estimates of watering to achieve desired control efficiencies vary widely in the literature, depending on particle size, road material types, climate, *etc*. In many articles, the efficiencies are reported but not the metadata. Using the equation in Cowherd *et al.* (1988), control efficiency can be estimated (equation).

$$C = 100 - \frac{0.8\ P\ d\ t}{i} \qquad (3-2)$$

where: C = average control efficiency, percent

P = potential average hourly daytime evaporation rate, mm/h

d = average hourly daytime traffic rate, (h^{-1})

i = application intensity, L/m^2

t = time between applications, h

Estimates of the potential average hourly daytime evaporation rate may be obtained from

$$p = \frac{0.0049\ x\ (value\ in\ Figure\ 3-2) for\ annual\ conditions}{0.0065\ x\ (value\ in\ Figure\ (3-2) for\ summer\ conditions}$$

Table 3-2 shows the predicted efficiency using this equation for waste and haul roads, using the maximum expected number of trips per hour from the dispersion model (max d). The value of p was determined from Lethbridge annual evaporation estimates from 2004-2009 of 900 mm (825 mm is the most recent climate normal). Various water application rates (i) were determined to meet 80% efficiency for times between applications of 4 to 12 hours.

Table 3-2 Water Requirements for 80% Efficiency					
Haul Road	**C (%)**	**p**	**Max d**	**i**	**t**
Waste	80	0.173754	50	1.7	4
	79	0.173754	50	2.5	6
	79	0.173754	50	5	12
Coal	81	0.173754	4	0.15	4
	79	0.173754	4	0.2	6
	79	0.173754	4	0.4	12

To estimate the total average annual volume of water required to meet this efficiency, the following assumptions were made:

- watering only in the 5 months of summer, on days with no rain. This is a total of 95 days (about 30x5 - 55 days with trace rain);
- water only 20 m of haul road width;
- 17 km of haul roads watered, of which 8 km are waste haul and 9 km are coal haul; and
- max waste haul trucks trips per hour on any road is 25 two-way trips, according to model.

The calculated annual water volume is dependent on the efficiency and vehicle count, for fixed road length, and is estimated to be about 150,000 m^3 for the waste haul road and 13,000 m^3 for the coal haul road. Total available water is about 60,000 m^3; as a result, chemical dust suppressants are also being considered.

A wide range of chemical suppressants are available, including $CaCl_2$ / $MgCl_2$, polymer or petroleum based suppressants. Typically, suppression efficiencies are in the range of those in Table 3-1. A number of studies on chemical suppressants are referenced by Cowherd and Muleski (2008). One of these studies, RTI International and MRI (2006), prepared a test plan for a petroleum product for the U.S. EPA and found average control efficiencies of 80% over three trials. In the study, initial application rates ranged from 0.85 to 1.3 l/m^2, which are consistent with watering rates in Table 3-2. Measurements were made 70-120 days after application which span half or more of the summer season at the mine site.

Benga is aware that, due to environmental concerns about leaching of compounds to soil and surface water, dust suppressant products must be investigated and then applied with caution. As part of Project design, roads will have integrated catch drains and any runoff from excess watering or additives will be retained within a closed mine water system.

Based on its assessment of water volumes required, Benga is of the current opinion that both watering and chemical suppressants will be required to manage road dust. The appropriate mix of suppressants would be further reviewed during the development of an emission management plan prior to the start of mine operations.

4. GREENHOUSE GASES

Reference: Consultant Report #1, Section 4.3; Appendix A, Section A8.0; Agency's Request for Additional Information, March 21, 2016 - AIR #48.

Preamble:

In Section 4.3., the direct greenhouse gas (GHG) emissions considered are fugitive methane, diesel combustion, and electricity combustion. However, mitigation measures for these emissions were not evaluated. In addition, other sources of GHGs were not provided, including GHG emissions from i) stationary equipment, and ii) carbon sink losses.

Information Required:

a. Account for the following additional emissions sources in the GHG assessment:
   i. stationary equipment (*e.g.*, boilers, heaters); and

Response:

Propane will be used for building HVAC and process heating on the Project. Total estimated annual propane consumption and associated emissions assuming 60% efficiency are listed in Table 4-1. Emissions are approximately 1% of the 326 kt CO_2e/year estimate presented in Consultant Report (CR) #1, Section 4.3. There are no other stationary sources of greenhouse gas (GHG) planned for the Project.

Table 4-1 GHG emissions from stationary equipment

Annual propane consumption	55,944	MMbtu
Emission factor for propane	61.46	kg CO_2 per mmBtu
GHG emissions	3.4	kt CO_2e/year

   ii. the carbon sink loss following deforestation, marsh destruction and overburden stripping.

Response:

No permanent loss of forest carbon sink is expected. An increase in forest carbon sequestration is expected after reclamation. Forest source/sink status requires more than estimations of tree biomass as significant source/sinks exist in dead organic matter and forest soil. In addition, as a forest establishes and grows the rate of carbon accumulation changes over time as do the rates of turnover in the amount of dead organic matter and carbon stored in the soil. Fire also plays an important role, particularly where the fire interval is short. For example, looking at western Canadian boreal cordilleran pine forest in Alberta, Price *et al*. (1997) found that carbon sequestration (in above and below ground pools) could be increased with intensive management. However, in the absence of intensive management, maintaining the natural fire regime is recommended (Government of Alberta 2010) to increase carbon sequestration because fire renews old forests that may be carbon sources due to slower growth and increased decomposition.

In Canada, forest carbon is typically modeled using the CBM-CFS3 model (Kurz *et al*. 2009). This model uses forest inventory information (*e.g.*, species, density, age), growth yield curves specific to location and species, and other variables such as specific decomposition rates for modeled above ground and below ground carbon pools. Much of the forest that will removed during Project operation are on unproductive (based on timber harvest standards) areas or are inaccessible for harvest due to terrain and thus detailed forest information to calibrate a model such as CBM-CFS3 would need to be estimated or rely on generic assumptions. A rough estimate of above ground biomass can be found in available literature. Penner *et al*. (1997) estimated the aboveground biomass as 83 t/ha for productive cordilleran forests in Alberta and 3 t/ha for unproductive (carbon portion is assumed 50% of biomass).

The estimated fire return interval for the forest management unit (FMU) C5 containing the Project averages 78 years (196-49 years) and risk of deforestation from mountain pine beetle is high (Government of Alberta 2010). The project will result in the loss of less than 2000 ha of forest over its lifetime and this is well within the range of natural disturbance for fire and mountain pine beetle (Government of Alberta 2010) for the forest management unit. Both fire and mountain pine beetle (Kurz *et al*. 2008) result in release of carbon to the atmosphere and without reforestation result in conversion from a sink to a source due to increased organic matter decomposition, and reduced growth (sequestration). The Project includes timely reclamation and much of the reclaimed landscape will be more subdued and able to support increased forest volumes. In addition, the Project will result in the reclamation of approximately 185 ha of historical disturbance (most of which was pine forest) resulting in a net increase in forested area.

Removal of wetlands will result in the loss of carbon storage but this is likely more than offset by reductions in methane generation. Generally, marshes and other non-peat forming wetlands are small GHG sources and not sinks due to anaerobic conditions and production of methane (IPCC 2000). Wetlands can be important sinks under some conditions but this is largely determined by climate, organic matter type and productivity (Laanbroek 2009). Due to the variability and wide ranging values reported in the literature, nationally, Canada only reports emission for losses of peatland wetlands. Soils associated with marsh wetlands may contain high amounts of organic carbon that are subject to losses with increased decomposition rates as the soils are no longer saturated. Methane emission associated with marsh soils will cease under aerobic stockpile conditions. Organic matter associated with wetland removal will be salvaged and used during reclamation. Suitable overburden below the wetlands will also be salvaged. Carbon losses due to soil salvage will be similar to that for other soils.

Overburden stripping and stockpiling is not a significant source of carbon emissions. Removal of topsoil from a mining site and mixing it with underlying soil considerably reduces the relative proportion of organic carbon but has little impact on the total carbon. Stockpiling has been reported to reduce total nitrogen, available nitrogen and the organic carbon content. Loss of organic carbon levels is not consistently reported in the literature. Organic carbon levels, as noted by Visser *et al.* (1984), were reduced by as much as 30%. This reduction in carbon was an immediate rather than a slow loss over the duration of the stockpiling. MacKenzie (2011) found that stockpiling upland surface soil for 16 months did not substantially alter the total percent nitrogen or organic matter; however, there was a slight trend for percent organic matter to

decrease within smaller stockpiles. While stockpiled topsoil becomes stagnant from a biological perspective, specifically for aerobic microorganisms, seeds and roots, there is little evidence to suggest that soils stockpiled in cool climates are stagnant from a nutrient perspective (Alberta Environment and Water 2012).

Losses of soil carbon occur when the input of organic matter ceases. Amending soil with woody debris or fertilizing and revegetating stockpiled soil provides enough organic carbon to minimize carbon level reduction due to soil salvage and storage.

b. Provide an evaluation of the mitigation measures associated with the following:
   i. fugitive methane, diesel combustion, and electricity combustion; and

Response:

Fugitive methane

Methane is released when pressure within a coalbed is reduced as a result of natural erosion, faulting, or mining. Deep coal seams tend to have higher average methane content than shallow coal seams, because the capacity to store methane increases as pressure increases with depth. Accordingly, underground mines release substantially more methane than surface mines, per ton of coal extracted (U.S. Environmental Protection Agency [EPA] 2009).

Although the options for recovering and using methane are primarily available for underground mines, gas recovery at surface mines may also be feasible in some circumstances (U.S. EPA 2008). There are three potential sources of fugitive methane emissions associated with surface coal mining. These are:

- Methane emitted by the coal excavated and processed during mining activities;
- Methane emitted by the coal and other gas bearing strata in the overburden, interburden and underburden exposed by mining activities; and
- Methane emitted by the overburden coal excavated and stored on site in waste piles.

At Grassy Mountain, the third source is not relevant because the coal content in the overburden is negligible.

For methane emissions covered by the first bullet, the available methane emitted by the excavated and processed coal is the estimated total gas content of the material excavated. For the second bullet, the available methane is more uncertain as it depends on a variety of factors such as gas content and thickness of the adjacent coal seams, permeability of the coals and other strata found in the overburden and underburden, overburden thickness, and the amount of disturbance to the mine floor and highwall as a result of mining.

The gas in coal and associated strata may be released during different stages in mining. Excavated coal will release methane as it is broken and removed from the highwall face, transported on site, and crushed and sized for transportation off-site. Overburden, inter-burden and uneconomic coal is normally dumped together with non-coal material in waste piles. The

methane contained in these coals will be released as the material is excavated, broken, dumped, and later used as backfill.

In addition, methane emissions will also migrate out of the floor and highwall of the surface mine. The magnitude of the floor emissions will depend on several factors such as:

- gas content of the unmined coal beneath the mine floor;
- proximity of the coal seams to the mine floor;
- extent of disturbance of the coal and the effect this has on its permeability;
- amount of coal left in the floor; and
- presence of water.

The magnitude of emissions from the highwall will similarly depend on:

- gas content of the unmined coal remaining in the highwall;
- extent of disturbance of the coal near the highwall and the impact this has on the permeability; and
- presence of water.

Unlike underground mines, for which degasification and ventilation emissions data are readily available, emission measurements are generally not made for surface mines because none are required for safety reasons due to the low risk of accidents resulting from excessive methane concentrations.

Realistically, the only feasible type of methane recovery to be deployed at surface mines is pre-mine drainage (U.S. EPA 2008). In theory, some pre-mining degasification and recovery could occur at "gassy" surface mines; however, the low gas content of surface mines relative to that of underground mines makes it unlikely that significant recovery would be technically feasible, let alone cost-effective (Edison Electric Institute and the Electric Industry Climate Initiative 2009). Coal bed methane recovery is not ongoing or being considered on the Grassy Mountain site, as the coal is not considered gassy and therefore methane recovery is not practical.

Diesel combustion

During the life of a project, the mine fleet is regularly upgraded; subsequently, equipment will likely become newer and more efficient than assumed in emission estimation as the mine progresses. Exhaust emissions from the U.S. EPA Tier 4 (2015) standards were used in Project emission estimates and it is likely that off-road standards will become more stringent with time.

The mine will have an integrated dispatch system to provide overall control of individual trucks and allocating sequencing and routing to minimize delays and unnecessary idling and fuel wastage. The fleet will also be managed to minimize fuel consumption by minimizing haul road length and gradient. The fleet will be regularly maintained, with one of the goals being to minimize fuel consumption.

The proposed open pit mine is currently planned to be mined using diesel powered mine equipment. Cost/benefit studies are currently underway to investigate supplying power to the open pit and powering some of the equipment (stripping shovels, blasthole drills, dewatering pumps) electrically. The GHG reductions using electrical power rather than diesel are one factor in the studies.

Lower-carbon diesel fuel is planned for production at the Sturgeon Refinery near Edmonton, Alberta (North West Redwater Partnership 2017). According to the company website, fuel economy can be improved by up to 30% resulting in lower GHG emissions. Diesel combustion currently accounts for about 3 Mt of project lifetime emissions and therefore potential reductions are up to 900 kt with the use of Sturgeon Refinery diesel. Benga expects this fuel to become available in 2018 and will continue to monitor its cost and availability in southern Alberta.

Electricity consumption

Power demand on site is planned to be about 16 Megawatts (MW). GHG emissions due to power consumption were based on the current grid which is 51% coal-fired. A lower energy intensity for grid power is anticipated as current government policy is implemented. If all coal were replaced with natural gas (a conservative assumption in terms of GHG reduction because additional renewable generation is planned), and assuming the natural gas emission intensity of GHG is about 55% that of coal, the overall GHG intensity of the grid, and Benga's intensity, could be reduced by about 28%.

Current Benga projections are that electricity contributes about 36% of lifetime GHG emissions. Changes in the future power mix of the grid could reduce project lifetime GHG emissions by about 10% (36% of 28%).

Wind power is produced in southern Alberta and is an alternative to the use of grid power. At best, with Benga's current power requirements, GHG emissions could be reduced by 36% using wind power rather than current grid power. Benga is following potential local sources of wind, and solar, power. Although these are not currently cost effective, they may become so in the future under an emission trading/carbon levy environment.

ii. the GHG sources identified in (a.)

Response:

Stationary combustion sources of fossil fuels contribute about 1% to annual GHG emissions. As such, other than considering design efficiency in procurement, no additional mitigation is planned.

Regarding the potential loss of GHG sinks, prompt reclamation and reforestation of the project disturbance and the historical mine disturbance will result in a forested area larger than baseline conditions and, due to creation of more subdued terrain post reclamation, the total forest biomass potential will be increased.

All soil stripped during operations will be used during reclamation. Reclamation will be ongoing throughout the operational life of the Project thus the lifetime of soil stockpiles will be minimized. The soil handling and storage proposed for the Project will effectively mitigate for loss of soil carbon in stockpiles. No net loss of soil carbon pool is expected following reclamation and prompt revegetation.

GROUND WATER AND SURFACE WATER

5. USE OF EXISTING INFORMATION

Reference: EIS Guidelines, Section 4.3.3; Consultant Report #5, Section 3.2.1, Pg. 31-78; Agency's Request for Additional Information, March 21, 2016 - AIR #23.

Preamble:

The Guidelines encourage Benga Mining to make use of existing information relevant to the Project, comment on how the data was applied to the Project and state any limitations on the inferences or conclusions that can be drawn from existing information.

Historical data for the Local Study Area (LSA) and Regional Study Area (RSA) were included in the establishment of baseline conditions for water quality. This historical dataset includes water quality data collected between 1974 and 2008. For several parameters (*e.g.*, cadmium, mercury), the detection limits for the historical dataset are higher than existing water quality guidelines. There is no mention of how these historical water quality values were incorporated into the dataset given the detection limits are above existing guidelines.

Although quality assurance/quality control (QA/QC) measures were provided for the current baseline results, there is no mention of any QA/QC on the historical data to determine the applicability/accuracy to establishing the baseline conditions for the LSA and RSA.

Information Required:

a. Describe how historical water quality data with detection limits above existing guidelines were used within the dataset.

Response:

Historical water quality data for the LSA were not available and are not reported in the EIA. For the RSA, historical seasonal water quality data for the Crowsnest River collected between 1974 and 2008 were used and presented to supplement recent baseline data (2013 to 2016). Given the limited availability of historical data, water quality data with detection limits above existing guidelines were not excluded from the datasets. However, these data were identified by a flagged asterisk sign (*) in the summary table and in the footnotes in Consultant Report (CR) #5, Section 3.2.1, Table 7. Of these historical data, three variables—total cadmium, total mercury, and total zinc—used higher analytical detection limits than current Alberta Environment and Parks (AEP) water quality guidelines. For total cadmium and total mercury, the majority of historical observations were non-detectable (Table 5-1). In the initial baseline assessment, data with concentrations below the detection limit were adjusted to being equal to the detection limit value (1xDL) in the calculation of summary statistics. This conservative approach likely resulted

in higher-than-actual concentrations presented in the summary table. The effect of this adjustment on predictive modelling results is discussed further in IR #5b and IR #5c.

Table 5-1 Available historical data for selected water quality variables with high analytical detection limits relative to current water quality guidelines

Variables	Years of Collection	Total Measurements	Total <DL
Total cadmium	1974, 1975, 1991, 1992, 1993, 1993, 1994, 1998, 2005 = 10 years	27	24
Total mercury	1974, 1975, 1976, 1985, 1986, 1991, 1992, 1993, 1994, 1995, 1996, 1998, 2000, 2001, 2002, 2005, 2007, 2008 = 18 years	87	80
Total zinc	1975, 1976, 1992, 1994, 1998, 2005 = 6 years	14	4

b. Describe any QA/QC procedures that were applied to the historical dataset to ensure the data are applicable.

Response:

No specific QA/QC or screening procedures were applied to the historical dataset presented in the EIA except to adjust non-detectable concentrations to the detection limit (1xDL) for summary statistics. To assess the influence of these high-DL historical data on calculated baseline water quality in the RSA, water quality data with detection limits above AEP guidelines for the three variables described above were excluded from the baseline characterization, and summary statistics were recalculated. These revised summary statistics for cadmium, mercury, and zinc are presented in Table 5-2.

Table 5-2 Summary of selected historical water quality variables in the Crowsnest River, including only those values measured at or above analytical detection limits at that time

Variables		Total cadmium	Total mercury	Total zinc
Units		**mg/L**	**µg/L**	**mg/L**
Spring	n	1	0	1
	Med	0.0002	-	0.023
	Min	0.0002	-	0.023
	Max	0.0002	-	0.023
Summer	n	4	3	3
	Med	<0.0002	0.0018	0.025
	Min	<0.0002	0.00026	0.012

Table 5-2 Summary of selected historical water quality variables in the Crowsnest River, including only those values measured at or above analytical detection limits at that time

Variables		Total cadmium	Total mercury	Total zinc
Units		**mg/L**	**µg/L**	**mg/L**
	Max	**0.0011**	**0.09**	**0.0412**
Fall	n	4	2	6
	Med	<0.0002	0.0026	0.003
	Min	<0.0002	0.0013	<0.001
	Max	**0.0005**	0.0039	0.013
Winter	n	0	2	2
	Med	-	**0.25**	**0.1**
	Min	-	**0.1**	**0.1**
	Max	-	**0.4**	**0.1**

- = No data. **Bold** values indicate AEP long-term water quality guideline exceedances.

c. Describe whether, and if so, how the current baseline conditions and the historical dataset were combined into one dataset for comparison to modelled predictions.

Response:

In the Application, concentrations of selenium and sulphate were modelled in the downstream Crowsnest River (RSA) through development of a simple volumetric-dilution model, which used outputs of the LSA model as inputs to the RSA model. Water quality baseline data from the upstream Crowsnest River were required as one of the inputs in this model; however, only recently collected baseline data (2013 to 2016) were used in this model because of the age of historical data. Therefore, shortcomings of historical data did not influence modeling exercises for both the LSA and RSA.

6. SELENIUM CONCENTRATIONS

Reference: EIS Guidelines, Section 6.2.2; Consultant Report #5

Preamble:

The Guidelines require that Benga Mining include a consideration of the predicted changes to groundwater and surface water quality as a result of the Project, including impacts associated with any mine effluent, releases, or surface runoff.

Measured and modelled selenium (Se) concentrations reported in the EIA are compared against a unique (site-specific) Se objective calculated using the proposed sulphate adjustment. This might underestimate the true environmental impacts of Se on biota.

Sulphate adjustments are not considered in any current approved Se guidelines and should not be the primary basis of comparison in the EIA.

Information Required:

Provide measured and modelled Se concentrations at stations in the natural watercourses as compared to established water quality guidelines, such as provincial guidelines or those of Canadian Council of Ministers of the Environment (CCME).

Response:

A site-specific water quality objective for selenium was proposed for watercourses in the Project area, rather than using the published water quality guidelines for Alberta or Canadian Council of Ministers of the Environment (CCME), to reflect significant advancement in the scientific understanding of the aquatic toxicology of selenium since these guidelines were produced. The current Alberta guideline for selenium in water of 1 µg/L was taken from the existing CCME guideline of the same value, which was developed 30 years ago, in 1987.

The 1987 CCME guideline is lower than all more recently developed guidelines (Table 6-1). South Africa and Australia/New Zealand have a chronic water column selenium guideline of 5 µg/L (Department of Water Affairs and Forestry 1996, ANZECC 2000). In 2014, the British Columbia government developed a water column guideline of 2 µg/L (with an "alert concentration" of 1 µg/L).

The U.S. Environmental Protection Agency (EPA) has been most active in developing and refining aquatic toxicity criteria for selenium over time. A 1999 chronic criterion of 5 µg/L in the water column was updated in 2004 to focus on fish-tissue concentrations rather than water-column concentrations. Recognizing the relationship between sulphate and selenium toxicity, the 1999 U.S. EPA acute selenium (selenite) criterion for water included an adjustment for sulphate concentrations (selenium has very low acute toxicity: at a sulphate concentration of 100 mg/L, this U.S. EPA acute criterion was 417 µg/L). Recently in 2016, two new chronic water-column criteria were finalized by U.S. EPA—one for flowing waters of 3.1 µg/L, and one for standing waters of 1.5 µg/L—reflecting different chemical speciation, potential for biotic uptake, and risk of chronic aquatic effects in these two types of environments. Although U.S. EPA (2016) recognized the significant effects of sulphate in ameliorating chronic aquatic effects of selenium in the development of these chronic criteria, the lack of paired sulphate-selenium data in many historical studies used to develop the chronic criterion did not allow for the formal incorporation of this relationship into the new criterion ("[I]nclusion of a sulfate relationship was not feasible on a national basis at this time, for lack of sulfate data at many sites in the database"). Therefore, the current U.S. EPA national criteria were developed to be protective in low-sulphate waters.

Table 6-1 Chronic Guidelines and Proposed Thresholds for Selenium in Water, from Various Sources

Source	Guideline Value (µg/L)	Source
Jurisdictional Guidelines or Criteria		
CCME	1	CCME 1987
Alberta	1	Alberta Environment and Sustainable Resources Development (AESRD) (2014), from CCME (1987)
British Columbia	2	British Columbia Ministry of Environment (BC MOE) (2014)
Australia, New Zealand	5	ANZECC (2000)
South Africa	5	Department of Water Affairs and Forestry (1996)
USA	3.1 (flowing waters) 1.5 (standing waters)	U.S. EPA (2016)
Proposed Sulphate-based Thresholds		
Environmental Toxicology and Chemistry	= EXP (1.389*ln([SO_4]) – 3.342)	DeForest *et al.* (2017)
Proposed site-specific objective for this Project	= 0.594*[SO_4]0.46	Consultant Report (CR) #5, Appendix A1

Increased sulphate concentrations in surface waters reduce selenate bioavailability at the base of the food web (Williams *et al.* 1994, Lo *et al.* 2015, U.S. EPA 2016, DeForest *et al.* 2017) and subsequently reduce the transfer of selenium to higher-trophic-level organisms, including fish. While many factors influence the selenium speciation, bioavailability, and bioaccumulation in aquatic systems, three key factors should be considered in developing waterborne selenium screening thresholds, including: the influence of exposure concentration on selenium partitioning among food chain compartments; the influence of sulphate on selenium bioavailability; and physico-chemical differences between flowing and standing waters (DeForest *et al.* 2017). For example, in well-oxygenated flowing (lotic) waters, oxidized selenate [Se(VI)] dominates over selenite [Se(IV)], while selenite is more prevalent in poorly-oxygenated, standing (lentic) waters. Therefore, a sulphate-dependent waterborne selenium guideline is more appropriate for well-oxygenated, fast-flowing streams such as Gold and Blairmore creeks than traditional generic guidelines designed to be protective in all receiving environments, including those dominated by selenite rather than selenate. A sulphate-dependent guideline for selenium for flowing waters would be analogous to hardness-dependent water quality guidelines or criteria for divalent metals (CCME 2007, U.S. EPA 2016).

DeForest *et al.* (2017) recently published a methodology for deriving sulphate-dependent waterborne selenium guidelines for lotic (selenate-dominated) streams, which conceptually aligns closely with that used to develop the proposed site-specific objective for this Project. This

type of objective is appropriate for the LSA and RSA of this Project as proposed, given local watercourses are well-oxygenated throughout the year. The presence of sulphate affects uptake of selenium into the tissues of primary producers (typically periphytic algae in lotic systems), while accumulation of selenium in organisms at higher trophic levels (*i.e.*, benthos and fish) occurs through food-chain transfer from algae to these higher trophic levels and is substantially unaffected by ambient sulphate concentrations. Given uptake of selenium into algae is the rate-limiting process affecting selenium accumulation throughout the aquatic ecosystem, understanding how site-specific conditions (*i.e.*, local water quality, including sulphate concentrations) affect uptake of selenium into algae provides a foundation for determining safe thresholds for ambient selenium concentrations for local aquatic biota.

DeForest *et al.* (2017) modelled selenate bioconcentration in particulates as a function of waterborne selenate and sulphate concentrations. Waterborne selenate and sulphate along with particulate selenium data collected from both lab and field studies were used. Particulate selenium concentrations were then used to predict selenium concentrations in invertebrates and fish eggs using quantile regression models, yielding the following recommended chronic waterborne guideline:

Waterborne Selenium Screening Guideline (µg/L) = EXP[2.446*ln(fish egg selenium guideline)-10.67+1.389*ln([SO_4])]

Using a safe-concentration threshold of selenium in fish eggs of 20 µg/g dw, representing the 5th percentile of a species sensitivity distribution (SSD) of predominantly fish egg selenium EC10s for reproductive effects (DeForest *et al.* 2012), the above equation was simplified as follows:

Waterborne Selenium Screening Guideline (µg/L) = EXP[1.389*ln([SO_4])-3.342]

The lower bound of this sulphate-dependent model was capped at a sulphate concentration of 43 mg/L, which is the sulphate concentration that results in a guideline of 6.5 µg/L, and also was proposed by DeForest *et al*. (2017) as a relevant guideline for lotic environments, which would not adjust for sulphate concentrations. The lotic selenium screening guideline of 6.5 µg/L was based, in part, on the observed relationship between waterborne and particulate selenium in a variety of lotic systems.

The site-specific objective proposed for this Project, derived using site-specific relationships of selenite, sulphate, and algal selenium uptake, is as follows:

Proposed site-specific objective for selenium in Blairmore and Gold creeks (µg/L) = 0.594*[SO_4]0.46

Relative to the recommended screening guideline in DeForest *et al.* (2017), the proposed site-specific objective for this Project is much more conservative at all sulphate concentrations (Table 6-2).

Table 6-2 Relative Comparison of Water-borne Selenium Guidelines Between Proposed Grassy Site-specific Objective and DeForest *et al.* 2017 Using Same Sulphate Concentrations

Sulphate Concentration (mg/L)	Proposed Site-specific Selenium Objective for this Project (µg/L)	Selenium Screening Guideline for Flowing Waters Proposed by DeForest *et al.** (µg/L)
43	3.35	6.5
75	4.33	14
100	4.94	21
150	5.95	37
200	6.80	56
300	8.19	98
400	9.30	145
500	10.36	198

*DeForest *et al.* 2017

It should be noted that, following its initial presentation in the 2015 Environmental Assessment Application, the proposed site-specific objective was revisited in response to a specific information request from Environment Canada (Attachment 1, Table 2, IR #14). Environment Canada acknowledged the appropriateness of this approach but requested testing of at least one more algal species, to provide additional confidence in the proposed site-specific objective. Therefore, in addition to results of tests using *Pseudokirchneriella subcapitata* (alga) and *Lemna minor* (duckweed) used to develop the original site-specific objective, tests were conducted in 2016 using a third algal species, *Scenedesmus acutus*. Results for this third species were very similar to those for the first two; and a slightly revised site-specific objective (Table 6-2) was presented in CR #5, Section 2.2.2 and CR #5, Appendix A1.

Measured and Predicted Selenium Concentrations in the LSA and RSA as Relative to Published Guidelines and the Proposed Project-specific Site-specific Objective

Measured baseline selenium concentrations in the LSA and RSA are shown in Figure 6-1; predicted selenium concentrations resulting from Project activities are presented in Figures 6-2 to 6-4 for the LSA and Figure 6-5 for the RSA. These concentrations are screened against published guidelines and the proposed site-specific objective. A summary of exceedances of these various thresholds appears in Table 6-3.

Baseline concentrations of total selenium measured in Blairmore Creek and the Crowsnest River were below all published water quality guidelines except the Alberta/CCME guideline. However, baseline selenium concentrations at Gold Creek were higher than all guideline values in at least two of 17 samples.

Selenium concentrations modelled in the LSA nodes during all mine phases were higher than published water quality guidelines from all jurisdictions but were lower than the proposed site-specific objective and the screening guideline proposed by DeForest *et al*. (2017). At the RSA nodes, predicted selenium concentrations were below all water quality guidelines except the Alberta/CCME guideline.

Table 6-3 Exceedances of Published Selenium Guidelines and Proposed Objectives During Baseline and Predicted Conditions in the LSA and RSA.

Stations	Total Observations	Exceedances (#samples)					
		AB/CCME	BCMOE	U.S. EPA	Australia	Site-specific	DeForest *et al.* 2017
Baseline Conditions							
Blairmore Creek	22	1	0	0	0	0	0
Gold Creek	17	9	4	3	2	4	2
Crowsnest River	14	14	0	0	0	0	0
Predicted Conditions							
Blairmore Creek							
BC01	83	73	66	61	0	0	0
BC03	83	74	67	63	56	0	0
BL02	83	72	65	62	61	0	0
BC07	83	72	66	62	61	0	0
Gold Creek							
GC02	83	62	56	0	0	0	0
GC04	83	0	0	0	0	0	0
GC10	83	28	0	0	0	0	0
Crowsnest River							
CRR01	83	83	0	0	0	0	0
CRR02	83	83	0	0	0	0	0

7. MINE PIT DEWATERING

Reference: EIS Guidelines, Section 6.1.4; Consultant Report #3, Section 5.1; Agency's Request for Additional Information, March 21, 2016 - AIR #32.

Preamble:

The Guidelines require that Benga Mining provide hydrogeological maps and cross-sections for the project area to outline the extent of aquifers and aquitards, including bedrock fracture and fault zones, locations and depths of wells, springs, surface waters, and project facilities. Groundwater levels, potentiometric contours, flow directions, groundwater divides and areas of recharge and discharge should be included.

Natural Resources Canada (NRCan) is of the opinion that Figures 5.3-1, 5.3-3 and 5.3-5 of Consultant Report #3 are insufficient to understand the impact of mine pit dewatering on groundwater levels. Cross sections are important for understanding the impact of the mining operations on the groundwater levels.

Information Required:

Provide figures illustrating the characteristic cross sections of the proposed mine permit boundary showing groundwater levels and pit contours.

Response:

- Consultant Report (CR) #3, Figure 5.3-1: Predicted Drawdown and Capture Zone for End of Mine (EOM)
- CR #3, Figure 5.3-3: Hydrogeological Cross-Section AA' – EOM
- CR #3, Figure 5.3-5: Predicted Drawdown and Capture Zone for Long Term Closure (LTC)

Other figures that are relevant for understanding the impact of mining operations on the groundwater levels include:

- CR #3, Figure 4.2-5: Hydrogeological Cross-Section AA' – Baseline
- CR #3, Figure 5.3-3: Hydrogeological Cross-Section AA' – EOM
- CR #3, Figure 5.3-7: Hydrogeological Cross-Section AA' – LTC
- CR #3, Figure 4.2-8: Hydrogeological Cross-Section DD' – Baseline
- CR #3, Figure 5.3-4: Hydrogeological Cross-Section DD' – EOM
- CR #3, Figure 5.3-8: Hydrogeological Cross-Section DD' – LTC

The two cross-sections are aligned across the mine permit boundaries and intersect the mine pit and rock disposal areas in the northern portion and southern portion of the pit. Baseline, EOM (including the full extent of the surface water management system) and LTC (following reclamation and re-contouring) shows the evolution of the groundwater heads beneath the mine prior to any disturbance, at the maximum of the disturbance and after mine closure and reclamation.

The six cross-sections listed above (CR #3, Figures 4.2-5, 5.3-3, 5.3-7, 4.2-8, 5.3-4, and 5.3 -8) were updated by overlaying the following information:

- Extended geology;
- Identification of aquifers and aquitards;
- Fault zones and fractures;
- Well depth and groundwater levels;
- Springs (if any);
- Topography at the time of the cross-section (*i.e.*, native topography, or topography during mining including rock disposal areas, *etc.*);
- Potentiometric contours;
- Flow direction; and
- Groundwater divides with recharge and discharge areas.

The extended geology used maps from Norris (1993) to extrapolate the geology outside of the detailed mapped areas.

Fault and fracture zones include both regional and local fault and fractures, identified at the Project and presented in plan view on CR #3, Figure 4.2-2.

Identification of aquifer and aquitards is consistent with the hydrostratigraphic log presented on CR #3, Figure 4.2-1.

Groundwater divides are associated with groundwater flow systems which are scale dependent. As defined by Freeze and Cherry (1979) and following the concept developed by Tóth, groundwater divides are imaginary impermeable boundaries beneath valleys and ridges across which there is no flow. Hence, in three-dimensional groundwater flow every groundwater flow line is technically a "divide" since, by definition, there is no flow across a flow line. In this case, groundwater divides presented on the cross-sections only include those relevant for the scale of the assessment (*i.e.*, scale of the mine) and do not reflect systems of larger or smaller size. Divides can either correspond to areas of "recharge" (diverging groundwater flow lines) or "discharge" (converging water flow lines) (Freeze and Cherry 1979).

Groundwater divides are infrequently added to cross-sections because of the complexity of the interpretation on a two-dimensional view of a phenomenon occurring in three-dimensions as well as because of the scale issue discussed above. Groundwater divides are easily identified in horizontal homogeneous isotropic materials stacked on top of each other (*i.e.*, groundwater divide is straight down), which is not the case at the Project where the geological units are heterogeneous, anisotropic and not neatly stacked on top of each other, with the presence of fractures.

Potentiometric contours are outputs from the numerical groundwater model created to assess the effect of the mine on the hydrogeological system (CR #3, Appendix C).

Flow direction and groundwater divides were interpreted based on the distribution of the potentiometric contours. Some of the groundwater divides, most relevant for the impact assessment, were presented on plan view maps on CR #3, Figures 4.5-3, 5.3-2 and 5.3-6. The groundwater heads presented on the maps correspond to the uppermost water level (*i.e.*, water table or perched groundwater), and do not reflect conditions at depth.

8. BASE FLOW RATES

Reference: EIS Guidelines, Section 6.1.4; Consultant Report #3, Appendix C, Section 3.1.4 & Section 4.4.4.2; Agency's Request for Additional Information, March 21, 2016 - AIR #33.

Preamble:

The hydrologic characteristics of Blairmore Creek, Gold Creek and Daisy Creek watersheds were characterized, based on 18 regional climate stations and 12 regional gauging stations located within a 90 km radius from the Project site. The catchment areas upstream of the gauging stations are very different in shape, surface area, and altitude. This difference could impact the magnitude of the various water budget components (*e.g.*, precipitation, runoff).

NRCan notes that Gold Creek Station G2 and Blairmore Creek Station BL-02 have markedly different base flows, suggesting the unit flow (base flow per unit km of contributing area) for Gold Creek may be 2 to 3 times higher than that of Blairmore Creek in the Project area.

In addition, recharge rates were adjusted during the calibration of the ground water numerical model to match the baseflow estimates for Gold Creek, Blairmore Creek and Daisy Creek. The base case calibrated average recharge over the model domain is equivalent to 16.5% of Mean Annual Precipitation (Appendix C, Figure 19). The low and high estimates (5 and 30%, respectively) were applied as part of the sensitivity analysis.

Information Required:

Provide the numerical values of the final calibrated recharge rate in mm/year/m2 for the upstream area of each gauging station considered in Table 1 and the overall recharge value for the whole modelled region.

Response:

Table 8-1 provides the numerical values of the final calibrated recharge rates for the upstream area of each gauging station and the overall recharge value for the whole modelled region.

Table 8-1 Numerical Values of the Final Calibrated Recharge Rate in mm/y/m^2

Creek Name	Label	Catchment Area (m^2)	Recharge Rate (mm/y/m^2)
Blairmore Creek	BL-04	8,967,750	133
Blairmore Creek	BL-03	15,221,400	129
Blairmore Creek	BL-02	24,142,830	127

Table 8-1	**Numerical Values of the Final Calibrated Recharge Rate in mm/y/m^2**		
Blairmore Creek Tributary	UNC-01	6,739,410	102
Blairmore Creek	BL-01	48,053,240	121
Gold Creek	G2	32,910,700	130
Gold Creek	GC-01	63,089,700	120
Daisy Creek	D1	64,616,500	128
--	**Model Domain**	**201,876,000**	**123**

9. STEADY STATE FLOW MODEL

Reference: EIS Guidelines, Section 6.1.4; Consultant Report #3, Appendix C, Section 4.5; Agency's Request for Additional Information, March 21, 2016 - AIR #35.

Preamble:

The steady-state flow model was calibrated with respect to observed groundwater levels and estimated averaged annual baseflow rates. The groundwater recharge occurs mainly during snowmelt season. The baseflow shows the same trend. According to NRCan, averaging both water budget components on an annual basis may result in over/under prediction of the impacts on the groundwater flow.

Information Required:

a. Provide spatial maps with depth to groundwater in the top model layer for the calibrated baseline case and End of Mine conditions.

Response:

Depth to groundwater in the top model layer for the calibrated baseline case and End of Mine conditions were presented in Consultant Report (CR) #3, Appendix C, Figures 3-17 and 3-24. They are also included in this response:

- CR #3, Appendix C, Figure 3-17: Simulated Depth to Water Table, Baseline
- CR #3, Appendix C, Figure 3-24: Simulated Depth to Water Table, EOM

b. Provide a discussion on the relevancy of the steady state flow approach in an area with such significant topographic relief.

Response:

The calibration approaches used for the model are presented in CR #3, Appendix C, Section 3.5.

The model was calibrated to baseline conditions first for steady-state and then for transient state. The baseline transient model simulated a three-year cycle with seasonal fluctuations of recharge and represented the average groundwater conditions (*i.e.*, neither a wet nor a dry

season/conditions) beneath the Project. It is the calibrated transient model that was used to simulate the Baseline, End-of-Mine and Long Term Closure conditions as it takes into account seasonal head variations and baseflow fluctuations associated with climate and topography in the area of the Project.

GEOLOGY AND GEOCHEMISTRY

10. SEISMIC ACTIVITY

Reference: EIS Guidelines, Section 6.6.2; Agency's Request for Additional Information, March 21, 2016 - AIR #36.

Preamble:

The Guidelines require that Benga Mining take into account how local conditions and natural hazards, such as external events (*e.g.*, seismic conditions etc.) could adversely affect the Project and how this in turn could result in impacts to the environment.

Benga Mining has indicated that the Project is located in a low seismic zone. In its review of the EIA, NRCan has indicated that they are aware of fracking for oil and gas in the northern and northwestern parts of Alberta that can cause induced seismicity. In its response to AIR #36, Benga Mining indicated that information will be provided under separate cover.

Information Required:

In Benga Mining's response, the Agency is expecting a discussion on the potential for induced seismicity that could possibly result from fracking in the Project's vicinity[3].

Response:

Although induced seismicity caused by hydraulic fracturing may be an issue in some parts of Alberta, there is currently no fracturing operations occurring in the vicinity of the Project. According to the website FracFocus, no licensees for hydraulic fracturing occur within the Municipality of Crowsnest Pass or the Municipal District of Ranchlands No. 66 (BC Oil and Gas Commission n.d.). Two wells located at 10-1-6-3 W5M and 5-4-4-30 W4M in the Municipal District of Pincher Creek No. 9 were last fractured on October 10, 2014 and November 2, 2014, respectively (BC Oil and Gas Commission n.d.). Although, companies conducting hydraulic fracturing operations have 30 days from the completion of operations to submit their records, the database indicates that hydraulic fracturing does not commonly occur in the area surrounding the Project. The potential for induced seismicity resulting from fracking in the vicinity of the Project is considered to be low.

According to the Alberta Seismic Events Interactive Map (Alberta Geological Survey 2017), which shows the locations and magnitudes of seismic events in Alberta, the Project is located in an area with low seismic activity. Table 10-1 provides a summary of the seismic activity that has occurred within approximately 40 km of the Project. Typically, seismic events may be felt

[3] The Alberta Geological Survey has detailed information on seismicity in Alberta. Benga Mining should also refer to the "Canadian Dam Association Guidelines 2013".

above 2.5 M_L. Since the seismic events registered below a 2.5 M_L, these events were not likely felt. Seismic conditions are not expected to adversely affect the Project and result in impacts to the environment.

Based on this information, Benga maintains that the potential for induced seismicity resulting from hydraulic fracturing in the vicinity of the Project is considered to be low and will not be discussed further.

Table 10-1 Alberta Earthquake Catalogue Record of Seismic Events in the Vicinity of the Project

Date	Location	Latitude	Longitude	Magnitude (M_L)[1]	Depth (bsl km)	Depth Value Adjusted (g) / Raw (f)
August 9, 2014	20 km SE of Elkford, AB	49.8072	-114.7973	1.75	3	g
July 20, 2007	18 km SSW of Crowsnest Pass, AB	49.4106	-114.6887	1.93	10	g
March 12, 2016	26 km SW of Claresholm, AB	49.8822	-113.8920	2.46	5	g
August 9, 2014	24 km SW of Granum, AB	49.7923	-113.8268	2.12	3	g

Source: Alberta Geological Survey 2017.

Note: Magnitudes less than 2.0 have an Earthquake Class of Micro and are usually not felt.
Magnitudes 2.0 to 4.0 have an Earthquake Class of Small or Minor and may be felt above 2.5 M_L.

11. GROUND MOTIONS

Reference: EIS Guidelines, Section 6.6.2; Section B8, Table B.8.6-3; Section B.8.6.3.2.1

Preamble:

The Guidelines require Benga Mining to describe the geological hazards that exist in the areas planned for project facilities and infrastructure including seismic activity, landslides, slope erosion, ground and rock instability and subsidence. The EIA references the 2010 National Building Code of Canada (NBCC) and the 2013 Canadian Dam Association Dam Safety Guidelines (CDA). There is reference to low seismicity rating and class "Seismic Zone 2, per Canadian NBC 1985" (Table B.8.6-3) however, NRCan has noted that in the calculations of peak ground acceleration (PGA) values the 2010 NBCC are used[4].

> "For the seismic stability analysis (pseudo-static cases), the 475-year design earthquake event was selected. A peak ground acceleration (PGA) of 0.056 g is associated with the in the 475-year event for the Grassy Mountain area (based on coordinates 49.69 North 114.4 West from 2010 National Building Code Seismic Hazard Calculation)".

[4] The 2015 NBCC ground motion parameters for use with the NBCC are now available on-line at: http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index-en.php.

NRCan notes that the "reference ground condition" used in the 2015 NBCC is Soil Class C, average Vs30 shear wave velocity 450 m/s, whereas the 2010 NBCC used "Site Class C", defined by a Vs30 of 360 to 750 m/s.

Information Requested:

a. Confirm why "Zone 2", as per the Canadian NBC 1985 is referred to in Table B.6-3. Consider removing reference to 1985 NBCC and "seismic zones 2".

Response:

Section B.8.6.3.1, Table B.8.6-3 references the British Columbia Mined Rock and Overburden Piles Investigation and Design Manual, Interim Guidelines, 1991 (British Columbia Mine Waste Rock Pile Research Committee 1991). This manual is the current manual and references the NBCC in effect at that time.

b. Confirm whether the 2015 NBCC values have been considered (*e.g.*, for the Earthquake Design Ground Motions for dam design). In the case where 2015 NBCC values have been considered, provide an analysis that uses the 2015 values and compares them to the PGA values from the 2010 NBCC.

Response:

The 2015 NBCC values have been considered for the structures that have been updated and analysed since 2016. These include the South Rock Disposal Area and the Raw Water Pond dam. As detailed design progresses, the current codes and standards will be referenced.

c. Confirm that the analysis will be modified, as required, based on actual shear-wave velocities at the project site.

Response:

The analysis will be modified, as required, based on actual shear-wave velocities at the Project site.

MIGRATORY BIRDS AND SPECIES AT RISK

12. WHITEBARK PINE

Reference: EIS Guidelines, Section 6.1.7 & 6.3.3; Appendix D, Section 4.2.6.3.2; Agency's Request for Additional Information, March 21, 2016 - AIR #37.

Preamble:

The Guidelines require Benga Mining to include a description of the abundance and distribution of species at risk, including habitat requirements, key habitat areas, identified critical habitat and/or recovery habitat, and the general life history of species at risk that will occur in the project area or be affected by the Project.

The Guidelines also specify that the EIS include direct and indirect effects of the Project on federally listed species at risk and their critical habitat, including direct and indirect effects on the survival or recovery of federal listed species and 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.

Limber Pine is listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is pending a Species At Risk Act (SARA) assessment. Benga Mining has indicated that less than 1000 Limber Pine trees will be affected by the Project. Benga Mining has indicated there will be seed collection of rust resistant trees which will be stored and used for their reclamation program, and that the success of all limber and whitebark pine planted seedlings on reclaimed or offset areas will be monitored. The number of Limber Pine seedlings Benga Mining will replant remains unclear.

If this species becomes listed under SARA, the general SARA prohibitions will become applicable. As this could happen during the Project timeframe, Benga Mining is being asked for information on the effects and mitigation for this species.

Information Required:

a. Provide details of the options explored to avoid and/or reduce the removal of individuals of the species and why the proposed approach was adopted.

Response:

The nature of the steep terrain and of surface mining operations precludes direct avoidance for individual trees located within the mine pits and rock disposal areas. Direct avoidance is only feasible for individual trees or groups of trees on the margins of mine footprint and access routes. Benga Mining has committed to monitoring for limber pine ahead of tree clearing for the purpose of cone (seed) collection (Consultant Report (CR) #8, Section 4.2.6.3.4). Where feasible and safe to do so, trees may be avoided where they are found on the edge of planned clearings or access routes. Avoidance would include marking, mapping and where required installation of fencing or signs.

Modifications to the plan to reduce the footprint of the Project and how this reduced the impact on limber pine is described in CR #8, Section 4.2.6.3.2.1. As part of the mine planning and scheduling, several iterations of the mine plan were considered and took into account potential impacts to terrestrial wildlife and plant habitat, aquatic habitat, and water quality. Specifically, efforts to minimize the spatial area of the external rock disposal areas and access roads were made. As a direct result of these efforts the ultimate rock disposal extent was kept to a minimum. Most of the rock material will be disposed of within the mined out pit areas, which helps to keep the disturbance Footprint considerably smaller than if additional external disposal areas are used. Also, access roads and other infrastructure are primarily routed within the mine pit itself thus minimizing the need to disturb adjacent, undisturbed areas. These efforts to reduce the footprint resulted in the avoidance of one of the four occurrences of limber pine found during the initial ground based survey within the LSA (CR #8, Figure 3.2-3).

b. Provide precise detail on the number and distribution of proposed removal of individuals of the species, in relation to the overall species' ecology, population and distribution, based upon best available information.

Response:

There are an estimated 28.9 million whitebark pine mature stems in Alberta and estimated 44.4 million limber pine (Alberta Whitebark and Limber Pine Recovery Team 2014a,b). Due to safety concerns on the steep terrain a complete census of limber pine trees from the ground is not possible. The estimate for the number of limber pine potentially occurring within the Project Footprint was compiled from aerial observations of individuals and areas deemed to provide suitable habitat, and from counts of trees on the ground. The estimated number of limber pine trees (n < 1,000) that may be present within the Footprint is conservatively over-estimated by counting pine from known locations (including juvenile and sub canopy trees) and multiplying by the area of suitable habitat that will be cleared or has been cleared by historical mining (Section F; Figures F.3.2-2, F.2.1-1, and F.2.1-2). Assessing the potential number of limber pine trees was done concurrently with estimations for whitebark pine so it is possible that the relative number of limber and whitebark pine may change. As the Project develops, access will improve, which will allow for a better estimation of the actual number of trees through a monitoring program.

The Canadian population of limber pine is not well understood but is estimated at 44.4 million trees (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2014). Limber and Whitebark pine numbers are declining primarily due to disease and insect attack and secondarily due to fire exclusion and climate change (COSEWIC 2014). The current distribution of limber pine in the region is described in the Vegetation and Wetlands Assessment (CR #8, Section 3.2.1.1) and shown in CR #8, Figure 3.2-2. CR #8, Figure 3.2-2 represents the most current publically available information on the distribution and occurrence of limber pine in the area. The identification and mapping of limber pine in the Project local study area represented new individuals not reported and thus the Project will have no impact on historically known populations.

c. Limber pine within the LSA was found on both east and west slopes and on elevations from 1560 m to 2075 m. During the aerial surveys limber pine was observed on well vegetated slopes mixed with lodgepole pine, on rock dumps from historical mining, and on exposed rock outcrops where they took on the characteristic twisted and shrubby form. Provide details and rationale for how the mitigation measures proposed will eliminate the adverse effect on the species. As a part of this information, provide the number of Limber Pine seedlings that will be planted and a rationale for the selected number.

Response:

Unlike most rare species the loss of habitat is not the main threat for limber pine (Alberta Whitebark and Limber Pine Recovery Team 2014b, COSEWIC 2014). Limber pine and is endangered due to disease and insect threats. Many dead pine trees were observed during the field assessment. Threats to whitebark and limber pine populations do to removal of trees or

alteration/loss of habitat are indirect threats by loss of potentially rust resistant trees. Much of the area within the Project Footprint is above 1,900 m and thus near the upper range reported for limber pine. With the exception of historical mine areas, lower slope lodgepole pine and mixed forests, and open water, the remainder of the Project Footprint is suitable limber pine habitat. The post reclamation landscape will provide suitable habitat above 850 m and below 1,900 m for establishing limber pine (Section F, Figure F.3.6-7). Historical mine areas and other existing anthropogenic disturbances above 850 m, which currently are not suitable habitat for limber pine, are included in the reclamation plan; this will increase the area of suitable limber pine habitat post reclamation versus what exists at baseline.

Benga proposes to plant a minimum of three times the number of trees removed due to operation of the Project (estimated at 1,000 trees thus 3,000 trees planted). Establishing limber pine by planting seedlings is feasible. According to Pigot and Moody (2013), "*limber pine seeds germinate readily, and it is possible to produce good quality seedlings for outplanting in one growing season. Survival after planting appears to be high and planting is one of the more productive restoration activities…*" As summarised in the Alberta Limber Pine Recovery plan, limber pine seed has been collected many times in the past in Alberta, and trees have been successfully established. Planting a minimum of three times the number of trees removed has been selected to account for mortality during planting, subsequent natural losses, uncertainty in long term survival, and to provide a buffer to ensure a net increase in the number of trees. Adaptive management (Section F.2.3) will be implemented throughout the reclamation period to reduce mortality from planting and to increase long-term survival.

As stated for whitebark pine, Benga has committed to work with the recovery strategy for limber pine and identify disease resistant trees if present for cone collection, and use disease resistant, and local, stock during reclamation to preserve genetic diversity (CR #8, Section 4.2.6.3.). Establishing resistant trees is critical (Schoettle and Sniezko 2007) for survival of high elevation pines (limber and whitebark) and is central to the provincial recovery plan

Benga is committed to updating its limber pine reclamation strategy with the best available science and additional guidance from federal recovery plans when they are prepared. Benga is participating in white-bark pine/limber pine conservation and recovery efforts and is working with provincial recovery team personnel to explore options that support the long term conservation of limber and whitebark pine populations.

13. LITTLE BROWN BAT

Reference: Guidelines, Section 6.1.7 & Section, 6.3.3; EIS Guidelines, Section 6.4; Consultant Report #9, Section 2.3.4 & Section 7; Agency's Request for Additional Information, March 21, 2016 – AIR #38.

Preamble:

The Guidelines require Benga Mining to include a description of the abundance and distribution of species at risk including habitat requirements, key habitat areas, identified

critical habitat and/or recovery habitat, and the general life history of species at risk that will occur in the Project area or be affected by the Project.

In Consultation Report #9, section 2.4.3.3.1.2, Benga Mining indicates that additional mistnetting and acoustic monitoring surveys are planned for July 2016 and these results will be submitted under a separate cover. In Benga Mining's addendum, the Agency is expecting a response to the following information requests that were originally identified in AIR #38 (March 21, 2016):

Information Required:

a. Provide the number and locations of bat hibernacula in the Project Development Area (footprint plus disturbance buffer), and whether little brown bats are using these hibernacula.

Response:

See in Attachment 3, IR #5.

b. Estimate the number of little brown bats that will be affected for each hibernacula disturbed/destroyed due to the Project.

Response:

See in Attachment 3, IR #5.

c. Identify hibernacula near, but unaffected by, the Project to which Project-impacted little brown bats could relocate.

Response:

See in Attachment 3, IR #5.

d. Identify mitigation measures for the destruction of little brown bat hibernacula.

Response:

See in Attachment 3, IR #5.

14. WILDLIFE RISK ASSESSMENT

Reference: EIS Guidelines, Sections 6.1.6, 6.1.7, 6.3.2 and 6.3.3; Consultant Report #12, Appendix G, Appendix G-1 and Appendix H, Table H.3; Agency's Request for Additional Information, March 21, 2016 - AIR #39.

Preamble:

The Guidelines require a discussion of the risks of exposure to the relevant contaminants of concern (COCs) based on data from existing sources as well the predicted direct and indirect effects of the Project on federally listed species at risk and migratory birds.

A screening level risk assessment is the initial tier in an ecological assessment and employs conservative assumptions regarding chemical exposure and toxicity to receptors. Benga Mining

conducted a screening- level wildlife health risk assessment (WRA) using the same risk assessment methodology (problem formulation, hazard and exposure assessment, and risk characterization) as per the human health risk assessment (HHRA).The WRA focused on assessing the risk associated with COCs associated with the Project's air emissions. The exposure of wildlife receptors to COCs in water was not conducted even though elevated water levels of nitrite, selenium, cobalt, cadmium, mercury, and zinc in the LSA and cobalt and zinc in the RSA are predicted.

Benga Mining expanded the breadth of their wildlife risk assessment to include other relevant pathways of wildlife exposure to COCs, other than the Project's predicted air emissions. The exposure routes evaluated are summarized in Table H.3 (Appendix H, Page 7). However, certain toxicologically relevant routes of exposure would benefit from additional information or were not evaluated at all. For instance, Benga Mining states that primary consumers are likely to be exposed to the highest concentrations of COCs given that these project-related compounds are not expected to biomagnify.

Information Required:

a. Update the WRA to incorporate the ingestion of plants and berries and assess the risk of exposure to primary consumers, including migratory birds. Link data from the Baseline Monitoring Program (Appendix G, and Appendix G-1) completed as part of the HHRA and include in the WRA.

Response:

In response to IR #14 and IR #15, the wildlife risk assessment (WRA) was further assessed to include the following dietary exposure pathways: ingestion of plants and berries and ingestion of fish and prey. Details on reasoning and results of this response are included in Appendix 14A.

The predicted hazard quotients for all contaminants of concern (COCs) for all surrogate wildlife species were below 1.0 (Appendix 14A, Section 1.4, Table 14A-6). These results support the conclusion that release of COCs by the Project is not predicted to have any adverse impact to wildlife in the Study Area. These results are consistent with results of the human health multimedia risk assessment, which concluded that ingestion of contaminated food sources made a minimal contribution to overall exposure (Consultant Report (CR) #12, Section 6.3 and CR #12, Appendix F).

For this response, the WRA included assessment of all COCs with the potential to bioaccumulate in plant or animal tissue; these COCs were issued in August 2016 as part of the Project application (CR #12, Section 5.1.1). Input vegetation concentrations used to calculate wildlife exposure for the Baseline Case exposure assessment were as reported from the Baseline Monitoring program (CR #12, Appendix G) and were modelled for Project contributions in the Application Case.

Potential wildlife receptors were previously identified in the baseline wildlife survey (CR #9, Section 2.0), including sensitive species (CR #9, Section 2.4.2, Table 2.4-2). Surrogate mammalian and avian species were selected from those lists for the WRA based on their value to

the nearby communities, their dietary composition, and the availability of exposure characteristics, with priority given to species at risk and migratory birds.

For these surrogate species, predicted exposure doses for the applicable COCs were calculated based on the exposure pathways identified in the original WRA (CR #12, Appendix H, Table H.3), using equations provided in CR #12, Appendix E.

b. Update the WRA to include exposure of wildlife to COCs through dietary pathways, such as the ingestion of fish and prey.

Response:

Please see response IR #14a.

c. Update the WRA to assess exposure to waterborne nitrite and nitrate.

Response:

Please see response IR #14a.

As discussed in CR #5, Section 4.0, no significant Project effects on surface water or groundwater quality are anticipated. Exposure to waterborne COCs is not an operative exposure pathway for human or wildlife receptors. Mitigation measures as described in Section E.5.5, and the Projects Water Management Plan in Section C.5.3 and Section C.5.5 were proposed to prevent the increase of nitrate and nitrite COCs in surface water.

15. SPECIES AT RISK AND MIGRATORY BIRDS

Reference: EIS Guidelines, Sections 6.1.6, 6.1.7, 6.3.2 and 6.3.3; Consultant Report #12, Appendix H, Section 2.3, Table H.3; Agency's Request for Additional Information, March 21, 2016 - AIR #40.

Preamble:

The Guidelines require a discussion of the risks of exposure to the relevant contaminants of concern (COCs) based on data from existing sources as well the predicted direct and indirect effects of the project on federally listed species at risk and migratory birds.

In the screening-level wildlife risk assessment, Benga Mining identified a number of COCs to wildlife based on Project activities including a suite of metals, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). Benga Mining indicates in Table H.3 (CR #12, Appendix H) that no COCs are expected to bioaccumulate or biomagnify. ECCC notes that mercury and selenium are capable of accumulating in biota and can bioaccumulate and biomagnify through the food web. Additional information is required on compounds with the potential to bioaccumulate and biomagnify to determine the impacts to wildlife species.

Information Required:

a. Update the list of COCs identified in the wildlife risk assessment by describing which compounds have potential to bioaccumulate and biomagnify up the food

chain. Include a description of the bioaccumulation and biomagnification pathways.

Response:

Please see response IR #14a.

b. For compounds identified in a), update the wildlife risk assessment to include a determination of the impacts of exposure through diet to valued wildlife components.

Response:

Please see response IR #14a.

16. CONTAMINANTS OF CONCERN

Reference: EIS Guidelines, Section 6.1.6 & 6.1.7; Consultant Report #12, Appendix H; Agency's Request for Additional Information, March 21, 2016 - AIR #42.

Preamble:

The Guidelines require a discussion of the risks of exposure to the relevant COCs based on data from existing sources as well the predicted direct and indirect effects of the Project on federally listed species at risk and migratory birds.

A thorough summary of research discussing the potential impacts of COCs associated with coal mining on wildlife was not provided by Benga Mining.

Information Required:

Provide a summary of research conducted or considered for COCs associated with coal mining activities and the impact to wildlife from exposure to those COCs, with appropriate references.

Response:

Baseline wildlife surveys were completed to delineate the existing wildlife habitat and determine what wildlife species were present in the Local and Regional Study Areas, including species at risk (Consultant Report (CR) #9, Section 2.0). An assessment was then completed for the key issues associated with the Project that could negatively impact wildlife. This included direct and indirect effects, such as loss of habitat, habitat fragmentation, increased mortality risk, sensory disturbances, and reduced abundance (CR #9, Section 3.1, Table 3.1-1).

Potential impacts associated with the Project on wildlife were summarized in the following sections of Section E:

- potential impacts on fish habitat (Section E.6.3.1);
- potential impacts on wildlife (Section E.9.3);
- potential impacts to species at risk (Section E.6.2.1 (fish), Section E.8.3.2 (vegetation); and Section E.9.3.7 (wildlife); and

- potential impacts to migratory birds (Section E.9.3.8).

An additional review of potential impacts of coal mining contaminants of concern (COCs) on wildlife is also included in the response to IR #14.

Risks to wildlife from exposure to mining related COCs were addressed through a screening level wildlife risk assessment (WRA), which was included as CR #12, Appendix H. The risk assessment was conducted in accordance with federal guidance documents, including *Ecological Risk Assessment Guidance* (Environment Canada 2012) and a *Framework for Ecological Risk Assessment* (Canadian Council of Ministers of the Environment [CCME] 1996). All emissions specific to Project activities were reviewed as COCs and included in the WRA.

Research on the toxicity to wildlife of COCs associated with coal mining activities (criteria air contaminants, polycyclic aromatic hydrocarbons, volatile organic compounds, and metals) was undertaken; however, virtually no controlled studies have been identified where wildlife species were exposed to the COCs. Instead, information on the wildlife toxicity of the COCs was obtained from the scientific literature related to the exposure of laboratory test animals such as mice, rats, and guinea pigs.

All toxicity reference values (TRVs) selected for the WRA were identified from available toxicological data based on ecological population-level endpoints. TRVs were located for acute and chronic inhalation by avian and mammal receptors (CR #12, Appendix H, Table H.5 and Table H.7, respectively). Chronic oral TRV were identified for the IR #14 response and are listed in Appendix 14A, Tables A14-7 to A14-9. Both CR #12, Appendix H and IR #14, Appendix 14A provide a summary of the TRV selected, the scientific rationale behind each TRV, the toxicity endpoints, and references to the original laboratory studies.

The literature review for chronic TRVs and identification of no-observed-adverse-effect levels (NOAELs) consisted of a search of the following sources:

- Canadian Council of Ministers of the Environment (CCME);
- Oak Ridge National Laboratory; and
- United States Environmental Protection Agency.

For COCs where TRVs were not available, the lowest reported NOAEL for population-level effects for the most sensitive species was selected as the TRV. Preference was given to a NOAEL to reduce the likelihood of underestimating potential risk to sensitive wildlife species; however, in the absence of an available value the lowest-observed-adverse-effect level (LOAEL) was used as the TRV after application of an uncertainty factor to account for the use of a LOAEL.

The results of the wildlife assessment support the conclusion that release of COCs by the Project is not predicted to have any adverse impact to wildlife in the Study Area. Mitigation measures designed to protect species at risk and migratory birds from Project activities are summarized in Section E.9.5.

See the response to IR #14 for additional detailed assessment of the potential impacts to wildlife from mining COCs.

HUMAN HEALTH

17. HUMAN HEALTH RISK ASSESSMENT

Reference: EIS Guidelines, Section 6.3.4; EIS Guidelines, Section 6.4; EIS, Section A.11, Pg. A-72 – A-73, A-96; Consultant Report #12, Section 5.4, Pg. 28; Section 6.1, Pg. 32; Section 6.2, Pg. 37; Section 6.4, Pg.44; Section 7.1, Pg. 45 – 46; Consultant Report #12, Section 6.1, Pages 34 – 39, Table 6.1-4; Agency's Request for Additional Information, March 21, 2016 - AIR #43.

Preamble:

The Guidelines require an assessment on human health, considering, but not limited to, potential changes in air quality, quality and availability of country foods, drinking water quality, and noise exposure. When risks to human health are predicted from one or more of these components, a complete Human Health Risk Assessment (HHRA), examining all exposure pathways for pollutants of concern, may be necessary to adequately characterize the potential risk to human health.

The HHRA notes three exceedances of PM10 for acute inhalation risk where the hazard quotient (HQ) exceeds 1 at R6, R8, and R14. However, the assessment dismisses the potential risk on human health from these exceedances: (1) the concentrations are primarily due to existing baseline conditions; (2) the Project's contribution to the predicted maximum concentrations are less than 10% of baseline values; and (3) the conservative assumption built into the toxicity reference value.

Health-based guidelines are based on human (and animal) toxicity studies and are intended to be protective of human health, whereas screening substances out from further assessment from the HHRA based on <10% increase from baseline has no human toxicological basis. All substances that exceed their applicable regulatory criteria/guideline value should be further evaluated in the HHRA irrespective of the percentage change in concentrations from Base Case.

Information Required:

All substances that currently exceed or that are predicted in the future to exceed an applicable health-based guideline value should be further evaluated in the HHRA, irrespective of whether the predicted increase is expected to be more or less than 10% from the Base Case.

Response:

The results of air dispersion modelling predicted exposures which exceeded human health toxicological reference values (TRVs) for the following contaminants of potential concern (COPCs):

- NO_2 (acute inhalation and chronic inhalation), at the maximum point of impingement (MPOI) only and R8 (Blairmore North);

- $PM_{2.5}$ (acute inhalation and chronic inhalation), at the MPOI only; and
- PM_{10} (acute inhalation and chronic inhalation) at the MPOI and R6, R8, and R14 (Coleman, Blairmore North, and Blairmore Centre).

The majority of the exceedances were predicted to occur at the MPOI located within the Mine Permit Boundary. A summary of the potential significance of these exceedances to human health was included in Consultant Report (CR) #12, Table 6.4-1.

In the Human Health Risk Assessment (HHRA), an additional level of assessment was conducted for all exceedances which included investigation of the assumptions made in the exposure and hazard assessment steps of the HHRA. It was determined that exceedances predicted at the MPOI all occurred within the Mine Permit Boundary, an area which will be inaccessible to the general public during construction and operation of the Project; therefore, exceedances predicted at the MPOI were determined not to pose a potential risk of adverse health effects for the general public.

Regarding the NO_2, a hazard quotient (HQ) slightly greater than 1.0 (HQ = of 1.1) was predicted at R8. This exceedance was determined to be due to existing baseline concentrations of NO_2, with predicted concentrations from project emissions (1.58 µg/m^3) being less than 5% of baseline values (42.6 µg/m^3). As the resulting concentration of NO_2 was only slightly higher than 1.0 it is not indicative of a potential risk of adverse human health risks.

Potential adverse health effects of exposure to NO_2 include respiratory symptoms, correlation with increased emergency department visits and hospital admissions, increased airway reactivity and bronchial response in asthmatics, irritation, and respiratory illness (CR #12, Appendix B, Section 28.0). Adverse respiratory effects from exposure to elevated concentrations of NO_2 are most likely to occur in individuals with pre-existing pulmonary dysfunction (United States Environmental Protection Agency [U.S. EPA] 2008).

The applied TRV for chronic exposure to NO_2 is based on evidence of a 20% increase in respiratory illness in primary children with an increase of 28 µg/m^3 nitrogen dioxide indoors (averaged over 1 year) (World Health Organization [WHO] 1997). The WHO value was determined using similar background concentrations (15 µg/m^3) as predicted annually for R8 (18 µg/m^3). That said, the U.S. EPA (2012) annual standard of 100 µg/m^3 is based on comprehensive epidemiological evidence of adverse health risks linked with exposure to NO_2 in an outdoor exposure scenario; a concentration greater than any predicted to occur at R8. While increases in NO_2 concentrations are correlated with adverse respiratory health effects, the baseline NO_2 concentrations are well below the U.S. EPA health-based standard of 100 µg/m^3, and the magnitude of NO_2 increases due to the Project contribution of 0.14 µg/m^3 would not be distinguishable from fluctuations in outdoor background concentration. NO_2 emissions from the Project are not expected to significantly impact human health in the study area.

In response to the initial PM_{10} results at R6, R8 and R14, the HHRA include more detailed assessment in order to determine whether there was a potential risk for adverse health effects, or whether the risk results were the result of conservative assumptions used in the HHRA. Thus the

inputs of the PM_{10} assessment were reviewed in even greater detail and additional health risk assessment included:

- evaluation of the hazard assumptions made in the HHRA in the derivation of the TRV (CR #12, Appendix B, Section 30.0), and
- a time-series assessment of PM_{10} contribution throughout the year in order to determine the proportion Project PM_{10} emission predicted to occur (CR #12, Section 6.1, Table 6.1-4; CR #12, Appendix C, Table C4; and CR #12, Section 6.2, Table 6.2-5).

Based on the detailed review of potential PM_{10} exceedances, the following observations were noted and used to support the conclusion that emissions of PM_{10} from the Project posed no significant risk to human health outside of the Project Footprint:

- for exceedances at R6, R8 and R14, the predicted HQs did not exceed 1.3 (CR #12, Section 6.1, Table 6.1-4 and CR #12, Section 6.2, Table 6.2-5) and the same HQ was predicted for the Baseline Case and Application Case indicating the Project contribution to the predicted risk was negligible;
- the time series analysis of the predicted 24 hour maximum concentrations of PM_{10} for everyday of the five years modelled in the air dispersion assessment was completed for the Application Case, a total of four PM_{10} exceedances over five years were predicted (CR #12, Appendix C, Table C4); indicating that there is a potential risk of exposures exceeding the TRV on average only 0.8 days per year;
- the risk results of the $PM_{2.5}$ assessments (acute and chronic) were all below the TRV at R6, R8 and R14. Assessment of $PM_{2.5}$ toxicology is a better indicator of potential adverse health effects associated with exposure to particulate matter and. The U.S. EPA (2012) has revoked the annual standard for PM_{10} because available evidence generally did not suggest a link between long-term exposure to current ambient levels of coarse particles and health effects (U.S. EPA 2010). The TRV for PM_{10} is based on associated exposure to $PM_{2.5}$ (World Health Organization [WHO] 2005). It is derived as the 99^{th} percentile of the distribution of daily concentrations over a year for $PM_{2.5}$;
- the TRV for PM_{10} (CR #12, Appendix B, Section 30.0) is based on $PM_{2.5}$ toxicity that assumes a $PM_{2.5}$:PM_{10} ratio of 0.5, with a recommendation to adjusting the PM ratio to reflect local conditions when data is available (WHO 2005). The applied PM ratio of 0.5 is conservative when compared to the current Project, which had a predicted average $PM_{2.5}$:PM_{10} ratio of 0.25 with a maximum value of 0.37 for the Application case; and
- the majority of predicted chronic PM_{10} exceedances in Coleman and Blairmore were not related to Project activities. The Project contribution to PM_{10} concentrations ranged from 0.0% to 7.6% in Blairmore and 0.0% to 6.1% in Coleman, with the average Project contribution at Coleman being 1.6%, and Blairmore being 1.5%. As demonstrated by the timeseries assessment, the maximum concentrations were predicted to occur infrequently (four times over five years).

While predicted concentrations of contaminants of concern (COC) exceed applicable TRVs, these exceedances are either: within the Project boundary, primarily related to existing background conditions, or extremely infrequent, or not directly associated with adverse health

outcomes based on more relevant measurements of $PM_{2.5}$. As such the existing mitigation measures to limit access of the general public to the Project Footprint, where TRV exceedances are predicted to occur, are considered to be sufficient mitigating measures for the protection of the general public.

18. ABORIGINAL FOOD CONSUMPTION

Reference: EIS Guidelines, Section 6.1.8 & Section 6.3.4; Consultant report #12; Section 5.1.3.2, Pg. 13-14, Table 5.1.3-2; Kickoff meeting notes, December 2-3, 2015; Consultant Report#12, Section 5.1.3.2, pages 18-20; Agency's Request for Additional Information, March 21, 2016 - AIR #44.

Preamble:

In the HHRA, Indigenous food consumption patterns were taken from literature. Both waterfowl and fish were included in the country foods consumption portion of the HHRA. However, it was revealed during the Kickoff meeting presentation (December 2-3, 2015) that Indigenous groups in the region of the proposed Project avoid waterfowl and fish, as those country foods are believed to be contaminated. According to Health Canada, there appears to be uncertainty as to regional country foods consumption patterns.

Benga Mining states that dietary composition was based on data on Indigenous food consumption patterns from Health Canada (2010a, b) and Wein *et al*. (1990)[5]. This consumption rate may not be representative of local Indigenous Peoples consumption rates. The First Nations Food Nutrition and Environment Study (FNFNES) should be consulted (in addition to any other dietary surveys or consumption studies for local Indigenous Peoples) in order to more accurately determine local consumption rates/patterns and those values should be used in screening equations to determine the COPCs to be evaluated in the HHRA. In addition, using consumption rates from Health Canada (2010a,b) does not take into consideration the potential for very high rates of consumption for short periods of time, such as during a weekend fishing trip or a ceremonial event.

Given that consumption rates were derived using the Health Canada (2010a, b) and Wein *et al*. (1990) ingestion rates and not more site-specific values, this may result in an underestimation of potential health risk and the screening out of substances which could be relevant from a human health perspective. HC recommends using the First Nations Food Nutrition and Environment Study[6].

[5] Wein, E., J.H. Sabry and F.T Evers. 1990. Food consumption patterns and use of country foods by Native Canadians near Wood Buffalo National Park, Canada. Arctic 44(3): 196-205.
[6] http://www.fnfnes.ca/

Information Required:

Provide more site-specific consumption patterns (including factors such as seasonality of exposure) when evaluating acceptable contaminant concentrations in country foods which are more representative of actual consumption rates/patterns for local Indigenous people.

Response:

The First Nations Food Nutrition and Environment Studies (FNFNES) from Alberta and British Columbia, referenced in the preamble, was reviewed in order to determine if additional data were available on traditional food consumption patterns which would better represent the local Indigenous Peoples in the Project area.

The Alberta FNFNES report (2016) was released in June 2016, after the original Project submission and therefore was not available for consideration during the original assessment. However, in response to the Additional Information Request, the report was reviewed in order to determine whether more accurate food consumption assumptions could be applied in the current Human Health Risk Assessment (HHRA).

No First Nations communities near the proposed Project area were included in the study (FNFNES 2016, Table 1 and 2, Figure 1); additionally, the FNFNES program did not complete sampling at any Indigenous communities in southeastern British Columbia which could potentially be in close proximity to the Project location. The closest communities to the Project included in the FNFNES study are the Wesley First Nation and Chiniki First Nation, both located within the Boreal Plains ecozone. These communities are farther than 100 km from the Project Study Area. Data for individual communities were not provided in the FNFNES report; however, the Boreal Plains ecozone borders the Montane Cordillera ecozone, where the Project is located, and was considered the most applicable dataset from the FNFNES report.

In order to determine if the traditional food consumption rates applied in the HHRA would be protective of actual First Nations communities, the exposure characteristics applied in the multimedia exposure model were compared with the mean and 95th percentile consumption rates reported in the FNFNES study. These FNFNES values are intended to represent average and heavy consumers in First Nations communities.

The consumption rates from FNFNES and the Health Canada consumption rates applied in the HHRA (Consultant Report (CR) #12, Section 5.1.3.2, Table 5.1.3-2) are compared in Table 18-1. The FNFNES values were based only on the highest recorded rates among adults (age 19-50 or 50+) which regularly consumed traditional foods. Individuals from these communities which did not regularly consume traditional foods were not included in calculating the FNFNES values. The FNFNES study does not provide any insight into seasonal variability of food consumption rates, and only daily average consumption rates are available.

Table 18-1 Consumption Rate Comparison (g/d)			
Parameter	**FNFNES (2016) Boreal Ecozone**	**FNFNES (2016) Overall mean (95th percentile)**	**Health Canada (2010)**
Traditional food (total)	34.2 (156.0)	61.2 (248.9)	844
Fish	7.8 (39.7)	14.4 (54.3)	220
Meat	36.4 (207.3)	57.2 (257.9)	270
Berries and Plants	5.1 (19.5)	18.5 (65.6)	354

In all cases the Health Canada recommended values applied in the HHRA were considerably higher and therefore more conservative than the FNFNES data.

Although the FNFNES data are a newer source of traditional food consumption rates than the Health Canada recommended values, the latter provide a more conservative estimate of potential exposure. The FNFNES values are based on studies of small populations (603 individuals total, 375 in Boreal Plains) and 24-hour dietary recall, and while they are a more applicable tool for determining how local populations utilize traditional food resources, consumption rates of traditional food can vary widely between individuals within a community.

The use of more conservative consumption rates, such as the values applied in the HHRA, is necessary in order to ensure that persons heavily consuming traditional foods, or fish or game, are considered in the HHRA. As a HHRA is intended to be protective of sensitive individuals and not populations, this approach was applied in the original application.

As such, it is believed that the Health Canada recommended values area conservative representation of potential local food consumption patterns and are protective of all individuals in the First Nations communities near the Project. It is important to note, that risk results of the HHRA, assuming the more conservative exposure estimates, were all below 1.0 and application of lower consumption rates would produce even lower risk results.

19. HUMAN HEALTH EFFECTS FROM LEACHATE

Reference: EIS Guidelines, Section 6.3.4; Consultation Report #12, Section 5.1., Pg. 7; Agency's Request for Additional Information, March 21, 2016 - AIR #45.

Preamble:

The HHRA states that the only COPCs identified are from air emissions, as project activities will not release chemicals directly into groundwater or surface water. However, ingestion of surface water and contact with surface water was still included in the assessment with the assumption that deposition of contaminants from the air would occur. The EIA did not discuss the potential for the leaching of metals and other contaminants from the raw coal stockpiles to potentially affect groundwater or surface water sources or the resulting potential impacts to human health.

The purpose of the HHRA is to assess the risk of adverse human health effects. While Health Canada appreciates that the project is unlikely to cause emission to water, there remains a potential risk to human health from this source.

Information Required:

Discuss the potential for leachate from storage areas (stockpile and disposal areas) to affect groundwater and surface water, and the potential impacts on human health.

Response:

Implementation of the mitigation measures proposed for the Project will prevent potential human exposure to leaching of metals and other contaminants from the raw coal stockpiles via groundwater or surface water. Therefore, the only operative of exposure to chemical of potential concern from Project activities is from emission to air. As per Health Canada Human Health Risk Assessment guidance, if there is no operative exposure pathway, there is no potential risk of adverse health impacts and additional risk characterization is not indicated.

The mitigation measures proposed to ensure groundwater and surface water are not affected by leachate from the storage areas are summarized below.

The water management strategy for the Project is described in Section C.5. The water management strategy 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. The planned water management infrastructure is shown in Section C, Figure C.5.3-5.

Water collected in the various mine pit phases will be pumped to sedimentation ponds for treatment and discharge. Water seeping from waste rock (placed in-pit or ex-pit) will either percolate naturally or be actively managed to pass through the saturated zones. A detailed discussion of the Project's water treatment objectives is provided in Section C.5.3.

The Project's water management strategy aimed to ensure the majority of the water quality (surface and groundwater) impacts were mitigated through the Projects design. All surface runoff and leachate from the three rock disposal areas will be collected by interceptor ditches and groundwater dewatering wells and sent to surge ponds for temporary storage (northwest surge pond, southeast surge pond, and the raw water pond). The capture efficiency of these features was expected to be 95%. A full description of the seepage minimization and capture process is included in Appendix 10, Appendix 10C, Section 3.2 and Appendix 10, Appendix 10C, Section 4.2.

The hydrogeology and surface water quality assessments have taken these design features in account. Potential impacts and additional mitigations for each are summarized in Section E.3, and Section E.5.

In addition to the aforementioned sections, Benga also provided an additional water quality management report in Appendix 10, Appendix 10C. The intent of the water quality management

report was to develop mitigation concepts to a level appropriate for environmental effects assessment. Site-specific tests, field investigations, ongoing monitoring, and engineering assessments will be conducted to further refine the required performance of the proposed measures.

20. NOISE IMPACT

Reference: EIS Guidelines, Section 6.3.4; Consultant Report #2, Section 2.2, Pg. 2; Section 3.3, Pg. 7; Section 4.2 Page 8; Section 5.4.2, page 28; Agency's Request for Additional Information, March 21, 2016 - AIR #46.

Preamble:

The Guidelines require an assessment of the indirect effects of the Project, such as avoidance of the area by Indigenous people due to increased disturbance (*e.g.*, noise, presence of workers). The Guidelines also require a description and analysis of how changes to the environment caused by the Project will affect human health, considering, but not limited to, potential changes in air quality, quality and availability of country foods, drinking water quality, and noise exposure.

The EIA also indicates that for mining operations, rock above the coal will be drilled and/or blasted, then excavated and hauled to either in-pit or ex-pit waste rock disposal locations. Although the EIA provides mitigation for blasting noise and vibration, it is unclear if the contribution of blasting noise was assessed.

High annoyance has been widely used as one way to estimate a community response to noise levels. High annoyance is an endpoint that is not directly measured but has been synthesized from self-reported annoyance in numerous large, community-based surveys. Although individual reaction varies greatly, the reported change in percent highly annoyed (%HA) among an average community in reaction to certain sound levels provides usable exposure-response relationships. Thus, the calculated %HA provides information on how an average community responds to a noise level.

A 55 dBA may result in interference with speech, particularly in outdoor areas and on-land during ceremonial or recreational activities.

Information Required:

a. Provide a discussion on the expected frequency of use and any regularly observed events taking place at these locations (*i.e.*, known high use rates at specific times of the year, annual community events, and ceremonial uses at specific times of the year, fishing frequency etc.).

Response:

A summary of the expected frequency of use and regularly observed events that take place in the area by Aboriginal Groups and recreational users is provided below.

Aboriginal Ceremonial Use

The Project's Mine Permit Boundary is located within eleven Aboriginal groups' traditional lands (Table 20-1). Based on information provided through continuous and on-going Aboriginal consultation for the Project, historical and current access to the area was identified by seven (7) Aboriginal groups for the purposes of hunting, plant gathering, trapping, fishing, use of trails and travelways, and for physical and cultural heritage (Table 20-1).

Traditional use studies (Appendix 7, Appendix 7b) identify sites that are located fully or partially within the Mine Permit Boundary and that are currently accessed throughout the year. More specifically, the Kainai, Piikani, and Tsuu T'ina Nations identify that plant gathering activities typically take place in the spring (*i.e.*, June).

Further information regarding seasonality, frequency of use, location of use, or receptor sites has been requested by Benga, but at the time of this response, has not yet been provided by the various Aboriginal groups. Benga is working on an Access Management Plan with each Aboriginal group that is specific to their access and use requirements. To help facilitate the access discussions, a conceptual Access Management Plan was included in Appendix 7, Appendix 7d(i). Information shared with Benga during the pre-construction period will be considered in the Access Management Plan for each Aboriginal group, which will allow for the continuation of traditional use activities in areas not impacted by physical disturbance.

Table 20-1 Traditional Use in the Project Area

Aboriginal Groups	Current Use in the Project Area					
	Hunting	Plant Harvesting	Trapping	Fishing	Trails and Travelways	Physical and Cultural Heritage Sites
Kainai Nation	✓	✓	-	✓	-	✓
Piikani Nation	✓	✓	✓		✓	✓
Siksika Nation	✓	✓	-	✓	-	✓
Stoney Nakoda Nation	✓	✓	-	✓	-	✓
Tsuu T'ina Nation	✓	✓	-	-	-	✓
Samson Cree First Nation	✓	✓	✓	✓	✓	-
Métis Nation of Alberta	✓	✓	-	✓	-	-
Ktunaxa Nation	-	-	-	-	-	-
Foothills Ojibway First Nation	-	-	-	-	-	-
Métis Nation of British Columbia	-	-	-	-	-	-

Table 20-1 Traditional Use in the Project Area						
Aboriginal Groups	**Current Use in the Project Area**					
	Hunting	**Plant Harvesting**	**Trapping**	**Fishing**	**Trails and Travelways**	**Physical and Cultural Heritage Sites**
Shuswap Indian Band	-	-	-	-	-	-

Recreational Use

Community Events

Community events that are held in Blairmore and Coleman are expected to occur throughout the year. These events currently contend with the existing noise levels resulting from Highway 3 and the Canadian Pacific Rail line. Based on the Noise Impact Assessment (NIA) Summary (Consultant Report (CR) #2b), existing noise levels are expected to increase slightly at each receptor in the Coleman and Blairmore areas when the rail alignment and loadout are operational. However, the predicted nighttime and daytime noise increases are considered to be minimal for most of the receptors in these areas (*i.e.*, less than 2.0 dBA). The maximum nighttime and daytime increases were predicted to be +4.1 dBA and +2.5 dBA, respectively. According to the guidance provided in Alberta Energy Regulator (AER) *Directive 038*, it is 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. Therefore, all increases in noise levels during operations of the Project are considered to be within acceptable limits and will not affect community events held in Blairmore and Coleman.

As indicated in the change in percent highly annoyed (%HA) results table provided in IR #20c (Table 20-2), the change in %HA is minimal at any one residential receptor. The maximum change in %HA is 0.7%. Therefore, the impact associated with Project-related noise is minimal and is not expected to impact community events held in the Blairmore and Coleman areas.

Day Use Activities

Once an approval is provided for the Project's Integrated Application, the area within the Mine Permit Boundary will be privately owned or held under lease by Benga; consequently, any day use that might occur in the surrounding area, including hiking, angling, hunting, and mountain biking, would occur outside of the Project boundaries. It is expected that day use users might frequent the area throughout the spring, summer and fall months and to some extent, during the winter months.

The NIA (CR #2) determined that noise levels will increase slightly above baseline conditions during operations of the Project; however, they will remain below the daytime and nighttime permissible sound levels. Residential and theoretical receptors within 1,500 m from the Mine

Permit Boundary were included in the assessment. The modelling conducted for the NIA also concluded that Project-related noise would further attenuate to lower levels outside of the 1,500 m assessment boundary. Based on this, Project-related noise levels are not expected to impact day use activities outside of the Mine Permit Boundary.

As indicated in the change in %HA results tables provided in IR #20c, the change in %HA is minimal at any one residential receptor or theoretical 1,500 m receptor. The maximum change in %HA is 0.7%. Again, any potential impact associated with Project-related noise is expected to be minimal and is not expected to impact day use activities in the area.

All-Terrain Vehicle and Snowmobile Trail Use

The area is also used by recreational off-road vehicle users including the Crowsnest Pass Quad Squad and the Crow Snow Riders Snowmobile Club. However, ATV activity in the area is considered to be a greater noise nuisance than the Project for any nearby receptors. ATV and snowmobile users will not hear any Project-related noise over the sound levels of the ATV and snowmobile engines. Therefore, Project-related noise is not expected to have an effect on ATV and snowmobile users in the area.

Crowsnest Pass Golf and Country Club

The Crowsnest Pass Golf and Country Club (CPGCC) is located on the southern end of the proposed Project, near the rail alignment and loadout components. A golf course is considered to be a business and is not considered to be a residential receptor that would be assessed as part of a noise assessment. Therefore, the CPGCC was not assessed further in the NIA.

b. Identify any additional noise mitigation measures that will be implemented to protect the expected peace and quiet of any such events or activities identified.

Response:

Refer to IR #20c. Section 6.0 of the Health Canada Useful Information for Environmental Assessments document suggests that mitigation be provided if a change in %HA is 6.5% or greater (Health Canada 2010). Therefore, in accordance with the Health Canada criteria, if the change in %HA value is less than 6.5%, then no additional mitigation is required. As indicated in the change in %HA results tables provided in IR #20c, the maximum change in %HA is 0.7%, which is well below the Health Canada criteria. Therefore, in accordance with the Health Canada criteria, the impact is minimal. However, the NIA modelling results indicate the possibility of a low frequency tonal noise. Assessment of low frequency tonal noise would require noise monitoring during normal operations of the Project. If Benga receives a low frequency noise complaint during operations of the Project, a comprehensive sound level (CSL) survey will be conducted in accordance with the requirements of the AER *Directive 038* and a noise monitoring plan would be implemented to mitigate the effect.

Mitigation measures relating to the effects of noise are outlined in Section E.2.5. With the implementation of the proposed mitigation measures, it was determined that the effects of noise

as a result of the Project was rated not significant. Based on this, no further mitigations for potential noise impacts as a result of the Project are provided at this time.

In regard to Aboriginal Groups, Benga will prepare an Aboriginal Group Access Plan and is willing to plan blasting activities around certain times of the year to avoid conflicts with First Nations who would like to visit the mine, or participate in an annual ceremony, plant harvesting, hunting, fishing, trapping or any other identified traditional land and resource use event or activity to protect the expected peace and quiet of such events. During construction and operations of the Project, sensory disturbances may result in wildlife avoiding the area. Sensory disturbance effects to wildlife associated with Project related noise during development is discussed in CR #9, Sections 3.1.1, 5.0 and 6.0 and in Section E.9.

Benga will also participate in a community notification program to ensure that local residents, including the golf course and other recreational users of the area, are kept informed of blasting days and times. As stated in Section E.2.5, blasting will only occur on weekdays during typical day time hours and will be limited to smaller, more localized blasts to reduce the amount of explosives used at any one time. Subsequently, events and recreational activities that occur on weekends will not be affected by blasting activities.

c. Provide an assessment of the project's impacts of noise using the change in %HA for potentially impacted Indigenous communities.

Response:

Noise associated with operation of the Project is considered long-term, and a NIA was conducted to determine the effects of the Project relative to baseline sound levels during operations (CR #2). There are no industrial noise sources within the study area that would contribute to noise impact. Baseline sound levels include traffic along Highway 3 as well as the Canadian Pacific Rail line. During operations, it was determined that noise levels will increase slightly above baseline conditions but the noise will be below the daytime and nighttime permissible sound levels as specified in AER *Directive 038* for all residential and theoretical 1,500 m receptors (CR #2). The assessment of overall noise effects covered various operational stages (Years 1, 6, and 18) as well as all residential and theoretical receptors within 1,500 m from the Mine Permit Boundary, including any located within Blairmore or Coleman, Alberta. Outside of that 1,500 m radius, the noise from the Project will further attenuate to lower levels. Overall, the increase in noise levels was rated not significant.

In addition to the above, an assessment was completed to evaluate the change in the percentage of the population who may become highly annoyed. Tables 20-2 and 20-3 summarize the change in percent high annoyance for residential receptors and theoretical 1,500 m receptors, respectively. Health Canada suggests that "*mitigation be proposed if the predicted change in %HA at a specific receptor is greater than 6.5% between project and baseline noise environments, or when the project-related noise is in excess of 75 dB*" (Health Canada 2010). Based on the assessment, the change in %HA at any one residential receptor or theoretical 1,500 m receptor associated with the Project is minimal. The maximum change in %HA is 0.7%,

which is well below the Health Canada criteria. Therefore, in accordance with the Health Canada criteria, the impact is minimal and no additional mitigation is required.

Table 20-2 Summary of the Change in Percent Highly Annoyed (%HA) for Residential Receptors

Receptor (Distance From Mine Permit Boundary)	Baseline LDN (dBA)	Baseline %HA	Maximum Project LDN (dBA)	Project + Baseline LDN (dBA)	Project + Baseline %HA	Change in %HA
Res-301 (200 m)	45.0*	0.8	44.1	47.6	1.1	0.3
Res-302 (130 m)	45.0*	0.8	44.6	47.8	1.2	0.4
R-001 (1,025 m)	37.7	0.3	38.7	41.3	0.5	0.2
R-002 (950 m)	38.2	0.3	39.2	41.7	0.5	0.2
R-003 (1,000 m)	38.9	0.3	38.4	41.7	0.5	0.2
R-004 (1,025 m)	39.4	0.4	38.4	42.0	0.5	0.2
R-005 (1,035 m)	40.1	0.4	38.5	42.4	0.6	0.2
R-006 (890 m)	45.6	0.9	39.1	46.5	1.0	0.1
R-007 (990 m)	47.2	1.1	35.7	47.5	1.1	0.0
R-008 (950 m)	47.2	1.1	35.4	47.5	1.1	0.0
R-009 (840 m)	49.5	1.5	36.9	49.8	1.5	0.0
R-010 (610 m)	56.4	3.8	38.3	56.5	3.9	0.0
R-011 (440 m)	56.1	3.6	38.3	56.2	3.7	0.0
R-012 (350 m)	53.2	2.5	39.4	53.4	2.5	0.1
R-013 (660 m)	60.6	6.6	38.4	60.6	6.6	0.0
R-014 (480 m)	59.3	5.6	39.0	59.3	5.6	0.0
R-015 (550 m)	51.7	2.0	39.7	52.0	2.1	0.1
R-016 (1,090 m)	48.0	1.2	38.2	48.4	1.3	0.1
R-017 (925 m)	48.0	1.2	38.9	48.5	1.3	0.1
R-018 (750 m)	47.9	1.2	38.7	48.4	1.3	0.1
R-019 (1,050 m)	45.0	0.8	38.0	45.8	0.9	0.1
R-020 (1,090 m)	44.7	0.8	38.3	45.6	0.9	0.1
R-021 (890 m)	46.9	1.0	38.9	47.5	1.1	0.1
R-022 (960 m)	46.6	1.0	39.5	47.4	1.1	0.1
R-023 (840 m)	47.4	1.1	44.3	49.2	1.4	0.3
R-024 (820 m)	48.7	1.3	45.7	50.5	1.7	0.4
R-025 (870 m)	47.0	1.0	45.7	49.4	1.5	0.4

Table 20-2	Summary of the Change in Percent Highly Annoyed (%HA) for Residential Receptors					
Receptor (Distance From Mine Permit Boundary)	**Baseline LDN (dBA)**	**Baseline %HA**	**Maximum Project LDN (dBA)**	**Project + Baseline LDN (dBA)**	**Project + Baseline %HA**	**Change in %HA**
R-026 (1,010 m)	46.1	0.9	45.1	48.7	1.3	0.4
R-027 (1,100 m)	46.4	1.0	45.2	48.9	1.4	0.4
R-028 (940 m)	48.1	1.2	45.3	49.9	1.6	0.4
R-029 (980 m)	47.8	1.2	46.2	50.1	1.6	0.4
R-030 (1,110 m)	43.9	0.7	44.5	47.2	1.1	0.4
R-031 (1,190 m)	42.6	0.6	43.9	46.3	0.9	0.4
R-032 (530 m)	55.8	3.5	48.7	56.5	3.9	0.4
R-033 (600 m)	54.9	3.1	48.5	55.8	3.5	0.4
R-034 (600 m)	55.9	3.6	48.9	56.7	4.0	0.4
R-035 (670 m)	53.9	2.7	48.4	55.0	3.1	0.4
R-036 (570 m)	59.9	6.0	49.5	60.3	6.3	0.3
R-037 (720 m)	54.8	3.1	48.7	55.8	3.5	0.4
R-038 (640 m)	59.5	5.7	49.4	59.9	6.0	0.3
R-039 (380 m)	55.8	3.5	48.7	56.6	3.9	0.4
R-040 (370 m)	55.4	3.3	50.6	56.7	3.9	0.6
R-041 (370 m)	55.2	3.2	50.9	56.5	3.9	0.7
R-042 (370 m)	55.1	3.2	51.0	56.5	3.8	0.7
R-043 (370 m)	55.1	3.2	51.1	56.5	3.9	0.7
R-044 (360 m)	55.1	3.2	51.0	56.5	3.8	0.7
R-045 (350 m)	55.0	3.1	50.9	56.4	3.8	0.7
R-046 (340 m)	55.1	3.2	50.9	56.5	3.8	0.7
R-047 (380 m)	55.7	3.4	51.0	56.9	4.1	0.6
R-048 (360 m)	55.7	3.4	50.6	56.8	4.0	0.6
R-049 (350 m)	55.8	3.5	49.9	56.8	4.0	0.5
R-050 (330 m)	55.7	3.4	49.5	56.6	3.9	0.5
R-051 (280 m)	55.2	3.2	48.0	55.9	3.6	0.3
R-052 (270 m)	55.2	3.2	46.8	55.8	3.5	0.3
R-053 (260 m)	55.2	3.2	45.4	55.7	3.4	0.2
R-054 (250 m)	55.3	3.2	44.5	55.6	3.4	0.2

Table 20-2 Summary of the Change in Percent Highly Annoyed (%HA) for Residential Receptors

Receptor (Distance From Mine Permit Boundary)	Baseline LDN (dBA)	Baseline %HA	Maximum Project LDN (dBA)	Project + Baseline LDN (dBA)	Project + Baseline %HA	Change in %HA
R-055 (240 m)	55.3	3.3	43.9	55.6	3.4	0.1
R-056 (300 m)	56.5	3.9	44.9	56.8	4.0	0.2
R-057 (250 m)	56.3	3.7	42.3	56.5	3.8	0.1
R-058 (210 m)	56.0	3.6	42.0	56.2	3.7	0.1
R-059 (110 m)	56.0	3.6	41.9	56.2	3.7	0.1
R-060 (80 m)	57.6	4.5	41.5	57.7	4.5	0.1
R-061 (110 m)	56.9	4.1	41.5	57.1	4.1	0.1
R-062 (90 m)	58.6	5.1	41.4	58.7	5.2	0.1
R-063 (90 m)	59.4	5.6	41.2	59.4	5.7	0.0
R-064 (170 m)	56.2	3.7	41.3	56.3	3.8	0.1
R-065 (170 m)	56.3	3.8	41.0	56.5	3.8	0.1
R-066 (130 m)	57.4	4.3	40.9	57.5	4.4	0.1
R-067 (130 m)	58.6	5.1	40.6	58.6	5.1	0.0

Note: Baseline values for first two receptors (denoted with an '*') assumed as per the AER Directive 038.

Table 20-3 Summary of the Change in Percent Highly Annoyed (%HA) for Theoretical 1,500 m Receptors

Receptor (1,500 m From Mine Permit Boundary)	Baseline LDN (dBA)	Baseline %HA	Maximum Project LDN (dBA)	Project + Baseline LDN (dBA)	Project + Baseline %HA	Change in %HA
R-01	45.0	0.8	33.8	45.3	0.8	0.0
R-02	45.0	0.8	33.1	45.3	0.8	0.0
R-03	45.0	0.8	40.7	46.4	1.0	0.2
R-04	45.0	0.8	38.2	45.8	0.9	0.1
R-05	45.0	0.8	32.0	45.2	0.8	0.0
R-06	45.0	0.8	38.2	45.8	0.9	0.1
R-07	45.0	0.8	21.2	45.0	0.8	0.0
R-08	45.0	0.8	24.2	45.0	0.8	0.0

Table 20-3 Summary of the Change in Percent Highly Annoyed (%HA) for Theoretical 1,500 m Receptors

Receptor (1,500 m From Mine Permit Boundary)	Baseline LDN (dBA)	Baseline %HA	Maximum Project LDN (dBA)	Project + Baseline LDN (dBA)	Project + Baseline %HA	Change in %HA
R-09	45.0	0.8	30.4	45.1	0.8	0.0
R-10	45.0	0.8	37.6	45.7	0.9	0.1
R-11	45.0	0.8	36.6	45.6	0.9	0.1
R-12	45.0	0.8	36.2	45.5	0.9	0.1
R-13	45.0	0.8	29.1	45.1	0.8	0.0
R-14	45.0	0.8	33.4	45.3	0.8	0.0
R-15	45.0	0.8	29.7	45.1	0.8	0.0
R-16	45.0	0.8	28.2	45.1	0.8	0.0
R-17	45.0	0.8	30.0	45.1	0.8	0.0
R-18	45.0	0.8	34.6	45.4	0.8	0.0
R-19	45.0	0.8	26.8	45.1	0.8	0.0
R-20	45.0	0.8	41.2	46.5	1.0	0.2
R-21	45.0	0.8	41.6	46.6	1.0	0.2
R-22	45.0	0.8	36.8	45.6	0.9	0.1
R-23	45.0	0.8	39.1	46.0	0.9	0.1
R-24	45.0	0.8	43.6	47.4	1.1	0.3
R-25	45.0	0.8	38.5	45.9	0.9	0.1
R-26	45.0	0.8	37.9	45.8	0.9	0.1
R-27	45.0	0.8	36.5	45.6	0.9	0.1
R-28	45.0	0.8	36.4	45.6	0.9	0.1
R-29	45.0	0.8	36.9	45.6	0.9	0.1
R-30	45.0	0.8	38.8	45.9	0.9	0.1
R-31	45.0	0.8	39.0	46.0	0.9	0.1
R-32	45.0	0.8	32.0	45.2	0.8	0.0
R-33	45.0	0.8	28.5	45.1	0.8	0.0
R-34	45.0	0.8	32.9	45.3	0.8	0.0
R-35	45.0	0.8	37.9	45.8	0.9	0.1
R-36	45.0	0.8	40.5	46.3	0.9	0.2
R-37	45.0	0.8	38.2	45.8	0.9	0.1

Table 20-3 Summary of the Change in Percent Highly Annoyed (%HA) for Theoretical 1,500 m Receptors						
Receptor (1,500 m From Mine Permit Boundary)	**Baseline LDN (dBA)**	**Baseline %HA**	**Maximum Project LDN (dBA)**	**Project + Baseline LDN (dBA)**	**Project + Baseline %HA**	**Change in %HA**
R-38	45.0	0.8	37.4	45.7	0.9	0.1
R-39	45.0	0.8	37.3	45.7	0.9	0.1
R-40	45.0	0.8	35.4	45.5	0.8	0.1
R-41	45.0	0.8	38.3	45.8	0.9	0.1
R-42	45.0	0.8	34.4	45.4	0.8	0.0
R-43	45.0	0.8	34.6	45.4	0.8	0.0

Note: Baseline value for all theoretical 1,500 m receptors assumed as per the AER Directive 038.

PROJECT OVERVIEW

21. SCHEDULING DETAILS

Reference: EIS Guidelines, Section 1.2; EIA, Table A.6.5-1, Section C, pg. C-74; Agency Request for Additional Information, January 13, 2016 - AIR #1

Preamble:

The Guidelines require Benga Mining to describe the Project's key components and associated activities, scheduling details, the timing of each phase of the Project, and other key features. However, the EIA does not provide details on the time of year, frequency or duration for all Project activities during the construction and operation phases.

Table A.6.6-1 provides a breakdown of the Project timelines, and indicates that site construction is to begin in mid-2017. However, the schedule lacks details on the timing of some major mine components such as transmission line installation, progressive mining from the south to the north, progressive backfilling the mined out portion of the pit, progressive reclamation and, construction of camp infrastructure.

Information Required:

Provide a schedule of the Project construction and operation activities, including, at a minimum, the time of year, frequency and duration of the activities. Update Table A.6.6-1 based on the Project's current projected timelines and provide a description of the key Project phases in which the development of each project component is to occur.

Response:

An updated schedule has been provided in Figure 21-1.

SIGNIFICANCE OF PROJECT EFFECTS

22. SIGNIFICANCE DETERMINATION

Reference: EIS Guidelines, Section 6.5; Section D.2.5.3, Table D.2.5-2; Agency's Request for Additional Information, January 13, 2016 - AIR #12 & AIR #17.

Preamble:

The Guidelines require Benga Mining to identify the criteria used to assign significance ratings to any predicted adverse effects and contain clear and sufficient information to enable reviewers to understand the proponent's analysis of the significance of effects. In the absence of sufficient information, the Agency has concerns with the methodology used to determine significance, as well as the validity of some of Benga's significance conclusions.

As per the Agency's Guidance on "Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012" and the EIS Guidelines, there are several criteria that should be taken into account in deciding whether the adverse environmental effects are significant. These criteria are: magnitude, geographic extent, timing, duration and frequency, reversibility, and ecological and social context. In assessing the significance against these criteria, the proponent shall, where possible, use relevant existing regulatory documents, environmental standards, guidelines, or objectives, such as prescribed maximum levels of emissions or discharges. Once the significance of the environmental effect is determined and clearly explained, the concept of likelihood should be applied.

According to the methodology described in Section D of the EIA, measurable parameters were selected, where possible and appropriate, to facilitate quantitative or qualitative measurement of potential Project effects and cumulative effects on VCs. The degree of change in these measurable parameters was used to help characterize Project's specific and cumulative effects and to evaluate potential residual effects. Benga Mining states that thresholds or standards were identified, where possible and appropriate, for each measurable parameter.

Benga Mining uses a range of criteria to predict the effects of Project-related changes on VCs and provides a definition for the criteria and ratings used. For example, Section D, Table D.2.5-2 defines 'insignificant' environmental effects as those that are predicted to be within the range of natural variability and below guideline or threshold levels. 'Significant" is defined as those environmental effects that are predicted to cause irreversible changes to the sustainability or integrity of a population or resource.

However, the Agency notes that for the majority of VCs, the EIA does not contain a description of the relationship between the significance rating and the scientific or socio-economic effect threshold, nor does the EIA provide a description of the range of natural variability of ecological, social, or economic parameters associated with the VC. The EIA also does not identify critical threshold levels for significance that would enable a determination of significance.

For example, released process water is used as a measurable parameter to evaluate surface water quality (CR #5). In Appendix 2, Table 2C-1, the residual effect is determined to be "neutral". Further, the magnitude of the effect is defined as "moderate" (sulphate), the duration of the effect

is "residual" (sulphate), and the effect is "irreversible" (sulphate). The overall significance rating is not significant. Given sulphate concentrations in Blairmore Creek are expected to exceed the published Alberta Guideline and remain consistently above the Guideline at all modelled locations downstream of the West Sedimentation Pond water release, it is unclear how the Guideline was applied when determining overall significance, as defined by Benga.

In addition, Benga Mining defines a residual Project effects as an effect that cannot be fully reversed, after the consideration of available mitigation measures. However, the use of the terminology "neutral", "positive" and "negative", as presented in Appendix 2, Table 2B-1 and Table 2C-1, has not been defined or used consistently in the EIA.

Further, in response to January 13, 2016, AIR #17, Table 2B-1 includes ecological / social context as a criterion. The criterion has no definition associated with it and is not consistently used as an evaluation criteria when determining the potential significance of a residual environmental effect.

For example, coniferous and mixed wood forests cover a large area of the WLSA (~70%), and host the highest species richness and diversity of all habitats occurring in the WLSA. The EIA predicts a 28% loss of coniferous forest and 31% loss of mixed hardwood forest, which is preferred habitat for many migratory birds, in particular the Olive-sided Flycatcher. The EIA noted that upon reclamation there is expected to be a net gain in grassland in the WLSA as the landscape is progressively reclaimed. However, there is no discussion of the ecological / social value of the forest or of the thresholds that were used to determine that a 24.3 % net loss is not significant.

Information Required:

a. Provide an explanation for the application of the classification system for the magnitude criterion to describe species at risk (*i.e.*, nil, low, moderate, and high, as provided in Table D.2.5-2), including whitebark pine, limber pine, olive-sided flycatcher, great grey owl, and little brown bat.

Response:

The wildlife species at risk associated with this Project include: olive-sided flycatcher, little brown bat, short-eared owl, and common nighthawk. Similarly, western toad (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] – Special Concern for calling and non-calling populations), barn swallow (COSEWIC – Threatened), and grizzly bear (COSEWIC – Special Concern) are also included. The information request suggests that great grey owl be included; however, this species is not a federally-listed species (COSEWIC – Not at Risk; SARA – no schedule, no status). Also included in this response are whitebark pine, along with the pending *SARA*-listed species; limber pine. Please note that significance ratings for westslope cutthroat trout were provided in the January 31, 2017 Addendum 1.

Magnitude refers to the expected size or severity of the potential Project-related effect. The magnitude of potential effects was assessed qualitatively based on key issues of concern for each wildlife Valued Component (VC) that would be affected by Project development including the proportion of habitat affected within the spatial boundaries established for the Project (Wildlife

Local Study Area [WLSA], Wildlife Regional Study Area [WRSA], and Grizzly Bear Regional Study Area [GBRSA]), natural annual variation, and established threshold criteria or standards, where possible. The qualitative definitions for low, moderate, and high magnitude that were used to guide the determination of magnitude of potential effects were provided in Section D.2.5.3, Table D.2.5-2 and provided below:

- Low: Disturbance predicted to be somewhat above typical background conditions, but well within established or accepted protective standards and normal socio-economic fluctuations, or to cause no detectable change in ecological, social or economic parameters.
- Moderate: Disturbance predicted to be considerably above background conditions but within scientific and socio-economic effects thresholds, or to cause a detectable change in ecological, social or economic parameters within range of natural variability.
- High: Disturbance predicted to exceed established criteria or scientific and socio-economic effects thresholds associated with potential adverse effect, or to cause a detectable change in ecological, social or economic parameters beyond the range of natural variability.

The Project site is located on a landscape that was previously disturbed by historical mining and left unreclaimed. As examples, a portion of the proposed mine footprint was previously mined in the 1950s and 1960s by surface mining. The Grassy Mountain landscape currently has a surface mining trench, with surface waste rock and discarded coal fine piles on either side or within the mined trench. This legacy disturbance was not reclaimed and provides no to poor habitat quality for various wildlife species. Based on this level of unreclaimed disturbance, the area was interpreted as having been impacted by a High magnitude disturbance, which was used as a benchmark for characterizing magnitude of potential effects of the Project. Potential residual effects were based on any potential effects that may exist once modern mining is complete and all of the site, including the legacy mining has been reclaimed. The primary intent of the reclamation mitigation is to reclaim the site to a state equal to or better than what existed prior to the legacy mining. Details of this reclamation plan were provided in Section F (Conservation and Reclamation Plan [C&R Plan]). The residual effects remaining after mitigation and reclamation were characterized based on an effectively and fully reclaimed site. Many examples of successful reclamation at mine sites exists across Alberta and western Canada.

For federally-listed wildlife species at risk (*i.e.*, olive-sided flycatcher, little brown myotis, common nighthawk, short-eared owl, barn swallow, grizzly bear, and western toad) and other wildlife VCs (including great grey owl) and special status species, the magnitude of residual effects (*i.e.*, after all mitigations, including reclamation, are implemented) was based on professional judgment (CEAA 2017) using the level definitions provided in Section D.2.5.3, Table D.2.5-2.

For potential effects on movement, mortality, and abundance, the magnitude of residual effects was rated low for all species assessed as VCs (including little brown myotis, olive-sided

flycatcher, western toad, and grizzly bear, as well as great gray owl) (Consultant Report [CR] #9, Section 5.3.11, Table 5.3-26). After reclamation, which aims to provide a diversity of natural wildlife habitats representative of the region, it is anticipated that the movement, mortality risk, and abundance of these species will be little changed from a general baseline situation.

The magnitude of potential effects on habitat availability for olive-sided flycatcher and little brown myotis was conservatively characterized as moderate. The rationale for this is that the reclaimed landscape is anticipated to be different from the current landscape; more different than would happen from natural disturbance such as fire. Because reclamation aims to restore the area to natural landcovers representative of the area and consisting of suitable habitats for these three species, the magnitude of effects is believed to be lower than high.

The magnitude of potential effects on habitat availability for western toad and grizzly bear was characterized as low, because the reclaimed landscape is anticipated to have more wetland area and primary source habitat than is currently present for western toad and grizzly bear, respectively. This characterization is conservative. Actual magnitude for western toad and grizzlies may be (less than) low because of the increase of suitable habitat after reclamation.

The overall magnitude of potential effects on barn swallow, common nighthawk, and short-eared owl was characterized as low (CR #9, Section 5.4.9, Table 5.4-1), as a result of the diversity of habitats provided in the reclaimed landscape.

The magnitude of potential effects of clearing resulting in the removal and/or mortality of trees is high for whitebark pine and limber pine. Effects will initially be of high magnitude with clearing of vegetation and mining operations exceeding that of large natural disturbances, including fire and insect infestations that are more selective and less homogeneous (CR #8, Section 4.2.7).

b. Provide evidence to show that the criterion of social/ecological context does not apply to VCs, for example, species at risk, migratory birds or land and resource use. Alternately, update the significance determinations to include a consideration of the social/ecological context, as appropriate. Include specific information of how input and feedback received from government, the public, and Indigenous groups were factored into the decision to include or exclude social / ecological context.

Response:

Section D shows this as Project Contribution. The significance criteria tables provided in Appendix 22A, provide the definitions for the ecological/social context used for the project.

c. For each measurable parameter used to evaluate changes to a VC, provide a quantitative or qualitative description of the existing environmental conditions, a description of how the Project is expected to result in a change to the measurable parameter, and the threshold or criteria that was used to predict a change to the VC. Discuss how the criteria and associated rating were weighed in determining overall significance.

Response:

The specific thresholds for each applicable discipline VC are provided in Appendix 22A.

d. Provide further details on how a threshold of 20% loss of effective habitat for valued species at the Wildlife Regional Study Area (WRSA) and Grizzly Bear Regional Study Area (GBRSA) level represents the residual threshold necessary to prevent rapid population decline in all wildlife and vegetation VCs, including species at risk VCs such as limber pine, whitebark pine, little brown bat, olive-sided flycatcher and great grey owl. Explain why significance determinations appear to be focused solely on whether effective habitat is maintained below the 20% threshold after reclamation and do not appear to incorporate information on ecological /social context, or be based on thresholds for magnitude and duration specific to the VC.

Response:

Benga used the conservative threshold of 20% loss of effective habitat at the regional level for significance of effect of habitat loss on wildlife species. Literature reviews support a threshold of 70% to 90% loss (or 10% to 30% regional landscape remaining effective habitat) for extirpation, with acknowledgment that effects on body condition, reproductive potential, and abundance are likely prior to extirpation (CR #9, Section 3.2.5.4.1). Every species will have a unique area-specific threshold for the maintenance of its health, reproductive output, and population size. Although these thresholds are not known for the VCs in general, and the VCs within the region and Project area specifically, Benga believes that the use of 20% loss as a residual effect to determine significance is a conservative threshold at which healthy populations will exist. In addition, other evaluation criteria (CR #9, Section 3.2.4, Table 3.2-4) were considered in determining overall significance, particularly the magnitude, reversibility, and duration of the effect on wildlife.

Within each of the available Recovery Strategies or Management Plans there are no specific guidance about the nature of or requirements for critical habitat for olive-sided flycatcher, little brown myotis, western toad, and grizzly bear; subsequently, it is not possible to develop Project-specific quantitative thresholds for habitat loss for each of these four species at risk. Therefore, the conservative 20% loss threshold was used. Residual effects for these species were rated not significant because:

- Habitat will be progressively reclaimed throughout the lifespan of the Project, making the loss of olive-sided flycatcher habitat temporary but long-term (CR #9, Section 5.3.3.1). The residual effect is expected to be reduced to well under 20% local habitat loss, and therefore much lower than 20% regionally.
- Since disturbed habitats will be progressively reclaimed throughout the life of the Project, the effects of bat roosting habitat availability will be temporary and reversible (CR #9, Section 5.3.5.1). Although old or mature trees are most likely to provide suitable roosting cavities for bats in habitats adjacent to the Project footprint, Benga will assess the potential for creating roosting sites for bats by constructing and erecting bat

houses in habitats adjacent to the Project footprint and in reclaimed areas. The residual effect is expected to be reduced to well under 20% habitat loss locally, and therefore much lower than 20% regionally.

- By Year 27, it is expected that there will be 8.3% less effective habitat available (particularly high-quality habitat) locally for western toad than was present under baseline conditions (CR #9, Section 5.3.2.1). Losses of effective habitat for western toad will be offset by reclamation and mitigation, which includes construction of wetlands. The residual effect is expected to be a gain in available suitable breeding habitat locally.
- Habitat will be progressively reclaimed throughout the lifespan of the Project, making the loss of grizzly bear habitat temporary but long-term (CR #9, Section 5.3.8.1). The residual effect is expected to be a substantial increase in suitable habitat locally, and very little effect regionally.

Residual effects on habitat loss for the remaining wildlife VCs were considered to be not significant for the following reasons:

- Columbia spotted frog: same conclusion as for western toad;
- Great grey owl: by Year 27, it is anticipated that there will be 12% more suitable habitat available locally that is currently present;
- American marten: same conclusion as for olive-sided flycatcher;
- Canada lynx: by Year 27, it is anticipated that there will be a 2.8% loss in effective habitat regionally;
- Moose and elk: by Year 27, it is anticipated that there will be a 20% and 60%, respectively, increase in effective habitat locally.

The existing landscape is heavily disturbed by previous development and current human activity. Habitat availability for wildlife is expected to increase because the reclamation process will include reclaiming previously unreclaimed landscapes from historical mining activities.

Effective habitat for limber pine and whitebark pine are broadly defined (Alberta Whitebark and Limber Pine Recovery Team 2014a,b) and currently undergoing review at the federal level. No habitat loss threshold was available at the time of submission in 2015, and as recently described in the draft federal recovery strategy for whitebark pine, that is a compilation of the earlier provincial plans and current science, there is still no available and scientifically supportable threshold for habitat loss (Environment and Climate Change Canada 2017). Natural ecological thresholds for forest patch size and age distribution based on fire regime as well as regional forest management thresholds were available and used in the assessment. The primary threats to both pine species are losses from disease and insect outbreak, thus successful mitigation of losses depends on establishing trees on the reclaimed landscape, including disease resistant strains. In this context, the 20% threshold is a useful and conservative management and planning tool, and a suitable benchmark for monitoring reclamation of habitat area. However, success will be based on numbers of pine established relative to the numbers of pine removed.

The Project will result in a net increase in habitat suitable for the establishment of limber pine and whitebark pine, based on the current description of suitable habitat. Effective habitat will depend on other factors including presence of competing vegetation, seed predators, and stand densities required to support the Clark's nutcracker (the species that whitebark pine depend on entirely for seed dispersal) (Environment and Climate Change Canada 2017).

EFFECTS OF POTENTIAL ACCIDENTS OR MALFUNCTIONS

23. ENVIRONMENTAL EFFECTS OF ACCIDENTS AND MALFUNCTIONS

Reference: EIS Guidelines, Section 6.6.1; EIA, Section C.9; Agency's Request for Additional Information, January 13, 2016 - AIR#13.

Preamble:

The Guidelines require the assessment of the environmental effects of accidents and malfunctions to include an identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form, and characteristics of the contaminants and other materials likely to be released into the environment and potentially result in an adverse environmental effect as defined in section 5 of CEAA 2012.

Benga Mining considered the potential interactions between eight accidents / malfunctions and the associated VCs for the Project. However, the up-dated EIA continues to use qualitative terms to describe the magnitude of the environmental effects, as opposed to quantitative terms required by the Guidelines.

Without a description on the quantity, mechanism, rate and characteristics of the contaminants likely to be released, it is difficult to assess the potential environmental effect of the accidents / malfunctions identified by Benga Mining.

Based on Benga Mining's methodology, only those interactions for which an environmental effect or concern was identified was carried forward to a description of the potential environmental effect and assessment of risk that may result from the accident or malfunction. The Agency cannot find evidence that this step in the assessment was carried forward for any of the environmental effects or concern identified. For example, the EIA indicates that, should there be a wall failure, there would be a number of VCs impacted such as, human life, soil and vegetation, hydrology, water quality or aquatic resources. However, a description of the potential environmental effects of the wall failure has not been provided.

In Section C.1.5.2, Benga Mining states that they plan to use a third-party specialist service provider for blasting activities. The successful bidder will be responsible for all permitting, manufacturing, storage, and delivery to service the Project's mining operations. Therefore, Benga Mining has indicated that the application to NRCAN for an Explosives Act licence or permit for the explosives storage facility will be completed by the third-party specialist service provider at a later date.

The Agency is of the opinion that the EIA does not provide sufficient information related to the manufacturing, handling, and storage of explosives for the purposes of the assessing environmental effects of accidents and malfunctions. For instance, the EIA does not provide an estimate of the quantity of explosives to be used at the construction phase or during operations. This information is required to verify whether appropriate/standard measures will be

implemented to minimize accidents and malfunctions and associated potential effects to the environment.

Information Required:

a. For each identified accident and malfunction, provide a quantitative description of the magnitude of releases and an assessment of the potential environmental effect for the VCs identified to be potentially impacted.

Response:

Section C.9 provides a list and an assessment (*i.e.*, scenario description, design and operations safeguards, and potential environmental effects) of potential accidents and malfunctions pertinent to the Project. The following provides additional and supporting information of the potential magnitude of possible releases and potential environmental effects for the identified Project-related accident and malfunctions.

1. Open Pit Wall Failure.

The Mine Design and Optimization of the pits are described in Section C.1.2. Section C.1.2.3 provides details of the geotechnical assumptions and the summary of the geotechnical assessment (provided in Section B). The geotechnical assessment indicates that the eastern portions of the pit will have close to vertical bedding, which may pose a risk for open pit wall failures. Based on this, the footwall design parameters for the east zone require benching to address the potential of this near vertical dip. Footwall inter-ramp angles of 48.1° have been used in the mine design for this zone. Additional design mitigation that was implemented into the mine design to minimize the risks of toppling failures include highwall inter-ramp angles of 37.3°. The combination of near angle of repose slopes with catch benches every 15 m of height were implemented into the mine design to eliminate any localized failures to the wall.

In the unlikely event of a wall failure, which would be limited to an inward direction (towards the active pit area), at a magnitude of 2 million cubic metres, approximately 4.4 million tonnes for a single event, the following valued components (VCs) were assessed.

Air Quality VC

Dust emissions for a wall failure upset case are calculated based on the total volume of fallen rock and emission factors described in AP 42 Section 11.19.2 (U.S. Environmental Protection Agency [U.S. EPA] 2004) (Crushed Stone Processing and Pulverized Mineral Processing). According to this document, the PM_{10} emission factor for unloading fragmented stone is 8.0E-06 kg/t.

If the material size distribution of this upset case is assumed to be the same as that of AP 42 Section 13.2.4 (U.S. EPA 2006) for aggregate handling and storage (Total Suspended Particulates (TSP)/PM_{10}=0.74/0.35, $PM_{2.5}$/PM_{10}=0.053/0.35), the emission factor is 1.7E-05 kg/t for TSP and 1.2E-06 kg/t for $PM_{2.5}$. This assumption is expected to be conservative, as much

larger pieces of stone are expected to be formed in the failure case than in the aggregate handling case, which would overstate the emission factor.

The estimated total volume for the large wall failure is roughly 2 million cubic metres, approximately 4.4 million tonnes. Using the above emission factors, the estimated dust emission due to this failure would be 5.3 kg $PM_{2.5}$, 35 kg PM_{10} and 74 kg TSP (Table 23-1). It is expected that these emissions would occur for a time interval of a few minutes.

To put the estimated emissions from this upset case into perspective, maximum hourly fugitive dust emissions generated from Project activities, including blasting, were approximately 20 kg/h $PM_{2.5}$, 185 kg/h PM_{10} and 675 kg/h TSP (Table 23-1). Therefore, dust emissions generated from the event of a large wall failure would be 11% to 27% of total hourly dust emissions generated from Project activities.

Table 23-1 Wall Failure Upset Emissions

	$PM_{2.5}$	**PM_{10}**	**TSP**
Emission Factor for Unloading Fragmented Stone (kg/t) (AP 42, Table 11.19.2-1)	1.2E-06	8.0E-06	1.7E-05
Total Dust Emission (kg) from Large Wall Failure with 4.4 Million Tonnes Volume	5.3	35	74
Total Dust Emission from Grassy Project Activities (kg/h)	20	185	675
Percentage of Wall Failure Emissions over Total Project Emissions	**27%**	**19%**	**11%**

The wall failure could occur inside an open sunken pit about 300 m below the surface. It is reasonable to expect that only a fraction of the fugitive dust generated during the wall failure at the pit floor escapes to the pit surface where it then may be transported to the mine boundaries. Applying the escape factor (described in Consultant Report (CR) #1A, Appendix A, Section A4.11) would reduce emissions by an additional 25% to 50% for PM_{10} and 80% for TSP. These additional reductions are not included in the table above.

Even though the upset emissions would originate over a single area in the centre of the operating mine, they are much less than normal emissions from Project activities spread over a larger area. It is expected that air quality impacts would be reduced in accordance with the reduction in emissions.

Noise VC

Based on the mine design to minimize or localize any wall failure, in the event that a wall feature should topple, the worst-case scenario for the Noise VC was anticipated to be similar to a standard mining operational activity involving the use of explosive charges to loosen the raw materials. Although the noise and vibration levels associated with blasting (or potential wall failure) 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 or wall failure in the Alberta Energy Regulator (AER) Directive 038, nor are there any other specific provincial or federal criteria.

Human Health VC

The Human Health Risk Assessment (HHRA) (CR #12) assessed potential health risks at 16 receptor locations, including the maximum point of impingement in the Regional Study Area (RSA-MPOI). Predicted hazard and risk quotients were presented for the RSA-MPOI as it represented the highest levels of predicted human exposure. Results for the remaining receptor locations were all lower than the RSA-MPOI and were included for reference in CR #12, Appendix C (Acute Inhalation Results). Since an unlikely event of a wall failure would be similar to an operational blasting activity, it was assumed that the HHRA assessment of acute inhalation results within the RSA-MPOI would be representative of the potential impacts to the Human Health VC.

Results presented in CR #12, Section 6.1 indicate that the RSA-MPOI results are representative of the worst-case acute exposure scenarios exposure; therefore, results from all other HHRA locations are lower. The complete list of risk quotients for all receptor locations assessed in the HHRA are provided in CR# 12, Appendix C (Acute Inhalation Results). These results are independent of the receptor group since they are evaluated based on concentrations only and the toxicity limits are the same for all age groups and receptor types. The results of the acute inhalation at the RSA-MPOI locations were below 1.0 for the majority of the chemicals of potential concern (COPC) assessed, indicating that the predicted exposures for those COPCs were therefore lower than the safe toxicological reference values and not indicative of potential adverse health effects. Results at all other human receptor locations were less than RSA-MPOI results (CR #12, Appendix C).

The complete HHRA assessment related to acute inhalation is provided in CR #12, Section 6.1; however, it concludes that the results of the acute inhalation assessment demonstrate that the Project-related emissions do not pose a risk of adverse health effects at the receptor locations assessed outside the Mine Project Boundary for all COPC assessed. For the purposes of a potential high wall failure, it was assumed that the impacts would be within the detailed worst-case scenario used for the Project emissions acute inhalation assessment.

Terrestrial Resources VC

During operations, logging and other vegetation clearing are scheduled to be completed a minimum of 2 years in advance of mining in any sub-pit. Topsoil is planned to be stripped and salvaged 6 to 12 months prior to mining activities advancing into a new area of the pit. As the mining is designed to occur in benches (15 m in width), any wall failure would result in slumping within a previously disturbed pit area, rather than away or towards an undisturbed vegetated area. Wildlife are not anticipated to be within the active mining areas. Impacts of a potential wall failure on terrestrial resources are expected to be negligible.

Aquatic Resources VC

As any potential wall failure is expected to occur within an active pit area, any potential impacts to aquatic resources are considered to be negligible as water within the active mining area would continue to be managed through the Project's water management plan. Water that may come into contact with a wall failure and any COPCs would be pumped to either the raw water pond, or a saturated backfill as described in Section C.5.

2. Waste Rock Disposal Area Slope Failure

For the Project, there are two proposed external rock disposal areas; the south and north rock disposal area (SRDA and NRDA, respectively). In support of the Grassy Mountain feasibility study, a waste dump and infrastructure geotechnical program was completed. Stability analysis was performed on the SRDA and NRDA with both areas achieving acceptable factors of safety.

Air Quality VC

The estimated total volume for a rock disposal area failure is 200,000 to 400,000 cubic metres - approximately 0.44 to 0.88 million tonnes (Mt). The rock displaced by this failure could be expected to run-out as far as 600 to 1,100 m from the disposal area. The event would last a few minutes. The rock in the disposal area is previously blasted rock with an average size of 40 cm.

The same emission factors described for the large wall failure were used to estimate the dust emissions from the rock disposal area failure. Estimated dust emissions due to this failure with 0.88 Mt volume of rock would be 1.1 kg $PM_{2.5}$, 7.0 kg PM_{10} and 15 kg TSP. Again, the application of aggregate size distributions to 40 cm stone pieces is expected to result in a conservative emission estimate.

Maximum hourly fugitive dust emissions generated from Project activities, including blasting, were 20 kg/h $PM_{2.5}$, 185 kg/h PM_{10} and 675 kg/h TSP (CR #1A, Section 4.2.2, Table 4.2-4). Therefore, dust emissions generated from the event of a rock disposal area failure would be 2% to 6% of total hourly dust emissions from Project activities.

A portion of the fugitive dust potential from the failure will already have been blown away during the initial blasting, material handling, and due to windblown removal. Therefore, the actual emission during the rock disposal area failure could be less than calculated.

Noise VC

In the event of a waste rock disposal area slope failure, the worst-case scenario for the Noise VC was anticipated to be similar to a standard mining operational activity involving the use of explosive charges to loosen the raw materials. Although the noise and vibration levels associated with blasting (or potential wall failure) 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 or wall failure in the AER Directive 038, nor are there any specific other provincial or federal criteria.

Water Quality and Aquatic Resources VC

In the event of a waste rock slope failure, the material associated with the disposal areas (*e.g.*, waste rock and reclamation soil and vegetation) would have potential impacts on water quality, sediment quality and aquatic resources (*i.e.*, benthic invertebrates) if released into the surrounding aquatic environments. The release of this material would result in a decrease of water quality along with a reduction in riparian and instream habitat. Regardless of the volume of waste rock deposited into the adjacent riparian and instream habitat, the initial magnitude of the impact would be considered high, as exceedances in water quality guidelines along with mortality of fish and the potential loss of critical and/or recovery habitat associated fish populations would be expected.

Through immediate emergency response clean ups and natural dispersion and dilution processes, the overall magnitude of the impact may be anticipated to be reduced to a moderate magnitude. With the implementation of emergency response plans and riparian and instream habitat restoration, impacts to water quality and aquatic resources would be reversible in the short-term and restricted to the local environment.

Based on the run-out analysis, there is little to no risk of a waste rock slope failure in the SRDA that would impact Gold Creek or the lower portions of Blairmore Creek (in relation to the Project Footprint). A portion of the upper reaches of Blairmore Creek would be impacted in the event of a waste rock slope failure of the NRDA. Deposition of coarse waste rock into Blairmore Creek would result in an alteration to riparian and instream fish habitat, and potential fish mortality.

The impact to fish and fish habitat would be local in extent, and short-term in duration, as emergency response and clean up efforts would be initiated to restore natural flow patterns and reclaim riparian and instream habitat. A monitoring plan would be implemented to ensure proper reclamation and monitor re-colonization of the habitat by fish. Although the effects of a waste rock slope failure are reversible, with Blairmore Creek being classified as a Class B habitat under the *Water Act* Code of Practice Maps, and as potential recovery habitat for westslope cutthroat trout, the magnitude would be considered high.

Terrestrial Resources VC

A waste rock slope failure would result in an alteration to habitat availability, either directly through habitat loss, or indirectly through wildlife avoidance as a result of sensory disturbance. Wildlife with small home ranges and highly specific habitat requirements may be affected at the local level, depending on population size and extent of the deposition. The effects of habitat loss can continue long after the habitat loss has occurred.

Sensory disturbance associated with a potential waste rock slope failure might result in indirect habitat loss. These sensory disturbances may result in wildlife avoiding otherwise suitable habitat, particularly species sensitive to human disturbances such as marten, wolverine, and various species of birds. During an emergency response and clean up phase, equipment noise and lights may even alter bird and bat movement behaviour, which in turn could potentially

increase energy expenditures and mortality risk. Some wildlife species, such as grizzly bears, may also avoid areas during this period of clean-up activity. For some sensitive species, indirect habitat losses may account for a greater loss of effective habitat than results from direct loss through vegetation removal.

In the unlikely event of a waste rock slope failure, although impacts would be short-term in duration, local in extent, and reversible through reclamation, the indirect effects of a failure might result in a moderate to high magnitude to some wildlife species.

3. Water Management Dam Failure

The scenario description of water management dam failure was provided in Section C.9. As part of the safe guards, it was identified that the primary method to prevent catastrophic failure of a water management dam is through engineering design and site selection. All of the Project's water management dams will be constructed as per the Canadian Dam Association 2014 Technical Bulletin "Application of Dam Safety Guidelines to Mining Dams". As it relates to timing of construction, the largest dam for the Project will be constructed first for the purposes of collecting water for coal processing purposes, and is referred to as the Raw Water Pond (RWP). Details of the RWP are provided in Section C.5. The following are additional design features of the pond that provide context of the potential magnitude of releases during a potential upset condition.

To ensure the importance of this specific dam (which would represent a worse-case scenario situation) was fully recognized by the engineering design, the RWP dam consequence classification was raised from "High" to "Very High" during engineering risk workshops. For comparisons to the environmental risk assessment for this Accidents and Malfunctions assessment, it would be comparable to raising the magnitude classification from "High" to "Severe". Based on this elevated classification, the dam was designed to hold a total storm volume of 0.664 Mm^3 with peak flow of 48.4 m^3/s, which represents the maximum probable flow for the catchment area associated with the location of the RWP.

Additional design features implemented into the RWP dam included foundation layer updates, modelling of fractured rock zone in the base to consider the possibility of fractured bedrock, a thicker clay core (to limit gradient and increase deformation of the clay zone in the dam), additional drainage pipes at the downstream drainage basket, provisions for uplift pressure control (by adding pressure relief wells at the downstream blanket) and updated seismic load increased from 0.8 g to 0.16 g, which result in a flatter downstream dam slope of 4.5H:1V (which was originally 4H:1V). With these updates, the likelihood of the dam failure is deemed rare.

Potential releases to the surrounding environment would be limited to the spillway. The RWP dam spillway is 10 m in width, and the estimated flow capacity is 5 m^3/s (10% of the peak design storm flow rate). The 10% flow rate will happen when about 95% of the storm has already passed; therefore, 95% of the flood would be stored within the RWP (which has a design capacity of 1.2 Mm^3) while a 10 m spillway can pass the remaining 5% of the flood.

As stated in Section C.9, and reiterated in Benga's response to IR #24 (Contingency Plans), Benga is committed to developing and implementing an Emergency Response Plan in relation to water management for a dam failure as well as implementing site-specific Standard Operating Policies and Procedures to prevent a failure. In addition, in the event of a dam or spillway failure, Benga are committed to restoring any impacted terrestrial and aquatic habitat.

The following provides additional details on potential impacts to pertinent VCs in the event of a failure of a water management dam feature, and for the RWP: its spillway, after the mitigation, emergency response, and restoration efforts.

Water Quality and Aquatic Resources VC

The Project's sediment ponds, which are much smaller capacity than the RWP, are designed to capture and hold non-contact water, an unwanted release of water would result in increased sediment (total suspended sediments), changes to downstream sediment quality, and changes to downstream aquatic resources (changes in benthic invertebrate and algae habitat). During a spring freshet event, the impacts may not be noticeable compared to a release during low flow periods (such as summer and winter). During low flow periods, changes in sediment concentrations will likely exceed established water quality guidelines (*e.g.*, Canadian Council of Ministers of the Environment). A release would be short-term in nature (less than 2 weeks) and local in extent (which associated tributaries and mainstems), ultimately draining into the Crowsnest River.

The RWP and surge ponds are designed to capture and hold contact/process water, an unwanted release of water would result in increased sediment, selenium, and other metal constituent concentrations. Releases from these water management features would likely exceed established water quality guidelines. Like a sediment pond release, the impact would be short-term and local in extent.

The impact of a failure on water quality is anticipated to be moderate in nature as it would be a short-term event, and reversible due to natural dispersion, and the downstream receiving environment would be monitored as part of a water quality monitoring program.

For fish and fish habitat, a sediment pond failure would result in additional flow and sediment to downstream receiving environments similar to an acute pulse typical of a spring freshet. If a failure did occur during a spring freshet event, dispersion and dilution over the length of either watercourse would reduce the overall extent of potential impacts. Outside of a seasonal high-low scenario, the impacts of additional sediment deposition and flow during summer or winter would have a greater impact to local downstream fish habitat and potentially to fish populations. In the case of a surge pond failure, fish and fish habitat (*i.e.*, benthic invertebrates, sediment quality, aquatic vegetation) would be exposed to both increased concentrations of sediment, as well as increased concentrations of selenium and other metals. This exposure however, would be short-term and local in extent as dispersion would reduce overall impacts.

In the event of a RWP dam failure, the impact to fish and fish habitat would be local in extent, and short-term in duration, as emergency response and clean up efforts would be initiated to restore natural flow patterns and reclaim riparian and instream habitat. A monitoring plan would be implemented to ensure proper reclamation and monitor re-colonization of the habitat by fish. Although the effects of a water management pond failure would be reversible with both Blairmore Creek and Gold Creek being classified as Class B habitat under the *Water Act* Code of Practice Maps (and Gold Creek listed as Critical Habitat under the *Fisheries Act* and the *Species at Risk Act*), the magnitude would be considered high.

4. Explosives Accident

Explosives will be stored on-site at the Grassy Mountain Explosive Magazine (GMEM). This magazine is planned to be located inside the southern permit boundary in the vicinity of 49°38'45.23"N and 114°25'52.64"W (LSD 08-14-008-04 W5M) (Figure 23-1). The maximum quantity of explosives that will be stored at the facility at any one time during the construction phase is estimated to be 53 t based on maintaining 3 days of supply. The potential impacts to associated environmental VCs is described in more detail in response IR #23c.

5. Vehicle Incident

As described in Section C.9, a vehicle accident is more likely to occur as a result of a light duty vehicle incident rather than a larger haul truck. Aside from a health and safety risk, which is not described in this environmental assessment, the primary risk to the environment would involve the release of a deleterious substance (*e.g.*, fuel) to the surrounding environment. For the purposes of a worst-case scenario it was assumed that the maximum volume of release would be fuel (diesel or gasoline) from a fuel delivery truck to the mine and would be 50 m^3.

The mine access road, which will extend from Highway 3 to the Coal Handling Process Plant does not traverse any permanently flowing watercourses, and the nearest watercourse (Blairmore Creek) will have at a minimum a 100 m riparian buffer zone from the road to the top of the bank. As a result of this, impacts to water quality and fish habitat were not assessed. VC's assessed for vehicle incidents included soils and wildlife.

Wildlife VC

The access road will have wildlife crossing points included in its design (CR #9, Section 7.1.4 and Figure 7.1-1); however, there is the potential a wildlife-vehicle collision may occur over the life span of the mine. With the implementation of the wildlife mitigation measures to reduce/prevent wildlife mortality in place, in the event a wildlife-vehicle collision occurs it will likely be limited to a single animal; subsequently, the overall impact to the species population would be nil to low.

Soils VC

In the event of a fuel spill from a vehicle incident, the surrounding vegetation and soil would be impacted. Post-clean up from the emergency response plan, additional soil reclamation would be

required, with subsequent revegetation of the affected area. Any contaminated soil would be removed for proper treatment and disposal, and clean soil would be used for reclamation purposes. A reclamation monitoring plan would be implemented to ensure the success of the soil and revegetation. A fuel spill on soil and any associated vegetation would be short-term in duration, local in extent, and reversible. The overall impact would be low.

6. Hazardous Materials Spill or Release

The primary impact to the environment from a hazardous material spill or release would be associated with fuel storage. The maximum volume of diesel fuel stored on site will initially be 800 m^3, which would increase to 1,200 m^3 by Year 8. The bulk diesel fuel will be stored in double containment 100 to 200 m^3 tanks located in the mine infrastructure area (MIA) of the Coal Handling and Processing Plant. It was assumed that after the implementation of mitigation measures, in the event a diesel fuel tank failed, approximately 200 m^3 of fuel would be released into the surrounding environment.

Water Quality and Aquatic Resources VC

The release of spills from hazardous substances (*e.g.*, fuel and oil) during Project construction, operations, reclamation, and closure has the potential to change surface water and/or aquatic sediment quality. This, in turn, can directly and/or indirectly adversely affect westslope cutthroat and its habitat. All drainage from the mine site is captured and collected and contained within the water management system so is unlikely to have an uncontrolled release into a watercourse. Subject to spill volume, concentrations and transport mechanisms, releases of hazardous substances could contaminate runoff and surface water that could cause acute or chronic effects on the different life stages of westslope cutthroat as well as their food sources. Generally, spills are preventable and local in nature and would be promptly reported and responded to with appropriate spill-response actions outlined in the Project Environmental Management Plan (*e.g.*, Hazardous Material Spill Response Procedure). If a spill occurred it is highly probable that it would be contained within the water management system, which allows for less impact and mitigation.

Several environmental design features and mitigation actions and policies have been developed as part of the Project Environmental Management Plan to specifically reduce the potential for, and mitigate effects of, spills and leaks on westslope cutthroat and the species habitat, should a spill or leak occur. Spill containment supplies will be made available in designated areas. Additionally, the spill response procedure developed for the Project will include instruction for rapid response, control, and management of land- and water-based spills on site.

During construction and early operations years, fuelling and lube maintenance will occur at the Coal Handling Processing Plant Maintenance Shop, which is 300 m from Blairmore Creek. During later operations years, fueling may occur at one or two stations within the pit areas. At those stations, fuel will be stored in double-walled tanks with a capacity of less than 100,000 L. Where oil-water separators are installed, they will be visually inspected continually to check for any potential petroleum bypass or other malfunctions. Stations will be sited to control drainage

in and around the area, and would be located at least 300 m away from any watercourse. Recovered product and contaminated materials will be handled and disposed of as per the Environmental Management Plan developed for the Project.

Implementation of the above-mentioned environmental design features and mitigation actions is expected to reduce the likelihood and extent of a hazardous spill and leaks on-site and along transportation corridors, thus result in no detectable changes in surface water or sediment quality in local watercourses relative to baseline conditions. Thus, this pathway was determined to have no linkage to effects on westslope cutthroat.

As the fuel tanks will be located within the MIA, as part of the site water management design, any release of fuel would drain and collect within the site sedimentation pond. As this pond would be contaminated from fuel, emergency response and emergency spill response clean up procedures would be implemented. All contaminated water would be properly pumped out of the sediment pond and properly removed and disposed of, off-site. As release of water from the sediment pond can be designed to control water retention and release, during clean up, water would not be released to downstream environments; subsequently, impacts to water quality and aquatic resources would be nil to low.

Soils VC

As described in the vehicle incident impact assessment, in the event of a fuel storage release, the surrounding soils of the MIA would be impacted. Post clean up from the emergency response plan, soil reclamation would be required. Any contaminated soil would be removed for proper treatment and disposal, and clean soil would be used for reclamation purposes. As the spill would be short-term in duration, local in extent, and reversible, impacts to soil would be low.

7. Train Derailment

As described in Section C.9, in the unlikely event of a train derailment, the primary VCs that would be affected include air and water quality. The impacts to these VCs are further described below.

Air Quality VC

It is extremely unlikely that all the cars in the entire train would empty all their contents. For this upset assessment, it was assumed that 40 cars derailed during a train accident, resulting in spilling 4,000 tonnes of clean coal.

According to the emission factor provided in AP 42 Table 11.9-4 (U.S. EPA 1998), the TSP emission factor for end-dump truck unloading of coal (batch drop) is 0.004 kg/t. If the same size distribution (TSP/PM_{10}=0.74/0.35, $TSP/PM_{2.5}$=0.74/0.053) as that of AP 42 Section 13.2.4 (U.S. EPA 2006) is used, the emission factors are 2.9E-04 kg/t for $PM_{2.5}$ and 1.9E-03 kg/t PM_{10}. The estimated dust emissions due to this worst-case train derailment with 4000 tonnes of clean coal would be 1.1 kg $PM_{2.5}$, 7.6 kg PM_{10} and 16 kg TSP.

To put the estimated emissions from this upset case into perspective, maximum hourly fugitive dust emissions generated from the train loadout under normal operations were 0.04 kg/h $PM_{2.5}$, 1.1 kg/h PM_{10} and 2.3 kg/h TSP (CR #1A, Section 4.2.2, Table 4.2-4), based on 2,000 tonnes of clean coal per hour unloading from conveyor onto rail cars. Therefore, dust emissions generated from the train derailment event would be about 29 times the hourly dust emissions from normal train load-out operations for $PM_{2.5}$ and seven times for PM_{10} and TSP (Table 23-2).

Table 23-2 Coal Train Derailment Upset Emissions

	$PM_{2.5}$	**PM_{10}**	**TSP**
Emission Factor for End Dump Truck Unloading Coal (kg/t) (AP42 Table 11.9-4)	2.9E-04	1.9E-03	0.004
Total Particulate Emission (kg) from Coal Train Derailment with 4000 Tonnes of Clean Coal	1.1	7.6	16
Total Particulate Emission from Normal Train Load-out (kg/h)	0.04	1.1	2.3
Ratio of Train Derailment Upset Emissions to Normal Load-out Emissions	**29**	**6.9**	**6.9**

According to detailed model predictions, the 9th highest hourly $PM_{2.5}$ prediction at model grid points outside the load-out during normal operations was about 1.9 $\mu g/m^3$ at receptor R8 resulting from normal train load-out emissions only. Based on the CALPUFF modelling results for this train derailment event only, the 9th highest hourly $PM_{2.5}$ prediction was about 20 $\mu g/m^3$, 25% of the 1-hour AAAQG of 80 $\mu g/m^3$. The MPOI for normal and upset events occurred at grid points about 600 m northwest of the train load-out. Compared to the normal train load-out, the $PM_{2.5}$ prediction is 10 times higher for the train derailment event. It is expected that increase of air quality impact for PM_{10} and TSP would be much smaller than $PM_{2.5}$ based on the emission comparison in the above table.

Water Quality and Aquatic Resources VC

As described in Section C.9, an overturned rail car(s) and any volume of coal or fuel (maximum amount from a fuel car being 90 m^3) would collect within a drainage ditch below the rail grade. The water in the drainage ditches alongside the tracks will report to the water management sediment pond located at the western end of the rail loop. Should water ponding occur due to interference of the derailment on the drainage ditch, then pumping may be necessary. The sediment pond will provide the ability to treat the water for suspended solids before discharge to the environment. Therefore, a derailment in the rail loop is not expected to adversely affect these VCs. As the derailment of a rail car at a very low speed (as associated with the rail loop), will be very unlikely, along with the implementation of an emergency response plan and site clean up, the impacts to water quality and aquatic resources would be short-term and local in extent, resulting in a nil to low magnitude for this VC.

b. Provide the following information with respect to the proposed explosive storage and

associated facilities:

- the types of explosives to be manufactured and stored;
- maximum quantity of explosives at each facility;
- the location of the explosives storage facilities, with distances to vulnerable features such as dwellings, roads, camps, etc., and the location of the explosive magazine;
- fuel and ammonium nitrate storage plans;
- liquid effluent disposal plans;
- spill contingency plans; and
- any temporary explosive facilities to be used for starting the Project.

Response:

The *Canadian Explosives Act* and Regulations specify legal obligations when using, transporting and manufacturing explosives. To reduce the risk of explosion, explosives and detonators will be stored on-site in compliance with applicable legislative direction in explosive magazines and, when required, will be loaded and transported to the blasting sites. Explosive magazines will be stored at a safe distance from other facilities.

During the construction phase, prilled ammonium nitrate or an emulsion product with detonators will be required for blasting purposes at the rail loop, overland conveyor and mine access corridor, the product stockpile pad and the coal processing plant area, mine industrial area and potentially other miscellaneous areas such as dams and drains. Explosives will be stored on-site at the Grassy Mountain Explosive Magazine (GMEM). This magazine is planned to be located inside the southern permit boundary in the vicinity of 49°38'45.23"N and 114°25'52.64"W (LSD 08-14-008-04 W5M) (Figure 23-1). This location provides sufficient separation distances from the open pit, mine buildings, power line, mine access road and fuel storage facilities. The location has also been planned to facilitate inbound logistics to allow delivery trucks carrying explosives to travel directly to the magazine without having to pass through the mine industrial area.

During operations, the type of explosives that will be stored at the GMEM to be used throughout the mine during blasting activities are expected to be an industry standard ammonium nitrate/fuel oil (ANFO) mixture along with an emulsion blend (Section C.9.6.1). Ammonium nitrate prill will be transported to site by a third-party explosives provider, which is not explosive on its own and poses little threat of accidental detonation. Once the prill is on-site, it is mixed with fuel oil and becomes an explosives product (ANFO) (Section C.9.6.1). The Project will have a designated area for both an explosives magazine and explosives manufacturing (Figure 23-1).

During construction, the total quantity of explosives required for blasting are provided in Table 23-3.

Table 23-3 Construction Explosives Requirements

Location	Volume to be blasted (m^3)	Rock Density (t/m^3)	Tonnes Blasted (t)	Powder Factor (kg/t)	Explosives Required (kg)	Start Date	End Date	Duration (months)	Typical Monthly Consumption of Explosives (t)
Rail Loop	275,000	2.4	660,000	1.0	660,000	Q1 2019	Q3 2019	6	110,000
Overland Conveyor and Access Road	270,000	2.4	648,000	1.0	648,000	Q2 2019	Q3 2019	5	129,600
Product Stockpile	95,000	2.4	228,000	1.0	228,000	Q3 2019	Q1 2020	6	38,000
Coal Handling Processing Plant and MIA	450,000	2.4	1,080,000	1.0	1,080,000	Q2 2019	Q4 2019	5	216,000
Miscellaneous	150,000	2.4	360,000	1.0	360,000	Q1 2019	Q4 2019	10	36,000
Total	1,240,000		2,976,000		2,976,000				529,600

During construction, the total amount of explosives to be used is estimated at approximately 3,000 t. This value is provided as an estimate only and may fluctuate once construction activities commence. This estimate is based on 1.0 kg of explosives per tonne of material to be blasted. Typically, explosives will be delivered by road to the various construction sites on a just-in-time basis; however, some explosives will be stored on-site at the GMEM to cover any shortfall in delivery or to provide storage for delivered explosives that cannot be used that day due to delays with preparing the blast site or weather. The likely maximum quantity of explosives that will be stored at the facility at any one time during the construction phase is estimated to be 53 t based on maintaining 3 days of supply.

Storage requirements for explosives will follow federal regulations as well as any supplier-specified storage requirements for the specific explosive material used during blasting activities. In accordance with the Explosive Regulations 2013, users of unlicensed high-hazard special purpose explosives must comply with Division 2 of the regulations. In addition, unlicensed users must store the explosives in a storage unit and ensure that the requirements of sections 264 and 265 are met regarding maximum quantity of explosives and storage requirements. In accordance with the Explosive Regulations 2013, no more than 20 kg of high-hazard special purpose explosives may be stored at any one time. In addition to the federal regulations, Benga will follow the Canadian Pacific Railway guidelines for blasting near Canadian Pacific railway tracks or property as well as the Canada Occupational Safety and Health Regulations SOR/86-304.

Table 23-4 summarizes the distances between the explosives storage facility and vulnerable features throughout and near the Project area. The explosives storage facility will be located in the vicinity of 49°38'45.23"N and 114°25'52.64"W (LSD 08-14-008-04 W5M), inside the southern permit boundary (Figure 23-1).

Table 23-4 Distances from the Explosives Storage Facility to Vulnerable Features

Feature	Construction Explosives Storage Facility
Crowsnest Pass Golf and Country Club	2,300 m
Highway 3	4,000 m
Rail Loadout Facility	3,400 m
Canadian Pacific Rail Line	4,300 m
Town of Blairmore	3,900 m
Blairmore Creek	1,300 m
Gold Creek	2,400 m
Construction Camp	1,300 m
Coal Handling Processing Plant	1,700 m
Administration Office Building	1,800 m
Security Building	1,300 m

Table 23-4 Distances from the Explosives Storage Facility to Vulnerable Features

Feature	Construction Explosives Storage Facility
Equipment Maintenance Workshop	1,800 m
Equipment Fueling Station	1,800 m
Fuel/ Diesel/ Propane Storage Facilities	1,300 m
Explosives Mixing Facility	130 m
Existing Powerline	1,200 m

Ammonium nitrate prill will be transported to site by a third-party explosives provider and mixed on-site with fuel oil to create an explosives product (ANFO) (Section C.9.6.1). Storage plans for fuel and the ANFO include a designated magazine area providing storage for:

- 2 x 10-20 t High Explosives magazines (one fore boosters and one for detonators);
- 80 t tank for ammonium nitrate emulsion storage (UN3375);
- 60 t of ammonium nitrate prill storage in silos or tippers;
- <10,000 L of diesel;
- 2 x Mobile Processing Units, trucks for mixing and delivery of explosives down the hole;
- tanks for storage of gasser or glass micro balloons;
- office facility (*i.e.*, administration); and
- fencing, pumps, communications, power and water supply, electric controls, bunding for effluent containment, sumps for effluent removal and safe disposal.

As part of the Standard Operating Policies and Procedures that will be developed prior to mine operations, a spill plan for liquids such as diesel will be incorportated to ensure the requirements for a rapid and correct response for clean up and remediation of any potential hydrocarbon or chemical spills that may occur to minimize the impact on the surrounding environment and to reduce the liklihood of personal injury. The plan will incorporate the CARD process, which involves the appropriate level of containment, absorbtion, reporting, and disposal of the spill.

As part of the Standard Operating Policies and Procedures that will be developed prior to mine operations, clean-up procedures will be included in the event of an ammonium nitrate spill. Contingency plans will be developed during the Operational Readiness phase of the Project. In the event of a spill, the facility will be equipped with an Emergency Response Plan to provide safe evacuations to designated muster points, to contain all spills with design bunds, and to have the proper equipment available to quickly respond and clean up the spill. Site procedures will also focus on minimizing storage and limiting access to only those personnel trained in the management of the facility.

If the explosive storage facility has not been built at the start of the Project, explosives will be delivered to the site on an as needed basis. If unused explosives remain at the end of the day, the third-party service provider will remove the explosives from site. If mobile processing units are used, they will be securely parked for the night at an appropriate distance from infrastructure. Benga does not plan to build a temporary explosives facility for construction purposes for starting the Project.

c. Provide a description of the worst case scenario in terms of an explosives accident, including the potential environmental effects of such an accident. Describe the resources required to effectively respond to such an event.

Response:

Accidents or malfunctions are unplanned events that can result in the adverse environmental, economic, social, heritage or health effects. Although the proposed Project has standards and practices in place to ensure that accidents or malfunctions are unlikely, the potential consequences of an accident or malfunction are evaluated so that emergency response and contingency planning can be identified to reduce the risk.

Benga is committed to designing, constructing and operating the proposed Project in a safe and environmentally responsible way. During operations, Benga will implement a number of standard activities associated with safety, including the use of a qualified third-party explosives service provider, implementing safe separation distances of the explosives storage facility from infrastructure and developing an Emergency Response Plan, which will include an evacuation plan. The Emergency Response Plan will be provided during the Operational Readiness phase of the application.

The worst-case scenario of an explosives accident would be the detonation of an explosives storage facility. Based on the Australian Explosives Industry and Safety Group Inc. (AEISG) *Code of Practice for Storage and Handling of UN3375*, the potential of such an event occurring is unlikely. Ammonium nitrate emulsions are very insensitive to overheating and shock and are very difficult to initiate, requiring further processing before becoming explosives (AEISG 2017). The only probable way for ammonium nitrate emulsions to accidentally explode is through a prolonged and intense fire engulfment (AEISG 2017). ANFO is also a very stable product on its own and will not initiate without assistance. A high explosive combined with a blasting cap is required to initiate the blast and this step is only completed right at the blast hole. Fuel tanks will be placed at a safe distance from the explosives storage facility to ensure that any risk of an accidental explosion is avoided. However, in the event of an uncontrolled fire capable of engulfing an explosives storage facility, the explosion will not be instantaneous and an evacuation of the site can take place. Evacuation distances will be based on the worst-case explosion to ensure the safety of all personnel. The Emergency Response Plan and evacuation plan will include designated safe locations for evacuation and will aim to have all personnel at a safe distance within 30 minutes of a fire starting and engulfing the explosives storage facility.

Potential effects that could result from an explosion of the explosives storage facility include:

- loss or damage to adjacent property or human health due to fire;
  - **Potential Impacts** - Depending on the blast radius and spread of the fire, an explosion or fire could pose a risk to adjacent property and land use and cause potential adverse effects on the current use of adjoining land for traditional and non-traditional purposes. In the event of a large fire or explosion where humans are in the vicinity of the event, human health, air quality, and greenhouse gas emissions may also be affected. The Emergency Response Plan will be implemented to ensure that all personnel are evacuated to the designated areas to ensure that no one is in the vicinity when the storage facility explodes. In addition, implementation of mitigation measures such as ensuring that all fuel sources are stored at a safe distance from the explosives storage facility, all necessary fire-fighting equipment is on hand and that all personnel are trained on its proper use, will ensure that a small manageable fire does not escalate into a major fire.
- potential effects on vegetation;
  - **Potential Impacts -** Following an explosion of the explosives storage facility, potential adverse effects on vegetation may occur if the blast radius extends beyond the MIA, spreading fire to undisturbed vegetation/forested areas. The fire could also affect cultural sites used for traditional purposes.
- loss or reduction of aquatic riparian habitat; and
  - Potential Impacts - The potential for adverse effects of fire to riparian habitat depends on whether the explosion causes the spread of fire from the explosives storage facility to surrounding undisturbed vegetation and forested areas. A large fire that spreads beyond the mine site could result in long-term loss of riparian habitat along Blairmore Creek, causing adverse effects to fish, species of conservation concern, and surface water. Implementation of fire prevention measures during operations will prevent fire from igniting or spreading as well as reducing the risk of the explosives storage facility being engulfed in fire for a prolonged period of time.
- potential effects on wildlife and wildlife habitat.
  - **Potential Impacts** - The potential for adverse effects of fire to wildlife and wildlife habitat depends on whether the explosion causes the spread of fire from the explosives storage facility to surrounding undisturbed vegetation and forested areas. A large fire that spreads beyond the mine site could lead to wildlife habitat loss. Depending on the species, the effects of habitat degradation or loss will differ. Large species that are more mobile with larger home ranges could be locally affected to a lesser degree than smaller, less mobile species that are restricted to smaller home ranges. Implementation of fire prevention measures during operations will prevent fire from igniting or spreading as well as reducing the risk of the explosives storage facility being engulfed in fire for a prolonged period of time.

    The resources required to effectively respond to such an event would include the development and implementation of an Emergency Response Plan as well as mitigation measures in the form of an Environmental Protection Plan. Detailed plans will be provided during the Operational Readiness phase of the application.

24. CONTINGENCY PLANS

Reference: EIS Guidelines, Section 6.6.1

Preamble:

The Guidelines require a description of the safeguards that have been established to protect against accidents and malfunctions and an identification of contingency plans and emergency response procedures if the identified events were to occur. Although Benga Mining has outlined established safeguards for each accident and malfunction, contingency plans and emergency response procedures have only been identified for two of these scenarios.

Benga Mining has noted that, in relation to water management for a dam failure, it would implement its Emergency Response Plan and Standard Operating Policies and Procedures. However, detailed procedures are not provided in the EIA.

Information Required:

a. Provide details of the Emergency Response Plan in relation to water management for a dam failure.

Response:

In the event of a dam failure for a water management structure, typical emergency response procedures are outlined in a draft Emergency Response Plan (ERP), which has been provided in Appendix 24A.

As stated in Section C.9, Benga is committed to developing an ERP in relation to water management for a dam failure as well as implementing site-specific Standard Operating Policies and Procedures (SOPPs) to prevent a failure. The ERP will provide the emergency responses to be implemented by Benga during the construction and operation of the dams in the event of a failure. The ERP will be reviewed and updated as needed throughout the construction and operations phases of the Project to incorporate changes in site conditions, continual environmental improvement and adaptive management based on monitoring results, if necessary.

Details of the ERP and SOPP for dams will be developed and finalized at the Operational Readiness stage for the Project. All plans, policies and procedures will be in accordance with the Terms and Conditions of the Approval issued for the Project. In addition, Benga will prepare all emergency response procedures, contingency plans and SOPPs in accordance with industry standards, as well as provincial and federal regulations and guidelines.

b. Identify contingency plans and emergency response procedures for all identified potential accident and malfunction scenarios.

Response:

Benga is committed to providing responsible management for its operations and will ensure that Project-related activities are carried out in a professional and environmentally responsible manner. Section C.9 provided an assessment of the following potential accidents and malfunctions:

- open pit wall failure;
- waste rock disposal area slope failure;
- water management dam failure;
- explosives accidents;
- vehicle incidents;
- hazardous materials spill or release; and
- train derailment.

Table 24-1 provides a summary of the typical contingency plans and emergency response procedures identified for each scenario.

Environmental impacts of accidents and malfunctions will be prevented and/or minimized through the implementation of design and operations safeguards, SOPPs, contingency plans, and emergency response procedures. An ERP will be developed for various emergency situations and implemented as needed. Detailed ERPs will be specifically designed for various sites and will be available throughout the Project area (*i.e.*, Plant, office complex, maintenance and light duty machine shops, fuelling stations and pit operations).

Details of the ERPs, contingency plans and SOPPs for all identified accidents and malfunctions will be developed and finalized at the Operational Readiness stage for the Project. All plans, policies and procedures will be in accordance with the Terms and Conditions of the Approval issued for the Project. In addition, Benga will prepare all emergency response procedures, contingency plans and SOPPs in accordance with industry standards, as well as provincial and federal regulations and guidelines.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
Open pit wall failure	Improperly designed pit walls or poor drilling and blasting practices could result in failures of the open pit walls causing safety concerns to miners.	• Geotechnical field program was conducted to support the pit slope design recommendations (Section B, Table B.8.6-1). • Routine geologic mapping will be performed during excavation to confirm/check the orientation of the structure against what is expected in the geologic model and to look for the presence and orientation of faults in the pit walls. • Groundwater monitoring will be performed on an on-going basis to establish site groundwater trends prior to mining.	• Site-wide Emergency Response Plan	• Stop work and evacuate immediate area to safe distance. • Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, Occupational Health and Safety [OHS]), where required. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Stabilization of disturbed slope. • Clean-up of debris from the pit. • Review the geotechnical stability of the pit slope design criteria and update or revise as appropriate.	• Assessment of safety measures. • Continue geologic mapping during excavation to confirm/ check the orientation of the structure against what is expected in the geologic model and to look for the presence and orientation of faults in the pit walls.
Waste rock disposal area slope failure	Slope failure of waste dumps could result in rock being transported into Gold or Blairmore creeks. A significant run-out of the South Rock Disposal Area (SRDA) could impact the plant site.	• A stability analysis was performed. • Progressively re-slope the waste dumps to 23 degrees, which provides a factor of safety of 1.78. • The in-pit portion of the SRDA has been designed so the toe of the re-sloped disposal area does not exceed the crest of the ultimate pit (increases geotechnical stability). • Strip weak, organic or fine grained soils within 50 m of toe of the dump foundations to prevent failure through soft foundation soils. • Inspection of foundations prior to rock placement. • Ditching to direct water towards sediment ponds and away from rock disposal areas.	• Site-wide Emergency Response Plan • Waste Management Plan	• Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, Fisheries and Oceans Canada [DFO], OHS), where required. • Halt failure and deposition of the waste dumps to the receiving environment, as soon as feasible. • Identify and repair the cause of the failure of the waste dump. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Stabilization of disturbed slope. • Clean-up of debris from failure and return to the waste dumps. • Re-contour waste dump pile in area of failure. • Install sediment and erosion control measures to prevent additional material from entering the watercourse. • Restore damaged water management infrastructure around the waste dumps, if necessary.	• Monitor water quality, sediment quality, aquatic resources, and fish in receiving environment, if necessary. • Conduct a stability analysis of the waste dump.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
					• Review the geotechnical stability of the waste dumps and design adjustments as appropriate.	
Water management dam failure	Failure of one of the water management dams could release large quantities of untreated water, and possibly some sediment, into the receiving environment and possibly into Gold Creek. Dam failure could result from overflow, slope failure, foundation failure, liquefaction, and erosion.	• Dams will be constructed as per the Canadian Dam Association 2014 Technical Bulletin *Application of Dam Safety Guidelines to Mining Dams*. • Regular inspections of ponds will occur. • The SOPPs will be implemented during construction and operations. **Sediment Ponds:** • Designed as wet ponds with permanent pools. • Outflows will occur *via* discharge pipes through the embankments, which will have inverts at the levels of the permanent pools. • Pond capacities and discharge pipes have been sized to provide the required retention for specified water quality design flood. • Emergency overflow spillways will convey the inflow flood design. • Water quality design flood and the inflow design flood were estimated using hydrologic modelling for the largest catchment area reporting to each of the ponds during its life. **Surge Ponds:** • Constructed with cross-valley dams and are located outside of the 100 m riparian buffer (except for NWSP).	• Dam Safety Emergency Response Plan • Water Management Plan • Waste Management Plan	• Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, Fisheries and Oceans Canada [DFO], OHS), where required. • Halt flooding to the receiving environment, as soon as feasible. • If a small leak, identify and repair the cause of the failure of the water management dam immediately. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Halt the discharge of untreated water and/or sediment to the receiving environment, as soon as feasible. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel. • Notification of appropriate stakeholders, where required. These include government agencies and any nearby communities or landowners. The prompt notification of government agencies is essential. • Initiate clean-up of untreated water and/or sediment from failure and dispose of at an approved facility.	• Monitor water quality, sediment quality, aquatic resources, and fish in receiving environment, if necessary.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
		• The downstream face of the embankment for the NWSP is located 30 m from Blairmore Creek in order to maximize the water storage capacity of this pond. • Water will be pumped directly and/or indirectly to the saturated backfill zones. • Emergency overflow spillways will be sized to convey the inflow design flood, which was estimated for the largest catchment area reporting to each of the ponds during its operating life.			• Install sediment and erosion control measures to prevent additional untreated water and/or sediment from entering the watercourse. • Repair damaged water management infrastructure.	
Explosives accident	Explosives accident/incident due to improper blasting techniques.	• Adherence to the *Explosives Act* and guidelines issued by the Explosives Safety and Security Branch of Natural Resources Canada governing the quantity and distance principals to be applied with respect to storage volumes and the locating of facilities. • A qualified third-party explosives service provider will be hired to provide blasting services to support mine operation. • Development of SOPPs to govern all aspects of mine operations, including a drill/blast SOPP, which will ensure compliance with all federal regulations. • Explosives are expected to be industry standard ammonium nitrate/fuel oil mixture and an emulsion blend, which will be mixed on site by a third-party explosives provider at their facility in accordance with all applicable legislation.	• Emergency Response Plan • Explosives Management Plan • Spill Contingency Plan • Hazardous Material Management Plan	• Stop work immediately and evacuate all personnel to the safe muster point. • Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, OHS), where required. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Clean-up and disposal of damaged materials and infrastructure. • Restore/rebuild damaged infrastructure.	• Monitor water quality, sediment quality, aquatic resources, and fish in receiving environment, if necessary.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
Vehicle incidents	Vehicle accident resulting in injury or fatality.	• Drivers will meet all applicable training and legal requirements. • Avoid the transportation of material during hazardous conditions or limited visibility. • Design, construct and maintain Project site and access roads for safe use. • Development and adherence to an SOPP outlining methods of road construction, maintenance and operation. • Regular inspection and maintenance of roads and vehicles • Speed limits will be strictly adhered to. • Haul roads to be constructed in accordance with Alberta OHS regulations (specification of berm heights and run-out ramps for grades >5%).	• Site Access Management Plan • Occupational Health and Safety Plan • Emergency Response Plan • Spill Contingency Plan • Hazardous Material Management Plan	• Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, OHS), where required. • Initiate the Spill Response and Clean-up Procedures, if necessary. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Clean-up of any spilled fuel or hazardous materials.	• Assessment of safety measures, including signage and speed limits.
Hazardous materials spill or release	Equipment leakage, a trucking accident on-site from the mine equipment refueling/lube truck, a spill from a ruptured fuel storage tank, or a spill within the CPP or CHPP.	• Reagents (*i.e.*, diesel, MIBC) will be stored inside double-walled tanks inside of a concrete protection berm. • Regents required to operate the flotation cell will be stored in a purpose built facility (fuel farm), which will consist of one storage tank for collector and one storage tank for frother. • Storage and handling of explosives will comply with the Guidelines for Bulk Explosives Facilities issued by Natural Resources Canada. • Operational safeguards include:	• Site-wide Emergency Response Plan • Spill Contingency Plan • Hazardous Material Management Plan • Water Quality Monitoring Management Plan	• Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, Alberta Environment and Parks [AEP], DFO, OHS), where required. • Product will likely be contained in water management facilities, prevent product from leaving and entering the environment. • Initiate the Spill Response and Clean-up Procedures.	• Contain and recover spilled material, using berms, diversions, vacuum trucks, absorbents, or booms when necessary and feasible. • Divert water around a spill, if necessary. • Clean-up of any spilled fuel or hazardous materials. • If practical, spilled material will be	• Monitor water quality, sediment quality, aquatic resources, and fish in receiving environment, if necessary.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
		• daily inspections of all fuel lube storage locations; • a volume accounting procedure put in place, which would include comparing volumes in tanks against expected consumption; • spill kits located at storage facility and on board mobile lube truck; and • lube truck drivers will be trained in safe driving procedures. • Training programs will ensure employees understand spill notification and clean-up procedures. Emergency Response Team members and senior foreman will all receive spill prevention training and hands on field training sessions.		• Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	recovered and returned to a storage area for reuse or recycle. • Recover and dispose of any contaminated media (*e.g.*, soil, fill, or vegetation) for proper disposal. • Restoration of any disturbed ground cover, including implementation of erosion control and terrain stability measures.	
Train derailment	Train derailment within the rail loop during switching operations resulting in the toppling of rail cars, discharging coal into the ditches alongside the tracks.	• The rail loop drainage design includes a sediment pond where all water collected in the track's drainage ditches is directed. • The water in the sediment pond is treated for total suspended solids prior to its release into the environment.	• Site-wide Emergency Response Plan • Waste Management Plan • Water Quality Monitoring Management Plan • Spill Contingency Plan • Hazardous Material Management Plan	• Notify supervisors and management, engage Emergency Response Team, if necessary. • Notification of regulatory agencies (*i.e.*, Transportation Safety Board, Railway Administrator, OHS), where required. • Immediate assessment of potential effects to environment, health, and safety, to ensure the safety of employees and site personnel.	• Contain and recover spilled material, using berms, diversions, vacuum trucks, absorbents, or booms when necessary and feasible. • Clean-up of any spilled fuel or hazardous materials. • Recover and dispose of any contaminated media (*e.g.*, soil, fill, or vegetation) for proper disposal.	• Monitor water quality, sediment quality, aquatic resources, and fish in receiving environment, if necessary.

Table 24-1 Description of Possible Accident and Malfunction Scenarios and the Management Plans/Contingency Plans and Emergency Response Procedures

Scenario	Description	Mitigation		Emergency Response Procedure	Clean-up and Restoration	Monitoring and Follow-up
		Design Measures	Management Plans / Contingency Plans			
					• Restoration of any disturbed ground cover, including implementation of erosion control and terrain stability measures.	

EFFECTS OF THE ENVIRONMENT ON THE PROJECT

25. EXTREME WEATHER EVENTS AND CLIMATE CHANGE

Reference: EIS Guidelines, Section 6.6.2, 6.3.3; Section C: Project Description Part 1, Section C.10, pg. C- 170, C-174; Canadian Environmental Assessment Agency's Request for Additional Information, January 13, 2016 - AIR #15.

Preamble:

The Guidelines require Benga Mining to account for changes in the environment, stemming from extreme weather events and long-term climate change implications, and the effect of those weather parameters on the Project. The Guidelines also indicate that this assessment should include extreme natural hazard events such as subsidence, fire, avalanches, landslide, and erosion. Additionally, standard environmental assessment practices generally include consideration of the impacts of climate change on a Project as a component of the assessment of the changes in the environment on a project. Projects may be affected by a change, over time, in climate parameters, or in the frequency and/or severity of extreme events.

In the additional information provided to the Agency in August 2016, Benga Mining has provided Table C.10.1-1, "Sensitivities of Project Phases and Components to the Environment", which identifies the potential impacts of climate change on key components of the Project and indicates whether these are sensitive to changes in climate and weather parameters (e.g. precipitation, wind, water levels, temperature, humidity, ice conditions, etc.). However, Benga Mining has failed to indicate whether any of these climate and weather parameters are projected to change over the duration of the Project, if they pose a risk to the Project, and consequently if they pose a risk to the public or the environment. No further discussion is provided on the impact of the natural hazard events on the VCs, mitigation success, reclamation plans, and recovery strategies and action plans for species at risk.

For example, the EIA indicates that it is reasonable to anticipate that wildfires will occur within the GBRSA during the life of the Project. The EIA recognizes the Project area as "steep mountainous terrain". While Table C.10.1-1 suggests the construction areas and camp are not located in sensitive areas, l, no data, rationale, or thresholds are provided for the classification of part of the study area as low sensitivity.

Benga Mining has provided projections of changes in the number of warm and cold days (i.e., temperature extremes), annual and seasonal precipitation totals and the number of frost free days to 2050 for Pincher Creek. These climate changes are discussed over the different phases of the Project and for the various Project components. However, there is no information given on how future climate change may alter the frequency (i.e., return period) or intensity of precipitation extremes. While Benga Mining identified possible sensitivity of some of the water management components of the Project to heavy rainfall extremes (e.g., Section C: Project Description Part 1, Section C.10, pg. C-170), projections of potential changes in mean annual and seasonal temperature are not provided. The scientific literature (e.g. IPCC, 2012, 2013; Kharin *et al.*,

2013)[7] points to an increased probability and intensity of extreme precipitation events in the future with continued climate change. Projected temperature increases by the end of the century could potentially alter conditions at the site.

The Guidelines require the proponent to discuss the longer terms effects of climate change up to the projected post-closure phase of the Project. As climate change is identified as a threat to all federally-listed species at risk identified by Benga Mining, the EIA should include a discussion of the impacts of climate change on the survival and recovery of federally listed species and on their recovery strategy and action plans.

Information Required:

a. With respect to identification and sensitivity of natural hazards:
   i. Discuss the frequency and severity of wildfires that are expected to occur during the life of the Project and the resulting potential effects on VCs, mitigation, and reclamation.

Response:

Wildfires are a complex product of many factors that affect fuel (availability, fuel moisture, and fuel loading), heat, and oxygen supply (*e.g.*, wind regime). All of these factors are affected by climate and a changing climate could affect the frequency and severity of wildfires. In a warmer environment, water is more likely to evaporate from vegetation, increasing fire risk. Rain and snow falling in heavier bursts, but less frequently, with longer periods of dryness in between, also increases fire risk. These changes may affect Valued Components (VCs) directly, but also through changes to insects, disease, habitat loss, and changes in habitat composition, function or structure. Wildfires not only cause direct mortality, but the reduced air quality produces increases in eye and respiratory illnesses. In Canada, the main economic costs of wildfires include timber losses, property destruction, fire suppression services, and reductions in tourism (Handmer *et al*. 2012). The Project will not affect the frequency or severity of wildfires.

To provide a more detailed review of wildfire impacts to VCs, historical fire data were retrieved from the Canadian Forest Service (2016) National Fire Database, which includes data from Alberta for 1931-2015. Wildfires within the Mine Permit Boundary (MPB) have been very infrequent in the past (Figure 25-1; Appendix 25A, Table 25A-1), with only one recorded fire crossing into the MPB and Wildlife Local Study Area (WLSA) in 1934. An additional six fires were recorded within the Wildlife Regional Study Area (WRSA).

Boulanger *et al*. (2014) used homogenous fire regime (HFR) zones to make model projections of fire occurrence and annual area burned across Canada. For the HFR zone in which the Project is

[7] IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken,
K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University

located (*i.e.*, Southern Cordillera), we obtained model projections for the time periods of 2011-2040 and 2041-2070.

1. Relative to the baseline from 1961-1990 (2-5 fires/100,000 km^2/yr), fire occurrence is projected to be reduced by at least 33% in 2011-2040 and by 25% to 33% in 2041-2070. Based on 1961-1990 baseline values, these changes equate to frequencies of less than 1.34/100,000 km^2/yr in 2011-2040 and less than 1.5/100,000 km^2/yr in 2041-2070.
2. Annual area burned is 1.11-1.33 times higher in 2011-2040 and 2-3 times higher in 2041-2070 than during the baseline period (<0.1% annual area burned). Because areal extent of burn is an increasing function of burn severity (Whitman *et al*. 2015), area burned is used here as a surrogate for understanding the potential effects of climate on burn severity.
3. Conclusion: fire frequency is predicted to decrease at least 25% to 33% over the lifetime of the Project, and total burn area (severity) is projected to increase 11% to 33% by 2040 and 200% to 300% by 2070. (Note: The final closure of the Project is anticipated to be ~2055.). Generally, this means fewer but larger wildfires.

Based on historical fire occurrences (area-standardized frequency) of 31.8, 20.8, and 11.2 fires/105 km^2/year in the MPB, WLSA, and WRSA, respectively, the projected percentage increase predicted by Boulanger *et al.* (2014) would equate to future fire occurrences of 21.3-23.8, 14.0-15.6, and 7.5-8.4 fires/105 km^2/yr in the MPB, WLSA, and WRSA, respectively (Table 25-1). These values are based on the assumption that Boulanger's baseline of 1961-1990 over a larger geographic scale is representative of the 1931-2013 Project baseline at the local scale.

Table 25-1 Projected Changes in Wildfire Regime

Characteristic and Timeframe	Mine Permit Boundary	Wildlife Local Study Area	Wildlife Regional Study Area
Frequency (fires/year)			
Historical 1931-2015	0.01	0.01	0.08
2011-2040	≤ 0.0067	≤ 0.0067	≤ 0.054
2041-2070	0.0067 – 0.0075	0.0067 – 0.0075	0.054 – 0.060
Fire Occurrence (fires/10^5 km^2/yr)			
Historical 1931-2015	31.8	20.8	11.2
2011-2040	≤ 21.3	≤ 14.0	≤ 7.5
2041-2070	21.3 – 23.8	14.0 – 15.6	7.5 – 8.4
Total Area Burned/Year (%/yr)			
Historical 1931-2015	0.02	0.01	0.13
2011-2040	0.022 – 0.027	0.011 – 0.013	0.14 – 0.17
2041-2070	0.06 – 0.08	0.03 – 0.04	0.39 – 0.52
Total Area Burned/Year (ha/yr)			

Table 25-1 Projected Changes in Wildfire Regime			
Characteristic and Timeframe	**Mine Permit Boundary**	**Wildlife Local Study Area**	**Wildlife Regional Study Area**
Historical 1931-2015	0.6	0.6	95.4
2011-2040	0.7 – 0.8	0.7 – 0.8	106 - 127
2041-2070	1.2 – 1.8	1.2 – 1.8	191 - 286

Other literature points to both increased burn area and increased frequency, resulting from a number of factors including climate change. For example, Westerling *et al*. (2006) and Riley and Loehman (2016) examined historical fire events in the western U.S. and found that large wildfire activity increased in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. They noted increased wildfire activity over recent decades reflected sub-regional responses to changes in climate. As virtually all climate-model projections indicate that warmer springs and summers will occur over the region in coming decades, the predictions support the tendency toward earlier spring snowmelt and longer fire seasons. This could accentuate conditions favorable to the occurrence of more frequent large wildfires.

The potential effects of changes in fire regime (reduced frequency, increased area burned) in relation to the historical fire on VCs and Benga's proposed mitigation and reclamation plans are summarized in Table 25-2. These changes are based on Boulanger *et al.* (2014) as they provide the most recently available site-specific predictions. Benga is aware that climate changes may be different than those indicated and will use adaptive management strategies to tailor its mitigation and monitoring plans to the conditions that prevail.

Table 25-2 Effects of Changes in Wildfire Frequency and Severity on Valued Components		
Valued Component	**Potential Effect**	**Effect on Mitigation**
Migratory birds	Altered landscape may increase preferred habitat for some species and decrease preferred habitat for others. Direct mortality of nestlings from fire may decrease in frequency but increase in severity.	No changes anticipated from specific mitigations / monitoring plans identified in CR #9, Section 7.0.
Olive-sided flycatcher	Increase of preferred post-burn habitat for foraging. Direct mortality of nestlings from fire may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in CR #9, Section 7.0.
Little brown myotis	Loss of non-critical habitat (*e.g.*, summer roosts, foraging habitat). Direct mortality of young in maternity roosts may decrease in frequency but increase in severity. Creation of snags for roosting.	No changes anticipated from mitigations/monitoring plans identified in CR #9, Section 7.0.

Table 25-2 Effects of Changes in Wildfire Frequency and Severity on Valued Components

Valued Component	Potential Effect	Effect on Mitigation
Common nighthawk	Increase (open areas for nesting and foraging) or decrease (shade) of suitable habitat for breeding and foraging. Direct mortality of nestlings may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in CR #9, Section 7.0.
Short-eared owl	Open habitats may increase if area burned increases. Due to nomadism, changing fire regime is not anticipated to have any effects on this species' habitat availability. Direct mortality of nestlings may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in CR #9, Section 7.0.
Whitebark pine and limber pine	Direct mortality in burn areas. Opening up of areas for new regeneration. Reduced competition from Engelmann spruce if total burn area increases in size. Fire mortality exasperates the effects of other key mortality factors, blister rust and pine beetles (both of these are also expected to increase with climate change).	No specific change to proposed mitigations identified in CR #8, Section 4.2.6.3. More details follow.
Westslope cutthroat trout	Potential for increased runoff/sedimentation from larger burns.	No change to proposed Project mitigations.
Aboriginal health	Reduced air quality during burns will be less frequent. Air quality may be further reduced during larger fires.	No change to proposed Project mitigations.
Aboriginal socio-economics	Reduced land use opportunities during burn and while landscape recovers.	No change to proposed Project mitigations.
Aboriginal physical and cultural heritage	No expected change in damage/disturbance of valued sites on land surface by fire.	No change to proposed mitigations identified in Section E.13.
Traditional land use and resource use	Reduced land use for hunting, trapping, gathering, and reduced access to trails and travelways during burn and while landscape recovers – will be come less frequent, but over larger areas.	No change to proposed Project mitigations.

The area to be reclaimed is located within the MPB. Changes to the historical fire regime, and potential impacts of fire occurrences, within this local area are uncertain (for reasons including the only fire record is not within Boulanger's baseline timeline, and n=1 fire does not allow for statistics/trends for prediction purposes). The fire regime and changing fire conditions will be monitored and adapted to as per Section F, Section F.3.9.

Although the project isn't a measurable contributor to wildfire impacts, Benga will consider the risk of fire in management and reclamation plans including the following (*e.g.*, Keane *et al.* 2017), specifically for whitebark pine and limber pine:

- reducing fuel loads in surrounding whitebark pine and limber pine habitat;
- thin forest stand containing whitebark pine and limber pine to reduce competition from other species, reduce fire severity risk, enhance survivorship;
- supporting planting and recovery efforts in burned areas in the area, within and beyond the MPB in the event that a fire does occur or as part of reclamation;
- implement efforts to protect seed and rust resistant trees and otherwise recover seed from cone trees in advance of construction where feasible to support broader conservation efforts; and
- incorporate climate change into reclamation plans to account for shifting conditions, *e.g.*, plant at higher elevations, consider slope and aspect, use suitable seed stock for conditions, *etc*.

During construction and operations appropriate procedures will be implemented to reduce the risk of fire and response plans developed in conjunction with local emergency services in the event that fires occur within the MPB or surrounding area. In addition, our vegetation management and reclamation plans will be developed to align with species recovery strategies and priorities. This may include additional mitigation measures implemented on site to reduce the risk of fire impacts on threatened species.

Climate change may also contribute to the spread of blister rust or mountain pine beetle outbreaks, which are the key mortality sources for both species. Blister rust is already present on site with an estimated >90% infection rate. Benga is working with the Crown of the Continent Ecosystem Hi5 Working Group, which is developing a restoration strategy for the whitebark and limber pine within the Crown of the Continent portion of their range. The strategy is being developed through a multis-takeholder initiative that includes state, provincial, federal (Canada and U.S.), conservation organizations, First Nations and Tribal governments, individuals, academia and industry. The objective is to develop a strategy that aligns with both Canadian and U.S. recovery strategies for the species by establishing best practices and priority areas to focus conservation efforts to support the conservation and recovery of the species.

ii. Evaluate and provide a map showing the landslide potential in the Project area. Provide an explanation on how the landslide potential will be addressed and mitigated. Incorporate this information into the sensitivity ratings and discuss the frequency and severity of landslides that are expected to occur during the life of the project and the resulting potential effects on VCs, mitigation, and reclamation.

Response:

The assumption in developing this response is that the Project area is the disturbed area of the mining operation. Section B documents the stability considerations in design of mine features including pit walls and storage dumps. Design criteria are included in, Section B, Section B.8.6 and are based on corehole and lab analysis conducted at discrete locations as part of preliminary design with information presented in cross sections and at points. As such, a map of stability or landslide potential has not been prepared.

Section B, Section B.8.6 notes instability in rock slopes (*i.e.*, the potential for landslides) can generally be classified according to two principal failure mechanisms:

- Structurally Controlled Failure Mechanisms: Structurally controlled failure in rock occurs as the result of sliding along pre-existing geologic discontinuities (*i.e.*, kinematic failures); and
- Rock Mass Strength Failure: Slopes excavated in weak or heavily fractured rock masses, or very high slopes, can be susceptible to overall rock mass failure, which involves the development of pseudo-circular type failure zones through intact rock.

Structurally controlled failures can be further subdivided into the following types based on the pit slope type:

- structural controlled failure in benched highwall, footwall, and endwall rock slopes are planar failure, wedge failure, and toppling failure;
- structurally controlled failure in unbenched footwall slopes are planar sliding failure; and
- ploughing failure, bi-linear sliding failure, and buckling failure.

To reduce the probability of undercutting of bedding and subsequently expose structures that could result in multi-bench instabilities, a bench face angle which follows the bedding dip slope will be adopted for benched and unbenched footwall slopes at Grassy Mountain. The magnitude and frequency of structurally controlled failures are directly related to the continuity of the structures along which sliding can occur. Structures that exhibit limited continuity, such as the cross joints at Grassy Mountain, may result in small bench-scale failures that are rarely of consequence to overall slope stability, but may adversely affect access ramps or fixed equipment. Conversely, larger scale failures can occur along continuous, through-going structures, such as bedding and major faults at Grassy Mountain. It is, therefore, these more continuous structures that are of primary concern to overall slope stability. Design recommendations have been developed as part of preliminary design based on the expected stability performance of proposed pit slopes, which are listed and illustrated in Section B, Section B.8.6.

Section B, Section B.8.6 also notes a semi-quantitative system for assessing the relative potential for dump stability from the British Columbia Mined Rock and Overburden Investigation and Design Manual, Interim Guidelines, 1991 (Table 5.1), which was used to develop a Dump Stability Rating (DSR), which in turn provided guidance for the level of effort for investigation and design (British Columbia Mine Waste Rock Pile Research Committee 1991). Section B, Section B.8.6 also summarises four classes of DSR values and recommends a level of effort for design, investigation and construction methods and monitoring for the rock disposal areas proposed for the Grassy Mountain mine such that minimum design factors of safety can be maintained.

Section B, Section B.8.6 also documents the conservative analysis conducted to model earthquake conditions as a trigger of landslides using the pseudo-static method of analysis, which

applies a horizontal force to the failure mass proportional to the design horizontal acceleration. From this analysis, recommended slope design criteria were developed based on the current understanding of the geology. To improve the understanding of the geology, routine geologic mapping will be carried out as the slopes are excavated. In essence, the design criteria ensure that pit slopes would fall into the pit rather than into the environment beyond the study area.

The current frequency of landslides in the study area is unknown. However, in the region it is understood that there are many documented pit collapses, as a result of the existing legacy pits in the area (Froese and Mei 2008) and that the frequency of collapse increases in spring. Some of these may trigger minor slides. Operation and reclamation of the proposed mine is expected to reduce the potential for these pit collapses and thus any slides they may trigger. The potential effects of landslides on VCs and Benga's proposed mitigation and reclamation plans are summarized in Table 25-3.

Table 25-3 Effects of Changes in Landslide Frequency and Severity on Valued Components

Valued Component	Pit Slope	Storage Area Slope
Migratory birds	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Olive-sided flycatcher	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Little brown myotis	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Common nighthawk	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Short-eared owl	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.

Table 25-3 Effects of Changes in Landslide Frequency and Severity on Valued Components		
Valued Component	**Pit Slope**	**Storage Area Slope**
	the pit. No changes to mitigation and monitoring plans.	
Whitebark pine and limber pine	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Westslope cutthroat trout	No effect and potentially reduced effects with reduced annual precipitation. Pit slopes designed to minimize potential slides into the pit. No changes to mitigation and monitoring plans.	No effect and potentially reduced effects with reduced annual precipitation. DSR criteria considered to be conservative. No changes to mitigation and monitoring.
Aboriginal health	No change to proposed Project mitigations.	No change to proposed Project mitigations.
Aboriginal socio-economics	No change to proposed Project mitigations.	No change to proposed Project mitigations.
Aboriginal physical and cultural heritage	No change to proposed Project mitigations.	No change to proposed Project mitigations.
Traditional land use and resource use	No change to proposed Project mitigations.	No change to proposed Project mitigations.

b. With respect to climate change:
   i. For each of the areas in which Project phases and components were deemed to be sensitive to natural hazards, provide a discussion on the frequency and severity of expected natural hazards at present and in the future as a result of climate change.

Response:

Future frequency and severity of natural hazards, relative to current frequency and severity, are provided in Table 25-4 and are based on predictions from the CMIP5 ensemble of models for temperature and wind (Canadian Climate Data Scenarios 2017), and CMIP5 projections for extreme temperature and precipitation (CCCMA 2017). The projection data are provided in Appendix 25A, Tables 25A-2 to 25A-13.

Table 25-4 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
Extreme Temperature – Frequency / Severity	1986-2005 max daily temperature: 95th percentile and max = 31.1°C and 31.8°C (Appendix 25A, Table 25A-2)		Higher frequency of extreme high temperatures (*i.e.*, >31.1°C) (Appendix 25A, Tables 25A-1 and 25A-2)	Higher maximum daily temperatures (Appendix 25A, Tables 25A-1 and 25A-2)
	1986-2005 minimum daily temperature: 5th percentile and min = -42.0°C and - 43.4°C (Appendix 25A, Table 25A-3)		Lower frequency of extreme low temperatures (*i.e.*, < - 42.0°C) (Appendix 25A, Tables 25A-1 and 25A-3)	Higher minimum daily temperatures (Appendix 25A, Tables 25A-1 and 25A-3)
Extreme Precipitation – Frequency / Severity	1986-2005 1-day maximum: 95th percentile and max = 65.7 mm and 70.9 mm (Appendix 25A, Table 25A-6) 1986-2005 5-day maximum: 95th percentile and max = 130.3 mm and 137.9 mm (Appendix 25A, Table 25A-7) 1986-2005 # days > 20 mm ppt: 95th percentile and max = 7.1 days and 8 days (Appendix 25A, Table 25A-9)		11% to 58% higher frequency of historical extreme based on P_{20} analysis (Appendix 25A, Tables 25A-4 and 25A-5) Lower frequency based on CMIP5 precipitation data: 1-day max, 5-day max, and # days > 20 mm ppt (Appendix 25A, Tables 25A-6, 25A-7, and 25A-9)	-- Lower severity based CMIP5 precipitation data: 1-day 95th percentile (33.9 mm to 57.3 mm), 5-day 95th percentile (81.5 mm to 103.2 mm) (Appendix 25A, Tables 25A-6 and 25A-7)
Streamflow	Base flows, low flows, and peak flows provided in CR #4, Sections 3.6, 3.7, and 3.8. Peak flows for return period of 25 years = 543 and 679 l/s/km^2 for Blairmore and Gold Creeks, respectively.		With general reductions in total annual precipitation (Appendix 25A, Table 25A-8) and # days with >20 mm precipitation (Appendix 25A, Table 25A-9), and a tendency towards longer dry periods (Appendix 25A, Table 25A-10), streamflow may be reduced, particularly for higher emissions scenarios. Based on P20 analyses, peak flows may become more frequent.	

Table 25-4 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
Groundwater / Soil Moisture	Groundwater conditions are described in CR #3, Section 4.0, and are complex due to the geology and topography. Soils are described in CR #7, Section 4.0. Soil conditions, including soil moisture, are very diverse across the Project.		Unknown. Recharge of shallow aquifers is likely to be more responsive to regional changes in climate than recharge of deep aquifers (Rivera *et al*. 2004, Clifton *et al*. 2010). Note that local conditions for the Project are not necessarily indicative of the regional conditions that affect aquifer recharge. Soil moisture is likely to decrease (Collins *et al*. 2013, Kirtman *et al*. 2013). Projections include 0% to 1% reduction in soil moisture in the near-term (2016-2035) relative to 1986-2005 (Kirtman *et al*. 2013). However, changes are also dependent on soil characteristics, which may themselves be altered by climate change (Kumar 2012).	
Evaporation Rate	Average annual lake evaporation = 738 mm/yr, average annual evapotranspiration = 262 mm/yr (CR #4, Section 2.6)		Likely to increase as a function of annual temperature increases (Collins *et al*. 2013, Kirtman *et al.* 2013). Projections include up to 5% increase in the near-term (2016-2035) relative to 1986-2005 (Kirtman *et al*. 2013).	
Wind	See Appendix 25A, Tables 25A-12 and 25A-13		Median, 95th percentile, maximum monthly wind speeds lower than historical values (Appendix 25A, Tables 25A-12). Frequencies of gusts of ≥28 km/h, ≥40 km/h, ≥70 km/h, and ≥90 km/h are projected to increase with climate change (Appendix 25A, Table 25A-13). Gust severity (*i.e*., speed) is not anticipated to increase. More frequent periods of light winds.	
Avalanche	--		Potential effects of climate change on avalanche risk, frequency, and severity are uncertain/unknown (Eckert *et al*. 2009, Bellaire *et al*. 2013, Sinickas *et al*. 2015)	
Erosion	--		Reduced total rainfall and 1-day and 5-day maximum rainfalls would result in reduced soil erosion; however, the analysis of P20 would indicate increased soil erosion risk from more frequent extreme rainfall events (Nearing *et al*. 2004). Effects of changes in precipitation on soil erosion are therefore uncertain. Erosion from wind may increase from increased gust frequency.	

Table 25-4 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
Landslide	--		Increased temperature and decreased annual precipitation may lead to drying that increases slope stability and reduces the risk of rockslides and mudslides. If wind gusts become more severe, slopes may destabilize. "*The type, extent, magnitude, and direction of the changes in the stability conditions of the slopes, and on the location, abundance and frequency of the landslides, are not completely clear. The effects of the warming climate on landslide risk, and particularly the risk to the population, also remain difficult to quantify*" (Gariano and Guzzetti 2016). Huggel *et al*. (2012) reviewed major landslide events occurring since the 1990s, including three in BC, and proposed a number of mechanisms that could significantly change landslide magnitude and frequency under a warming climate. Riannaa *et al* (2014) modelled changes in slope movement with precipitation amount, and forecasted reduced movement based on reduced predicted climate-induced rainfall. Similarly, Bathurst *et al*. (2005) used scenario runs of the Hadley Center global circulation model HadRM3 for 2070–2099 as input to a physically based model to assess changes in landslide activity at a site in the Italian Alps. They found slightly reduced debris flow activity in a warmer drier climate. Laloui *et al*. (2010) expected shallow slips and debris flows will take place more frequently as a consequence of more extreme weather events, using the example of Switzerland, with stable total precipitation but an increased tendency to stormy and intense weather, especially in fall, spring and winter. As a result, they expected more rain at higher altitudes and increased occurrence of shallow landslides in steep mountainous slopes.	
Subsidence	--	--	No anticipated changes in subsidence resulting from climate change during the life of the Project.	
Seismic Events	From 1985-2016, 4 earthquakes within 25 km of Project centre (magnitude 2.1 to 2.5) and 40 within 100 km (magnitude 0.0 to 4.3) (Natural Resources Canada 2017).		No anticipated changes in seismicity resulting from climate change during the life of the Project. If climate change affects plate tectonics, this would be over a much longer time scale than that of the Project.	
Wildfire	See response to IR #25a(ii)			

ii. Provide projections of the range of possible changes in annual and seasonal temperature over the projected lifetime of the mine and the period of active management following closure. The projections should come from a range of climate models for a range of future emission scenarios.

Response:

Projected changes in winter (December, January, February), summer (June, July, August), and annual median temperature relative to historical (1986-2005) winter, summer, and annual median temperature for the Project were determined for three time periods (2020-2029, 2035-2044, and 2050-2059) (Appendix 25A, Table 25A-2). Historical and projected future temperatures were acquired from Canadian Climate Data Scenarios (2017). Ensemble projections were extracted for three future emissions scenarios (RCP2.6 – low emissions, RCP4.5 – intermediate emissions, and RCP8.6 – high emissions) for the location of 49.5°N latitude and 245.5°E longitude, which is the closest available location to the Project and about 20 km SW from the centre of the proposed pit.

On average, median annual temperatures are projected to increase by 1.1°C to 1.6°C over the duration of the Project under mitigated (low) emission conditions, 1.2°C to 2.3°C under intermediate emissions, and 1.3°C to 2.9°C under high emission conditions. Summer temperatures are projected to increase more than winter temperatures during all time periods and emission scenarios.

Extreme maximum and minimum temperature data were obtained from CCCMA (2017) to assess potential changes in severity with climate change (Appendix 25A, Tables 25A-3 and 25A-4). Daily temperature maxima are projected to increase from historical values over the duration of the Project, and extreme temperatures (greater than the 95th percentile of historical values) are more probable at higher emission levels and at later dates (Appendix 25A, Table 25A-3). With winters expected to warm, cold temperatures are not projected to be as extreme as historical minimum temperatures (median, 5th percentile, and minimum) (Table 25-5).

iii. Provide information on potential future changes in precipitation extremes over the projected lifetime of the mine and the period of active management following closure. Projections from a range of climate models for a range of future emission scenarios should be considered.

Response:

Potential future changes in precipitation extremes were discerned through two methods:

- Changes in the historical 20-year return period (?P20) for annual daily precipitation extremes were calculated to assess potential future changes in precipitation extremes for the duration of the Project and for three emissions scenarios; and

- Climate model precipitation data (CCCMA 2017) (1-day maximum, 5-day maximum, total annual, number of days >20 mm precipitation, maximum number of consecutive dry days) were reviewed.

ΔP20

We calculated the sensitivity of the historic 20-year return period for annual daily precipitation extremes (ΔP20) for the location (49.5°N latitude and 245.5°E longitude), scenarios, and median annual temperatures provided in Appendix 25A, Table 25A-2. Percentage changes in P20 were calculated based on Kharin *et al.*'s (2013) estimate of 10% to 20% reduction in P20 per 1°C increase in local annual temperature for land in the northern hemisphere (Appendix 25A, Table A25-5); return times for equivalent extreme precipitation were subsequently calculated (Appendix 25A, Table 25A-6).

From the ΔP20 metrics, it is expected that extreme rainfalls will occur more frequently as time progresses and if emission levels are higher. Under the worst-case scenario included in the Appendix 25A, Table 25A-6, historical P20 precipitation may be experienced every 8.4 years in 2050-2059. If emissions in the future are similar to the mitigated (low) scenario, historical P20 rainfall is projected to occur approximately every 17-18 years (10% reduction scenario) or 13-16 years (20% reduction scenario) for the duration of the Project. It must be noted that Kharin *et al.* (2013) stated that extreme precipitation projections have large uncertainties associated with them (approximately ±20% error in the extratropics).

Precipitation Model Projections

Projections from the CMIP5 ensemble of models were obtained and reviewed for 1-day and 5-day precipitation maxima, total annual precipitation on wet days (days with >1 mm precipitation), number of days with >20 mm precipitation, and consecutive dry days (days with <1 mm precipitation). Data were extracted from historical data and three future emissions scenarios (RCP2.6, RCP4.5, and RCP8.6) from CCCMA (2017) for the available locations of 1) 49.72°N latitude and 244.69°E longitude and 2) 49.72°N latitude and 246.09°E longitude, which are approximately 64 km west (in mountainous terrain) and 39 km east (in prairie landscape) of the Project, respectively. It is anticipated that future precipitation will be more similar to the mountainous Location 1 than to the prairie Location 2, and the discussion therefore focuses on Location 1.

Projected 1-day and 5-day maximum precipitation (Appendix 25A, Tables 25A-7 and 25A-8), total annual precipitation during wet days (Appendix 25A, Table 25A-9), number of days with >20 mm precipitation (Appendix 25A, Table 25A-10), and consecutive dry days (Appendix 25A, Table 25A-11) were determined for three periods (2020-2029, 2035-2044, and 2050-2050) and compared with historical values (1986-2005).

Each of these five metrics are projected to change over time, with trends differing among potential emissions scenarios and timeframes. The model projections indicate:

- 1-day maximum precipitation values in the future are within the range of historical values, and 95th percentiles and maximum values are all lower than the historical maximum at Location 1 (Appendix 25A, Table 25A-7);
- 5-day maximum precipitation values in the future are within the range of historical values, and 95th percentiles and maximum values are all lower than the historical values at Location 1 (Appendix 25A, Table 25A-8);
- total annual precipitation in the future is within the range of historical annual accumulations, and 95th percentiles and maximum values are all lower than the historical values at Location 1 with the exception of one 95th percentile (rcp26, 2035-2044) (Appendix 25A, Table 25A-9);
- number of days annually with more than 20 mm precipitation in the future is within the range of historical values, and 95th percentiles and maximum values are all lower than or the same as the historical values at Location 1(Appendix 25A, Table 25A-10); and
- median maximum number of consecutive days annually with less than 1 mm precipitation is generally within the range of historical values, but 95th percentile values for rcp45 and rcp68 at Location 1 were higher than historical values (Appendix 25A, Table 25A-11).
- overall: total annual and extreme (high) precipitation events are projected to decrease in the future for the Project as a result of climate change, and extended dry (or extreme low) precipitation events are likely to be more common.

Conclusion

The analyses of P20 and ΔP20 indicated historical extreme precipitation levels should occur more frequently in the future due to the local increases in annual temperature (Appendix 25A, Table 25A-5 and 25A-6). However, the precipitation data indicated 1-day and 5-day maximum precipitation extremes were lower than historical values (Appendix 25A, Table 25A-7 and 25A-8), which contradicts the former conclusion.

Environment Canada (2016a) noted climate models are limited when it comes to predicting precipitation extremes due to the spatial resolution of the models. Kharin *et al*. (2013) also indicated a high level of uncertainty in the projections of extreme precipitation achieved with the most current climate models used in Canada.

Due to the magnitude of the discrepancy in conclusions achieved from the analysis of P20 and the analyses of precipitation projections, it is not possible to discern the probable impacts of climate change on precipitation and precipitation extremes for the Project location. Nonetheless, design criteria for the structures sensitive to precipitation amounts are conservative and included as one potential design basis for the maximum probable flood (PMF). The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation and snow melt measurements coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event but Benga has used PMF as one input in developing its range of dam designs.

iv. For each of the 'local conditions' or natural hazards identified in Table C.10.1-1, indicate whether any of the climate and weather parameters are projected to change over the duration of the Project, if the changes pose a risk to the Project, and consequently if there is a risk to the public or the environment.

Response:

The response in Table 25-5 is based on predictions of the CMIP5 ensemble of models at Location 1 as discussed in the response to IR #25b(ii) above. Benga recognizes that use of the P20 return period projections suggests alternative changes in some of the hazards, and other interpretations of risks.

Table 25-5 Changes in Natural Hazards Over Time and Associated Risks

Natural Hazard	Projected to Change	Confidence	Risk to Project	Subsequent Risk of Effects on Project		Additional Mitigations Required
				To Public	To Environment	
Annual Temperature	Yes – increase (Appendix 25A, Table 25A-2)	High	Low	Low	Low	None
Extreme Temperature – Frequency / Severity	Yes – increase of hot extremes, decrease of cold extremes (Appendix 25A, Table 25A-3, 25A-4)	High	Low	Low	Low	None
Total Annual Precipitation	Yes – decrease (Appendix 25A, Table 25A-9)	High	Low	Low	Low	None
Extreme Precipitation – Frequency / Severity	Uncertain – increase (Appendix 25A, Table 25A-6) or decrease (Appendix 25A, Table 25A-7, 25A-8, 25A-10) in heavy ppt extremes. Increase in # consecutive dry days (Appendix 25A, Table 25A-11).	Low	Drought – Low Flooding - Low	Low	Low	None
Streamflow	Yes- likely to decrease in general, altered flow regimes, droughts, increased frequency of high flow events (Table 25-4).	Moderate	Low	Low	Low	None
Groundwater / Soil Moisture	Uncertain – groundwater levels (Table 25-3) Yes – soil moisture likely to decrease in general (Table 25-4).	Low High	Low Low	Low	Low	None
Evaporation Rate	Yes - likely to increase 0-5% (Table 25-4).	High	Low	Low	Low	None
Wind	Yes – increase in gust frequency (Appendix 25A, Table 25A-13).	High	Low	Low	Low	None
Avalanche	Uncertain (Table 25-4).	Low	Low	Low	Low	None
Erosion	Uncertain (Table 25-4).	Low	Low	Low	Low	None
Landslide	Uncertain (Table 25-4).	Low	Low	Low	Low	None
Subsidence	Uncertain – related to groundwater levels, particularly in shallow aquifers. Unlikely during life of Project.	Low	Low	Low	Low	None

Table 25-5 Changes in Natural Hazards Over Time and Associated Risks

Natural Hazard	Projected to Change	Confidence	Risk to Project	Subsequent Risk of Effects on Project		Additional Mitigations Required
				To Public	To Environment	
Seismic Events	Unlikely in lifetime of Project (Table 25-4).	High	Low	Low	Low	None
Wildfire	Yes – decreased frequency, increased severity (Table 25-1).	High	Loss of access to mine site - Low Loss of mine infrastructure - Low Loss of coal resource - Low	Low	Low	None

v. Describe the potential effects of climate change on the Project, from the standpoint of effects on VCs, using the Agency's procedural guidance on "Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners".

Response:

Based on analyses completed for temperature, precipitation, and projections resulting from climate change (Appendix 25A, Table 25A-2 to 25A-13), we can be confident that mean annual temperature, hot temperature extreme frequency/severity, and frequency of wind gusts will increase during the lifetime of the Project, and that cold temperature extremes will decrease in severity and frequency. However, due to contradictions in precipitation predictions, we are not confident in concluding whether the Project will experience more or fewer extreme heavy precipitation events, and therefore what the implications would be on VCs.

Potential effects of these climate change conclusions on VCs during the life of the Project (*i.e.*, 2018 – mid 2050s) are summarized in Table 25-6.

Table 25-6	**Potential Effects of Climate Change on Valued Components**	
Valued Component	**Potential Effect**	**Effect on Mitigations[1]**
Migratory birds	Increased temperature (up to 4°C increase in annual median temperature by 2050s): Range shifts northwest up the Rocky Mountains and to higher elevations to marginal habitats, until vegetation responds to climate change; this may reduce reproduction and survival. Species ranges may shift northwest up the Rocky Mountains and higher in elevation in response to increased temperatures. Migratory birds, including species at risk, not currently in the WLSA or WRSA may shift into these areas. Birds may arrive earlier in the spring and nest earlier – if this occurs out of sync with food availability, nestling survival will decrease. Sources: King and Finch (2013), Iverson and McKenzie (2014), Nature Canada (2017)	Annual breeding bird surveys will be conducted for the duration of the Project to monitor changes in the migratory bird community, including changes in presence and relative abundance of species at risk. The Conservation and Reclamation Plan (C&R Plan) will be adapted accordingly over time to accommodate requirements of shifting migratory bird community.
	Less precipitation and fewer heavy rainfall events: as for increased temperature. precipitation-sensitive species' ranges may shift with precipitation rather than temperature (*e.g.*, to lower elevation). Or Increased frequency of heavy rainfall events: precipitation-sensitive species' ranges may shift with precipitation. Sources: King and Finch (2013), Nature Canada (2017)	As for increased temperature.
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Olive-sided flycatcher	Increased temperature (up to 4°C increase in annual median temperature by 2050s): As for migratory birds. Recovery Strategy (Environment Canada 2015a) indicates habitat shifting and alteration from climate change will have unknown severity of effect and that the causal certainty of any effect is low (*i.e.*, plausible, but not confirmed).	As for migratory birds. Any additional information made available for this species (*e.g.*, finalized Recovery Strategy, confirmation of sensitivity to climate change) will

Table 25-6 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
		be reviewed. C&R Plan will be adapted accordingly. If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada.
	Less precipitation and fewer heavy rainfall events: As for increased temperature. As for migratory birds. Or Increased frequency of heavy rainfall events: As for increased temperature.	As for increased temperature. As for migratory birds.
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Little brown myotis	Increased temperature (up to 4°C increase in annual median temperature by 2050s): Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species. As for fire (Table 25-2).	Any additional information made available for this species (*e.g.*, finalized Recovery Strategy, confirmation of sensitivity to climate change) will be reviewed. C&R Plan will be adapted accordingly. If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada.
	Less precipitation and fewer heavy rainfall events: Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species. As for fire (Table 25-2).	As for increased temperature.

Table 25-6 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
	Or Increased frequency of heavy rainfall events: Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species.	
	Reduced median monthly wind speeds: May overall increase abundance of flying insect prey and suitable foraging time. Increased frequency of hourly wind gusts: Temporary reductions in prey availability and suitable foraging time if more frequent during peak foraging periods.	As for increased temperature.
Common nighthawk	Increased temperature (up to 4°C increase in annual median temperature by 2050s): Recovery Strategy (Environment Canada 2015c) indicates moderate severity and medium causal certainty for effects of temperature extremes related to climate change on this species. These effects are described for cold wet weather during breeding and tropical storms during fall migration, neither of which are applicable to the Project. Therefore, climate change projected for the WLSA and WRSA would have unknown severity and low causal certainty for this species. Recovery Strategy (Environment Canada 2015c) indicates unknown severity and low causal certainty for effects of habitat shifting related to climate change on this species. As for migratory birds. As for fire (Table 25-2).	Any additional information made available for this species (*e.g.*, finalized Recovery Strategy, confirmation of sensitivity to climate change) will be reviewed. C&R Plan will be adapted accordingly. If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada.
	Less precipitation and fewer heavy rainfall events: As for increased temperature. Or Increased frequency of heavy rainfall events: If heavy rainfall events occur during nesting season, reproductive success may decrease, especially if accompanied by cold temperatures (Environment Canada 2015c).	As for increased temperature.

Table 25-6	**Potential Effects of Climate Change on Valued Components**	
Valued Component	**Potential Effect**	**Effect on Mitigations[1]**
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Short-eared owl	Increased temperature (up to 4°C increase in annual median temperature by 2050s): Management Plan (Environment Canada 2016b) indicates negligible severity with high and medium causal certainty for habitat shifting/alternation and severe weather resulting from climate change (*i.e.*, climate change is not anticipated to have any effects on this species).	None
	Less precipitation and fewer heavy rainfall events: As for increased temperature. Or Increased frequency of heavy rainfall events: As for increased temperature.	None
	Reduced median monthly wind speeds As for increased temperature Increased frequency of hourly wind gusts As for increased temperature	None
Whitebark pine and limber pine	Increased temperature (up to 4°C increase in annual median temperature by 2050s): increased survival spread of mountain pine beetle leading to increased mortality. reduced suitable and available habitat. increased competition from species better adapted to warmer temperatures (*e.g.*, subalpine fir, lodgepole pine). shift in range northwards through Rocky Mountains. Source: AWLPRT (2014a,b).	Any additional information made available for this species (*e.g.*, federal Recovery Strategy) will be reviewed. The C&R Plan will be adapted accordingly.

Table 25-6	**Potential Effects of Climate Change on Valued Components**	
Valued Component	**Potential Effect**	**Effect on Mitigations[1]**
	Less precipitation and fewer heavy rainfall events: may increase wildfire severity, which has unknown effects on the population of whitebark pine and limber pine at the Project (would be beneficial in terms of eliminating competing species, opening up regeneration sites, and reducing susceptibility to mountain pine beetle; would be detrimental in terms of high-intensity fires killing mature trees). Source: AWLPRT (2014a,b). Or Increased frequency of heavy rainfall events: no anticipated effect.	As for increased temperature.
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Westslope cutthroat trout	Increased temperature (up to 4°C increase in annual median temperature by 2050s): Medium to High severity with Low mitigation potential resulting from increased air/water temperature, shortened winters, higher evapotranspiration, reduced runoff, reduced summer streamflows, and increased fire intensity (Alberta Westslope Cutthroat Trout Recovery Team 2013). Reduced suitable habitat availability, survival, and reproduction.	None
	Less precipitation and fewer heavy rainfall events: As for increased temperature. Or Increased frequency of heavy rainfall events: Increased streamflow and increased runoff may reduce some of the effects of increased temperature.	None

Table 25-6 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Aboriginal health	Increased temperature (up to 4°C increase in annual median temperature by 2050s): no anticipated effects assuming people self-mitigate appropriately (*e.g.*, stay indoors during extreme heat, air conditioning, staying hydrated).	None
	Less precipitation and fewer heavy rainfall events: No anticipated effects. Or Increased frequency of heavy rainfall events: No anticipated effects assuming people self-mitigate appropriately (*e.g.*, stay away from streams during/after high rainfall events, follow public warnings or evacuation notices).	None
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Aboriginal socio-economics	Increased temperature (up to 4°C increase in annual median temperature by 2050s): As for fire (Table 25-2).	None
	Less precipitation and fewer heavy rainfall events: As for fire (Table 25-2). Or Increased frequency of heavy rainfall events: No anticipated effects unless washouts/flooding prevent workers from attending workplace.	None
	Reduced median monthly wind speeds:	None

Table 25-6 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
	No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	
Aboriginal physical and cultural heritage	Increased temperature (up to 4°C increase in annual median temperature by 2050s): No anticipated effects.	None
	Less precipitation and fewer heavy rainfall events: No anticipated effects. Or Increased frequency of heavy rainfall events: No anticipated effects.	None
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None
Traditional land use and resource use	Increased temperature (up to 4°C increase in annual median temperature by 2050s): As for fire (Table 25-2).	None
	Less precipitation and fewer heavy rainfall events: as for fire (Table 25-2). Or Increased frequency of heavy rainfall events: reduced use of flooded areas during and while landscape recovers. reduced use if access roads/bridges wash out from flooding.	None

Table 25-6 Potential Effects of Climate Change on Valued Components		
Valued Component	**Potential Effect**	**Effect on Mitigations[1]**
	Reduced median monthly wind speeds: No anticipated effects. Increased frequency of hourly wind gusts: No anticipated effects.	None

[1] Mitigations in addition to those provided in the EIA

c. With respect to federally listed species at risk:
   i. Provide a discussion on the direct and indirect effects on the survival or recovery of all federally listed species (e.g. westslope cutthroat trout, whitebark pine, limber pine, olive-sided flycatcher, great grey owl, and little brown bat) based on predicted changes to the environment resulting from extreme weather conditions, natural hazards and predicted climate change.

Response:

Westslope Cutthroat Trout

Alberta Westslope Cutthroat Trout Recovery Team (2013) concluded that climate change would result in impacts to westslope cutthroat trout with medium to high severity and with low mitigation potential, due to reduced habitat suitability and availability, increased air/water temperature, shortened winters, higher evapotranspiration, reduced runoff, reduced summer streamflows, and increased fire intensity resulting in erosion. Reduced habitat suitability may subsequently result in a competitive advantage to other fish species.

With limited mitigation potential based on current knowledge of this species and the restricted available habitat for this species, recovery from climate change may be limited.

Whitebark Pine and Limber Pine

Currently, potential effects of climate change on whitebark pine are not understood. Since this species already occurs at the northern limits of its range and at treeline, there is little to no room to expand its range northwards or up in elevation (AWLPRT 2014a). It is likely that its range will shrink. It is also likely that threats from mountain pine beetle will increase due to increased winter survival of this beetle as temperatures increase. Effects of a changing fire regime are not known and may be negative or positive depending on, for example, the amount of direct mortality, the resulting landcover, changes in competition from other tree species, and change in risk from white pine blister rust.

Limber pine could respond to increasing temperatures by shifting its range northward or up in elevation (AWLPRT 2014b). Similar to whitebark pine, limber pine is expected to have increased risk from mountain pine beetle as temperatures increase, and unknown effects from a changing wildfire regime. Limber pine may also become more susceptible to limber pine dwarf mistletoe during drought conditions.

Both of these species are expected to exhibit long lag times (>1,000 years) to respond to changing climate, during which physiological stress may lead to reduce survival of these species (AWLPRT 2014b).

Due to limber pine currently having more geographical flexibility in where it can shift its range, it is likely to adapt to climate change better than whitebark pine. Should whitebark pine suffer large losses in suitable habitat, extreme physiological stress during its lag in adapting, and higher

risks from white pine blister rust and mountain pine beetle, climate change will have a detrimental effect on its survival and recovery.

Olive-sided Flycatcher

Currently, there is no understanding of potential impacts of climate change on olive-sided flycatcher (Environment Canada 2015a). Similarly, little is known about impacts of other potential threats to this species in its breeding range. It is thought that the greatest threat to this species is loss and degradation of wintering habitat in South America. Should climate change adversely affect this species' wintering habitat by contributing to further habitat loss and degradation, survival of this species may be reduced.

If climate change does negatively impact this species' breeding range due to increasing temperatures, including within the Project location, it is expected that this species will move northward or to higher altitudes to suitable coniferous or mixedwood habitats. It is also possible that this species may experience an overall benefit from a changing fire regime within its breeding range. Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Little Brown Myotis

Currently, there is no understanding of potential impacts of climate change on little brown myotis (Environment Canada 2015b). Increasing temperatures may be detrimental (*i.e.*, increased evaporative water loss) or beneficial (*i.e.*, increased suitable locations for hibernating), as may be a changing wildfire regime. Reduced precipitation may alter the available insect prey community, thereby indirectly affecting growth and survival.

Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Common Nighthawk

There is little known about effects of climate change on this species (Environment Canada 2015c). Currently, the most probable effect of climate change on this species is the indirect affect related to reduced insect prey abundance, particularly if unusually cold and wet weather occurs during the breeding season (Environment Canada 2015c).

If climate change negatively impacts this species' breeding range due to increasing temperatures, including within the Project location, it is expected that this species will move northward or to higher altitudes. Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Short-eared Owl

Based on Environment Canada's (2016b) Management Plan for this species, climate change is expected to have a negligible effect on this species within its breeding range. Therefore, climate change is not expected to affect this species' survival or recovery. Should information about potential affects of climate change on this species change in the future, this can be re-evaluated.

Note: Great grey owl is not a federally-listed species, and is therefore not included in this response.

ii. Provide a discussion of the impact of extreme weather conditions, natural hazards and predicted climate change on the existing Recovery Strategy and Action Plans for all federally listed species (e.g. westslope cutthroat trout, whitebark pine, limber pine, olive-sided flycatcher, great grey owl, and little brown bat).

Response:

Benga believes it is beyond the scope of this information response to comment on the existing Recovery Strategy and Action Plans for all federally-listed species, or how the action plans might change in the event of climate change. Benga considers this to be the responsibility of Environment Canada. Benga has presented potential changes to its proposed mitigation and monitoring plans in the face of a changing climate and will update these plans in the event of any modifications to species-specific Recovery Strategy and Action Plans.

CUMULATIVE EFFECTS ASSESSMENT

26. CUMULATIVE EFFECTS ASSESSMENT

Reference: EIS Guidelines, Section 6.6.3; EIA Volume 1, Sections D.2.4.5, E.1.4, E.2.4, E.3.4, E.4.4, E.5.4, E.6.4, E.7.4, E.8.4, E.9.4, E.10.4, E.11.4, E.12.4, E.13.4; EIA Volume 3, Appendix 2A; Consultant Reports 1-12, Agency's Request for Additional Information, January 13, 2016 - AIR #16.

Preamble:

To enable the assessment of Project-related effects and cumulative effects of the Project in combination with the effects of other projects and activities that have been or will be carried out, Benga Mining considered three assessment cases:

- Baseline Case: includes existing environmental conditions, existing projects and "approved" activities;
- Application Case: includes the Baseline Case plus the Project; and
- Planned Development Case (Cumulative Effects): includes the "Application Case" combined with past studies, existing and anticipated future environmental conditions, existing projects or activities, plus other "planned" projects or activities.

The determination of significance and use of terminology, including understanding of what constitutes a residual and/or cumulative effect, remains inconsistent in the cumulative effects sections for each VC in the revised EIA. These inconsistencies may be due, in part, to Benga Mining's failure to provide the cumulative effects assessment in a stand-alone section, as recommended in Part 1, section 4.4 of the Guidelines. For some VCs, Benga Mining has continued to assume that it should only include the significant residual effects of the Project and has failed to include all residual effects of the Project, including those that were not determined to be significant, for other VCs there is no well-documented presentation of the methodology, models, analysis or thresholds used for determination of significance for cumulative effects In addition, the concordance table presented in Volume 3, Appendix 2A makes no mention of the location of new information related to AIR 16.1 and 16.2, but rather indicates simply that AIRs 16.1 and 16.2 were answered.

Benga Mining integrated effects of past projects and activities into the baseline assessment and as a result, the EIA did not explicitly examine these effects in the context of cumulative effects. Specifically, Benga Mining considered effects of past projects (e.g. legacy mines) to be reflected in the baseline and the 'not- significant' determination to mean that none of the effects of the Project would overlap with predicted future effects. Consequently, for the majority of VCs, it was determined that no future projects would interact with the non-significant residual effects of the Project and the results of the Planned Development Case analysis would be identical to those for the Application Case.

CEAA 2012 requires that any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out, be taken into account in the environmental assessment. The Guidelines require an analysis of the total cumulative effect on a VC over the life of the Project, including the incremental contribution of all current and proposed physical activities, in addition to that of the Project. The Agency's guidance on "Addressing Cumulative Environmental Effects under CEAA 2012" sets out the general requirements and approaches to consider cumulative environmental effects of designated projects and provides methodological options and considerations to support the implementation of CEAA 2012.

While existing conditions have been shaped by effects of past projects and activities, using only the current state of a VC in combination with future effects to fulfill the requirement of a cumulative effects assessment may not always provide a full understanding of the cumulative effects of successive projects from the past, present and future. If each successive project in an area uses a baseline into which past effects have been incorporated, the baseline is continually shifted and significant effects to VCs could be overlooked because of the absence of consideration of the effects of prior projects.

A cumulative effects assessment that fulfills the requirements of CEAA 2012 and the Guidelines would need to provide a clear understanding of the following:

- how each VC was identified and the rationale for its selection,
- the spatial and temporal boundaries for the assessment,
- the sources of potential cumulative effects,
- whether each VC has been affected by past projects and activities,

- whether each VC will be affected by future projects and activities,
- the measures that are technically and economically feasible to mitigate the potential cumulative effects,
- the significance of any cumulative effects, including the VC-specific thresholds used for determination of significance, and
- a follow-up program to verify the accuracy of the environmental assessment and the effectiveness of the mitigation measures (as required) for cumulative effects.

Consideration of past effects could be done by describing qualitatively known trends in the condition of the VC using available Aboriginal traditional knowledge, historic data or any other sources and describing how past activities have affected the conditions of the VC.

Information Required:

a. Review the cumulative effects assessment and provide, as appropriate, additional detail or an explanation for inclusion/exclusion of the following activities with respect to each VC with residual adverse effects identified:
   - Michelle Creek Coking Coal project in the Elk Valley, BC;
   - Teck Baldy Ridge Expansion Project at the existing Elkview Mine, BC;
   - Castle Rock Ridge to Chapel Rock Transmission Project, AB;
   - Tourism activities including hiking, ATV use, horseback riding, the Lost Lemon Campground, local ski hills, mountain bike trails, and the Crowsnest Trail;
   - Crowsnest Pass Golf course;
   - Helicopter pads or activities;
   - existing dams on Gold and Blairmore Creeks;
   - nearby leases;
   - Legacy mines including Greenhill, Bear Valley, and Bellevue underground mines;
   - future plans and access to the 'green area' defined in the South Saskatchewan Regional Plan
   - South Saskatchewan Trail Systems Plan;
   - agriculture and ranching, including cattle crossing or creeks and tributaries;
   - condo and/or residential developments in Blairmore; and
   - Specific project/activities from the communities of Maycroft, Burmis, Lundbreck, Cowley.

Response:

Final response currently under development. To be provided to the Agency as a separate document in January 2018.

b. For each VC that is predicted to have residual adverse effects as a result of the Project, provide an analysis of the total cumulative effects, following the Agency's guidance on "Addressing Cumulative Environmental Effects under CEAA 2012". The identified VCs should include those outlined in the Guidelines (i.e. surface water quality, fish and fish habitat, migratory birds,

species at risk, and Aboriginal people). The analysis should include:

- how the VC for cumulative effects was identified and the rationale for its selection, spatial and temporal boundaries, sources of cumulative effects, criteria and thresholds for significance;
- how the VC has been affected by past projects and activities;
- how the VC would be further affected by the residual effects of the Project, including specific identification of what the residual effects of the project are; and
- how other certain and reasonably foreseeable projects and activities may also affect the VC mitigation measures, significance determination and follow-up program.

Response:

Final response currently under development. To be provided to the Agency as a separate document in January 2018.

SUMMARY OF EFFECTS ASSESSMENT

27. SUMMARY OF EFFECTS

Reference: EIS Guidelines, Section 7; Volume 3, Appendix 2B and 2C

Preamble:

The Guidelines require Benga Mining to provide a table summarizing the potential environmental effects of the Project, the proposed mitigation measures to address the predicted effects, the potential residual effects, and the significance of the residual environmental effects. In the additional information provided to the Agency in August 2016, Benga Mining provided Appendix 2B (Potential Effects, Mitigations, and Impact Ratings for CEAA Valued Components) and Appendix 2C. However, it is unclear which of the residual effects listed remain after mitigation and therefore, should be carried forward into the cumulative effects assessment.

Information Required:

a. Update Volume 3, Appendices 2B and 2C to clearly indicate which of the effects listed are residual following mitigation and have been carried forward to the cumulative effects assessment.

Response:

Final response currently under development. To be provided to the Agency as a separate document in January 2018.

b. In Benga Mining's list of mitigation measures, clearly identify which measure applies to which specific VC. For instance, indicate which of the proposed mitigation measure applies to old growth forests and contributes to a positive residual effect for this VC.

Response:

Final response currently under development. To be provided to the Agency as a separate document in January 2018.

REFERENCES

3. ATMOSPHERIC ENVIRONMENT

Environment Canada. 2012. Guidance on estimating road dust emissions from industrial unpaved surfaces. https://ec.gc.ca/inrp-npri/default.asp?lang=En&n=5DF2CF83-1.Cowherd, C. and G.E. Muleski. 2008. Road Dust Control Performance Monitoring. 13 p.

Cowherd, C. Grelinger, M.A. and Gebhart, D.L. (2006): Development of an emission reduction tern for near-source depletion. 15th International Emission Inventory Conference, New Orleans.

Cowherd, C. and G.E. Muleski. 2008. Road Dust Control Performance Monitoring. 13 p.

Midwest Research Institute (MRI) 1985. Fugitive Emission Measurement of Coal Yard Traffic at a Power Plant – Confidential Client (Referred at US EPA, 1998).

National Stone Association (1994). PM-10 Emission Factors for a Haul Road at a Granite Stone Crushing Plant, Washington, D.C., December 1994 (Referenced in US EPA 1998).

South Coast Air Quality Municipal District. 1996. Improvement of Specific Emission Factors (BACM Project 1), Contract No. 95040 (Referenced in US EPA 1998).

RTI International and Midwest Research Institute (MRI). 2006. Environmental Technology Verification, Dust Suppressant Products: Midwest Industrial Supply, Inc.'s EK35. EPA/600/R-05/128. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1001GVV.PDF?Dockey=P1001GVV.PDF.

U.S. Environmental Protection Agency (U.S. EPA). 1981 Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contract No. 68-03-2924, Assignment 1, July 1981 (Referenced in US EPA 1998).

U.S. Environmental Protection Agency (U.S. EPA). 1983a. Iron and Steel Plant Open Source Fugitive Emission Control Evaluation, EPA Contract No. 68-02-3177, Assignment 4, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency (U.S. EPA). 1983b. Extended Evaluation of Unpaved Road Dust Suppressants in the Iron and Steel Industry, EPA Contract No. 68-02-3177, Assignment 14, Research Triangle Park, North Carolina (Referenced in US EPA 1998).

U.S. Environmental Protection Agency (U.S. EPA). 1994. Surface Coal Mine Emission Factor Study, EPA Contract No. 68-D2-0165, Assignment I-06, Research Triangle Park, North Carolina (Referenced in US EPA 1998).

U.S. Environmental Protection Agency (U.S. EPA). 1998. Emission Factor Documentation for Section 13.2.2 (Unpaved Roads), Fifth Edition (AP-42). EPA Purchase Order 7D-1554-NALX; MRI Project No. 4864, Prepared by MRI for US EPA. Office of Air Quality Planning and Standards Emission Factor and Inventory Group Research Triangle Park.

4. GREENHOUSE GASES

Alberta Environment and Water. 2012. Best Management Practices for Conservation of Reclamation Materials in the Mineable Oil Sands Region of Alberta. Prepared by MacKenzie, D. for the Terrestrial Subgroup, Best Management Practices Task Group of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. March 9, 2011.

Edison Electric Institute and the Electric Power Industry Climate Initiative. 2009. Power Partners Resource Guide. Available: http://www.uspowerpartners.org/Topics/SECTION6Topic-CoalMineMethane.htm.

Government of Alberta, 2010. C5 Forest Management plan 2006-2026. ISBN 0-7785-4545-8 (On-line edition) Revised July 2010.

IPCC, 2000. Land Use, Land-Use Change and Forestry. Robert T. Watson, Ian R. Noble, Bert Bolin, N. H. Ravindranath, David J. Verardo and David J. Dokken (Eds.). Cambridge University Press, UK. pp 375

Kurz, W.A., Dymond, C.C., Stinson, G., Rampley, G.J., Neilson, E.T., Carroll, A.L., Ebata, T., Safranyik, L. 2008. Mountain pine beetle and forest carbon feedback to climate change. Nature. 452: 987-990.

Kurz, W.A., Dymonda, C.C., White, T.M., Stinson, G., Shawb, C.H., Rampley, G.J., Smyth, C., Simpson, B.N., Neilson, E.T., Trofymow, J.A., Metsaranta, J., and M.J. Apps. 2009. CBM-CFS3: A model of carbon-dynamics in forestry and land-use change implementing IPCC standards. Ecological Modelling 220: 480–504.

Laanbroek, H.J., 2009. Methane emission from natural wetlands: interplay between emergent macrophytes and soil microbial processes. A mini-review. Ann Bot. 105(1): 141–153. Published online 2009 Aug 17.

MacKenzie, D. 2011. Reclamation Using Upland Surface Soils from Boreal Forests in the Oil Sands. PhD Thesis. University of Alberta, Edmonton, Alberta.

North West Redwater Partnership. 2017. Sturgeon Refinery. https://nwrsturgeonrefinery.com/project/maximizing-the-value/. Accessed: November 2017.

Penner, M., Power, K., Muhairwe, C., Tellier, R., and Y. Wang. 1997. Canada's forest biomass resources: deriving estimates from Canada's forest inventory. Information Report BC-X-

370. Natural Resources Canada, Pacific Forestry Centre, Victoria, B.C.

Price, D.T., Halliwell, D.H., Apps, M.J., Kurz, W.A., and S.R. Curry. 1997. Comprehensive assessment of carbon stocks and fluxes in a Boreal Cordilleran forest management unit. Can. J. For. Res. 27: 2005-2016

U.S. Environmental Protection Agency (U.S. EPA). 2008. U.S. Surface Coal Mine Methane Recovery Project Opportunities. http://www.epa.gov/cmop/docs/cmm_recovery_opps_surface.pdf.

U.S. Environmental Protection Agency (U.S. EPA). 2009. Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Profiles of Selected Gassy Underground Coal Mines 2002-2006. EPA 430-K-04-003. http://www.epa.gov/cmop/docs/profiles_2008_final.pdf.

Visser, S., Fujikawa, J., Griffiths, C.L., & Parkinson, D. 1984. Effect of topsoil storage on microbial activity, primary production, and decomposition potential. Plant and Soil Journal 82: 41-50.

6. SELENIUM CONCENTRATIONS

Alberta Environment and Sustainable Resources Development (AESRD). 2014. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Policy Division. Edmonton. 48 pp.

ANZECC. 2000. Australia and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra, Australia.

British Columbia Ministry of Environment (BC MOE). 2014. Water quality guidelines for selenium. Technical report update. Water Protection and Sustainability Branch, Environmental Sustainability and Strategic Policy Division.

Canadian Council of Ministers of the Environment (CCME). 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Winnipeg, MB, Canada.

DeForest DK, Brix KV, Elphick JR, Rickwood CJ, deBruyn AMH, Tear LM, Gilron G, Hughes SA, Adams WJ. 2017 (in press). Lentic, lotic, and sulfate-dependent waterborne selenium screening guidelines for freshwater systems. Environ Toxicol Chem DOI: 10.1002/etc.3793.

DeForest DK, Gilron G, Armstrong SA, Robertson EL. 2012. Species sensitivity distribution (SSD) evaluation for selenium in fish eggs: Considerations for development of a Canadian tissue-based guideline. Integr Environ Assess Manag 8:6-12.

Department of Water Affairs and Forestry. 1996. South African water quality guidelines. Volume 7: Aquatic ecosystems. Pretoria, South Africa.

Lo BP, Elphick JR, Bailey HC, Baker JA, Kennedy CJ. 2015. The effect of sulphate on selenate bioaccumulation in two freshwater primary producers: a duckweed, Lemna minor, and a green alga, Pseudokirchneriella subcapitata. Environ Toxicol Chem 34:2841-2845.

U.S. Environmental Protection Agency (U.S. EPA). 2016. National recommended water quality criteria - aquatic life criteria table. Washington, DC. Available from: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

Williams MJ, Ogle RS, Knight AW, Burau RG. 1994. Effects of sulfate on selenate uptake and toxicity in the green alga Selenastrum capricornutum. Arch Environ Contam Toxicol 17:449-453.

7. MINE PIT DEWATERING

Freeze R. A. and J. A. Cherry. 1979. Groundwater. Prentice Hall, Inc. 604 pages.

Norris, D.K. 1993. Geology and Structure Cross-Sections, Blairmore (West Half), Alberta Geological Survey of Canada, Map 1829A, Scale 1:50 000.

10. SEISMIC ACTIVITY

Alberta Geological Survey. 2017. Alberta Seismic Events Interactive Map. Available: http://ags-aer.maps.arcgis.com/apps/webappviewer/index.html?id=1b1efd0717c441f595dbfdba66d95217. Accessed: November 2, 2017.

BC Oil and Gas Commission. n.d. Frac Focus: Chemical Disclosure Registry. Available: http://www.fracfocus.ca/. Accessed: November 1, 2017.

11. GROUND MOTIONS

British Columbia Mine Waste Rock Pile Research Committee. 1991. *Mined Rock and Overburden Piles: Investigation and Design Manual – Interim Guidelines*. Prepared by Piteau Associates Engineering Ltd., May 1991. 177 pp. Available: http://mssi.nrs.gov.bc.ca/Geotechnical/minedrockoverburdenpile_investigationdesignmanual.pdf.

12. WHITEBARK PINE

Alberta Whitebark and Limber Pine Recovery Team. 2014a. Alberta Whitebark Pine Recovery Plan 2013-2018. Alberta Environment and Sustainable Resource Development. Alberta Species at Risk Recovery Plan No. 35. Edmonton, Alberta. 61 pp.

Alberta Whitebark and Limber Pine Recovery Team. 2014b. Alberta Limber Pine Recovery Plan 2014-2019. Alberta Environment and Sustainable Resource Development. Alberta

Species at Risk Recovery Plan No. 35. Edmonton, Alberta. 61 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2014. COSEWIC assessment and status report on the Limber Pine Pinus flexilis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 49 pp. (www.registrelepsararegistry.gc.ca/default_e.cfm).

Pigot, D. and Moody, R. 2013. Limber Pine in British Columbia; Factsheet 2. Available from www.yellowpointpropagation.com

Schoettle, A.W. and Sniezko R.A. 2007. Proactive intervention to sustain high-elevation pine ecosystems threatened by white pine blister rust. J For Res (2007) 12:327–336.

16. CONTAMINANTS OF CONCERN

Canadian Council of Ministers of the Environment (CCME). 1996. *A framework for Ecological Risk Assessment: General Guidance*. The National Contaminated Sites Remediation Program. Winnipeg, Manitoba.

Environment Canada. 2012 *Ecological Risk Assessment Guidance for Federal Contaminated Sites*. Vancouver, BC.

17. HUMAN HEALTH RISK ASSESSMENT

U.S. Environmental Protection Agency (U.S. EPA). 2008. Integrated Science Assessment for Oxides of Nitrogen - Health Criteria. National Center for Environmental Assessment. EPA/600/R-08/071. Available at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=194645. Accessed October 2013.

U.S. Environmental Protection Agency (U.S. EPA). 2010. Quantitative Health Risk Assessment for Particulate Matter. US Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC. June 2010. EPA-452/R-10-005. Available at: http://www.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdfAccessed January 2015.

U.S. Environmental Protection Agency (U.S. EPA). 2012. National Ambient Air Quality Standards (NAAQS). Washington, DC: U.S. Environmental Protection Agency, Office of Air and Radiation. Available at: http://www.epa.gov/air/criteria.html. December 14, 2012. Accessed January 2015.

World Health Organization (WHO). 1997. United Nations Environment Programme, International Labour Organisation, World Health Organization, International Programme on Chemical Safety. Environmental Health Criteria 188. Nitrogen Oxides (Second

Edition). World Health Organization, Geneva. Available at: http://www.inchem.org/documents/ehc/ehc/ehc188.htm#PartNumber:9. Accessed October 2013.

World Health Organization (WHO). 2005. Air Quality Guidelines. Global Update 2005. Particulate Matter, ozone, nitrogen dioxide and sulfur dioxide. ISBN 92 890 2192 6. World Health Organization, Germany. 2006. Available at: http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/pre2009/air-quality-guidelines.-global-update-2005.-particulate-matter,-ozone,-nitrogen-dioxide-and-sulfur-dioxide. Accessed January 2015.

18. ABORIGINAL FOOD CONSUMPTION

First Nations Food, Nutrition & Environment Study (FNFNES). 2016. Results from Alberta 2013. University of Ottawa, Universite de Montreal, Assembly of First Nations.

20. NOISE IMPACT

Health Canada. 2010. Useful Information for Environmental Assessments. Minister of Health. ISBN: 978-1-100-15153-3.

22. SIGNIFICANCE DETERMINATION

Alberta Whitebark and Limber Pine Recovery Team. 2014a. Alberta Whitebark Pine Recovery Plan 2013-2018. Alberta Environment and Sustainable Resource Development. Alberta Species at Risk Recovery Plan No. 34. Edmonton, Alberta. 63 pp.

Alberta Whitebark and Limber Pine Recovery Team. 2014b. Alberta Limber Pine Recovery Plan 2014-2019. Alberta Environment and Sustainable Resource Development. Alberta Species at Risk Recovery Plan No. 35. Edmonton, Alberta. 61 pp.

Canadian Environmental Assessment Agency (CEAA). 2017 Technical Guidance. Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012. April 2017 DRAFT Version 1.

Environment and Climate Change Canada. 2017. Recovery Strategy for the Whitebark Pine (Pinus albicaulis) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 54 pp.

23. ENVIRONMENTAL EFFECTS OF ACCIDENTS AND MALFUNCTIONS

Australian Explosives Industry and Safety Group Inc. (AEISG). 2017. *Code of Practice for Storage and Handling of UN3375*. Edition 4. May 2017. ISBN 978-1-921308-19-2.

U.S. Environmental Protection Agency (U.S. EPA). 1998. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.9 Western Surface Coal Mining, Fifth Edition (AP-42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency (U.S. EPA). 2004. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing, Fifth Edition (AP-42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency (U.S. EPA). 2006. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 13.2.4 Aggregate Handling and Storage Piles, Fifth Edition (AP-42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

25. EXTREME WEATHER EVENTS AND CLIMATE CHANGE

Alberta Westslope Cutthroat Trout Recovery Team. 2013. Alberta Westslope Cutthroat Trout Recovery Plan: 2012-2017. Alberta Environment and Sustainable Resource Development, Alberta Species at Risk Recovery Plan No. 28. Edmonton, AB. 77 pp. Available online at: http://aep.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/fish/documents/SAR-WestslopeCutthroatTrout-RecoveryPlan-A-Mar2013.pdf. Accessed May 2017.

Alberta Whitebark and Limber Pine Recovery Team (AWLPRT). 2014a. Alberta Whitebark Pine Recovery Plan 2013-2018. Alberta Environment and Sustainable Resource Development, Alberta Species at Risk Recovery Plan No. 34. Edmonton, AB. 63 pp. Available online at: http://aep.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/plants/documents/SAR-WhitebarkPineRecoveryPlan-Jan-2014.pdf. Accessed May 2017

Alberta Whitebark and Limber Pine Recovery Team (AWLPRT). 2014b. Alberta Limber Pine Recovery Plan 2014-2019. Alberta Environment and Sustainable Resource Development, Alberta Species at Risk Recovery Plan No. 35. Edmonton, AB. 61 pp. Available online at: http://www.whitebarkpine.ca/uploads/4/4/1/8/4418310/sar-limberpine-recoveryplan-sep2014.pdf. Accessed May 2017.

Bellaire, S., B. Jamieson, and G. Statham. 2013. The avalanche climate of Glacier National Park, B.C., Canada during 1965–2011. In: Proceedings of 2013 international snow science workshop, Grenoble.

Boulanger, Y., S. Gauthier, and P.J. Burton. 2014. A refinement of models projecting future Canadian fire regimes using homogenous fire regime zones. Can. J. For. Res. 44:365-376.

British Columbia Mine Waste Rock Pile Research Committee. 1991. *Mined Rock and Overburden Piles: Investigation and Design Manual – Interim Guidelines*. Prepared by Piteau Associates Engineering Ltd., May 1991. 177 pp. Available: http://mssi.nrs.gov.bc.ca/Geotechnical/minedrockoverburdenpile_investigationdesignmanual.pdf.

Canadian Centre for Climate Modelling and Analysis (CCCMA) (2017). ETCCDI Extremes Indices Archive. Available online at: http://www.cccma.ec.gc.ca/data/climdex/index.shtml. Accessed April 2017.

Canadian Climate Data and Scenarios (CCDS). 2017. CMIP5: Gridded Data. Available online at: http://ccds-dscc.ec.gc.ca/index.php?page=gridded-data. Accessed April 2017.

Canadian Forest Service. 2016. National Fire Database – Agency FireData. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Available online at: http://cwfis.cfs.nrcan.gc.ca/datamart. Accessed May 2017.

Clifton, C., R. Evans, S. Hayes, R. Hirji, G. Puz, and C. Pizarro. 2010. Water and Climate Change: Impacts on Groundwater Resources and Adapation Options. Water Working Note No. 25 of Water Sector Board of the Sustainable Development Network of the World Bank Group. Available online at: http://documents.worldbank.org/curated/en/659981468162559562/pdf/550270NWP0Box01Groundwater01PUBLIC1.pdf. Accessed May 2017.

Collins, M., R. Knutti, J. Arblaster, J.-L. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W.J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A.J. Weaver and M. Wehner, 2013: Long-term Climate Change: Projections, Commitments and Irreversibility. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Eckert, N., E. Parent, and M. Naaim. 2009. Assessing the impact of climate change on snow avalanche activity in France over the last 60 winters using hierarchical Bayesian change point models. In: Proceedings of the International Snow Science Workshop, Davos, 2009.

Environment Canada. 2015a. Recovery Strategy for Olive-Sided Flycatcher (Contopus cooperi) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 51 pp.

Environment Canada. 2015b. Recovery Strategy for Little Brown Myotis (Myotis lucifugus), Northern Myotis (Myotis septentrionalis), and Tri-colored Bat (Perimyotis subflavus) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. ix + 110 pp.

Environment Canada. 2015c. Recovery Strategy for Common Nighthawk (Chordeiles minor) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 48 pp.

Environment Canada. 2016a. Climate data and scenarios for Canada: Synthesis of recent observation and modelling results. Available online at: http://publications.gc.ca/collections/collection_2016/eccc/En84-132-2016-eng.pdf. Accessed April 2017.

Environment Canada. 2016b. Management Plan for the Short-eared Owl (Asio flammeus) in Canada [Proposed]. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. v + 35 pp.

Froese, C.R. and S. Mei. 2008. Mapping and monitoring coal mine subsidence using LiDAR and INSAR. GeoEdmonton '08. 1127-1133.

Handmer, J., Y. Honda, Z.W. Kundzewicz, N. Arnell, G. Benito, J. Hatfield, I.F. Mohamed, P. Peduzzi, S. Wu, B. Sherstyukov, K. Takahashi, and Z. Yan, 2012: Changes in impacts of climate extremes: human systems and ecosystems. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 231-290.

Huggel, C., J.J Clague and O. Korup. 2012. Is climate change responsible for changing landslide activity in high mountains? Earth Surf. Process. Landforms 37, 77–91 (2012)

Iverson, L.; McKenzie, D. 2014. Climate change and species distribution. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. Available online at: www.fs.usda.gov/ccrc/topics/species-distribution. Accessed May 2017.

Keane, R.E., L. M. Holsinger, M. F. Mahalovich, and D. F. Tomback. 2017. Restoring Whitebark pine ecosystems in the face of climate change. General Technical Report RMRS-GTR-361, Fort Collins, CO. US Department of Agriculture, Forest Service, Rocky Mountain Research Station. 123 p.

Kharin, V.V., F.W. Zweirs, X. Zhang, and M. Wehner. 2013. Changes in temperature and precipitation extremes in the CMIP5 ensemble. Climatic Change 199: 345-357. Available online at: ftp://ftp.cccma.ec.gc.ca/pub/skharin/cmip5_extremes/10584_2013_705_MOESM1_ESM.pdf

King, D., and D.M. Finch. 2013. The effects of climate change on terrestrial birds of North America. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. Available online at: www.fs.usda.gov/ccrc/topics/wildlife/birds. Accessed May

2017.

Kirtman, B., S.B. Power, J.A. Adedoyin, G.J. Boer, R. Bojariu, I. Camilloni, F.J. Doblas-Reyes, A.M. Fiore, M. Kimoto, G.A. Meehl, M. Prather, A. Sarr, C. Schär, R. Sutton, G.J. van Oldenborgh, G. Vecchi and H.J. Wang, 2013: Near-term Climate Change: Projections and Predictability. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Laloui, L., A. Ferrari, and J. Eichenberger. 2010. "Effect of Climate Change on Landslide Behaviour." Geo-Strata. October:36-41

Nature Canada. 2017. How is climate change affecting birds? Available online at: http://naturecanada.ca/what-we-do/bird-conservation/climate-change-birds/. Accessed May 2017.

Natural Resources Canada. 2017. Earthquakes Canada: Search the Earthquake Database. Available online at: http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-en.php. Accessed May 2017.

Nearing, M.A., F.F. Pruski, and M.R. O'Neal. 2004. Expected climate change impacts on soil erosion rates: A review. Journal of Soil and Water Conservation 59(1):43-50.

Riannaa, G., A. Zolloa, P. Tommasib, M. Paciuccib, L. Comegnac, and P. Mercogliano. 2014. Evaluation of the effects of climate changes on landslide activity of Orvieto clayey slope. Procedia Earth and Planetary Science 9 (2014) 54 – 63.

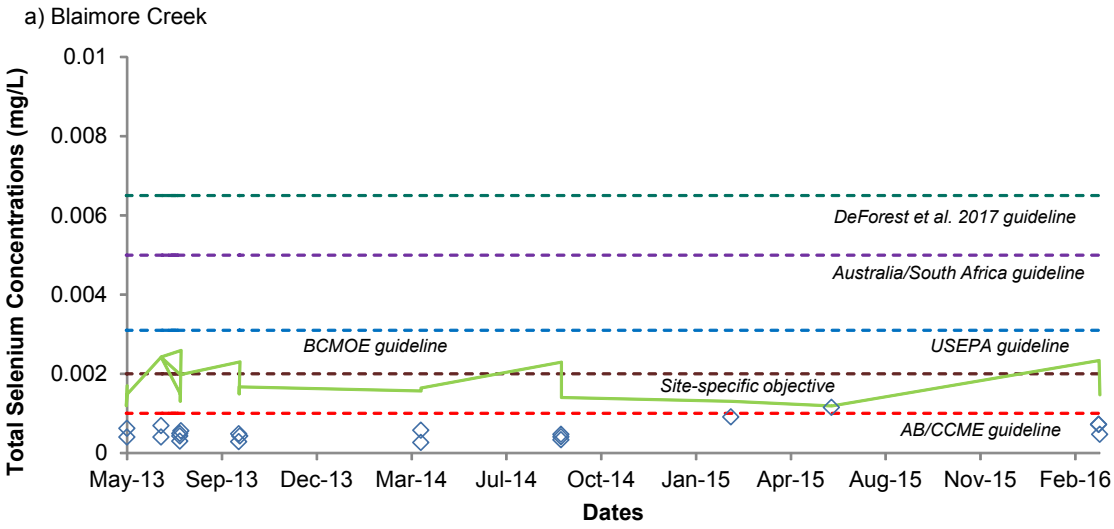
Riley, K. L., and R. A. Loehman. 2016. Mid- 21st- century climate changes increase predicted fire occurrence and fire season length, Northern Rocky Mountains, United States. Ecosphere 7(11):e01543. 10.1002/ecs2.1543

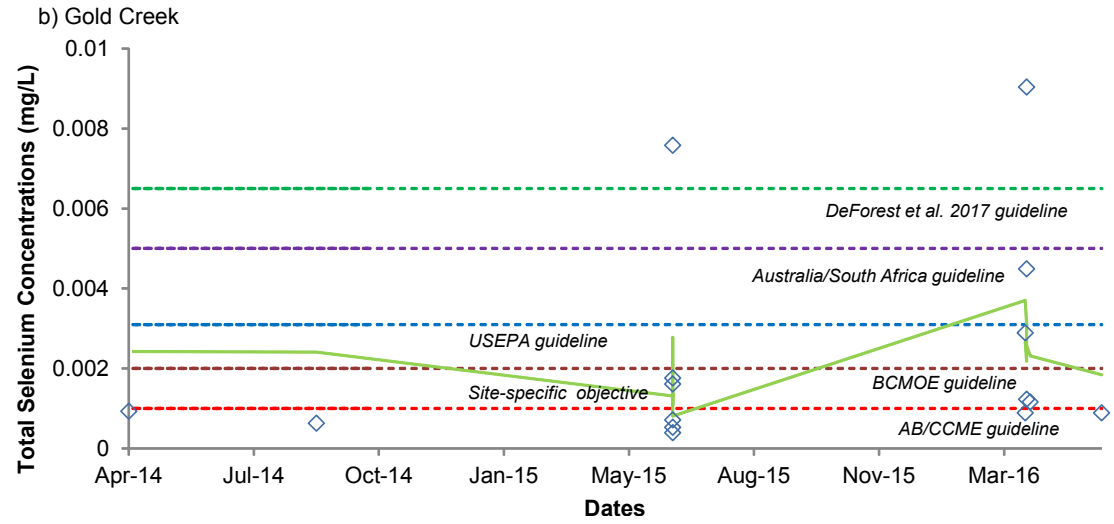
Rivera, A. D.M. Allen, and H. Maathuis. 2004. Climate Variability and Change - Groundwater Resources. In: Environment Canada. Threats to Water Availability in Canada. National Water Research Institute, Burlington, Ontario. NWRI Scientific Assessment Report Series No. 3 and ACSD Science Assessment Series No. 1. 128 p.

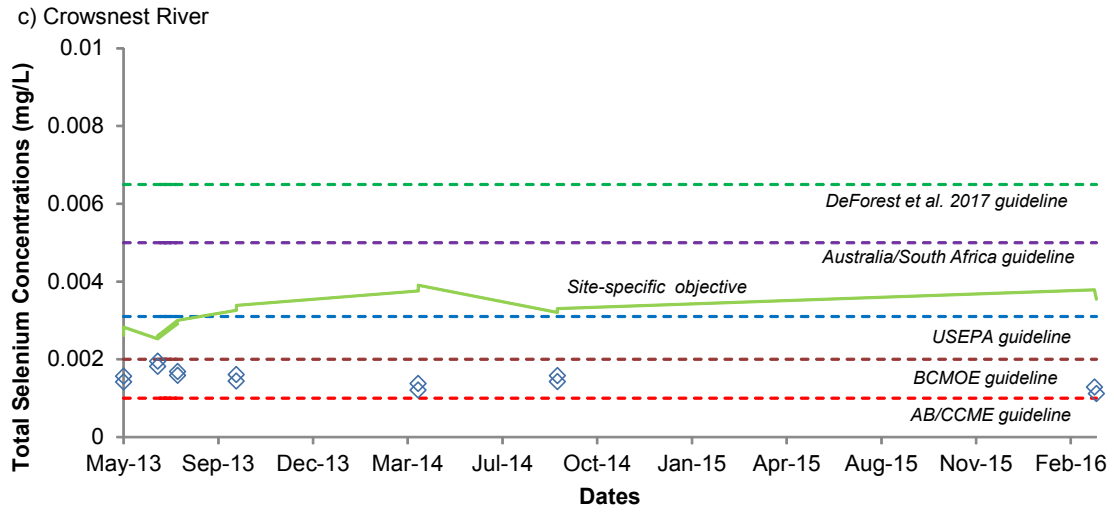
Sinickas, A., B. Jamieson, and M.A. Maes. 2016. Snow avalanches in western Canada: investigating change in occurrence rates and implications for risk assessment and mitigation. Structure and Infrastructure Engineering 13(4):490-498. Available online at: http://dx.doi.org/10.1080/15732479.2015.1020495.

Westerling, L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam. 2006. Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity. Science. Vol. 313, Issue 5789, pp. 940-943.

FIGURES







RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

BASELINE SELENIUM CONCENTRATIONS IN THE LSA (A. BLAIRMORE CREEK; B. GOLD CREEK) AND RSA (C. CROWSNEST RIVER) AS COMPARED TO PUBLISHED WATER QUALITY GUIDELINES

MEMS, 2017

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	JL
CHECKED BY:	CH
DATE:	NOVEMBER 17, 2017
FIGURE	6-1

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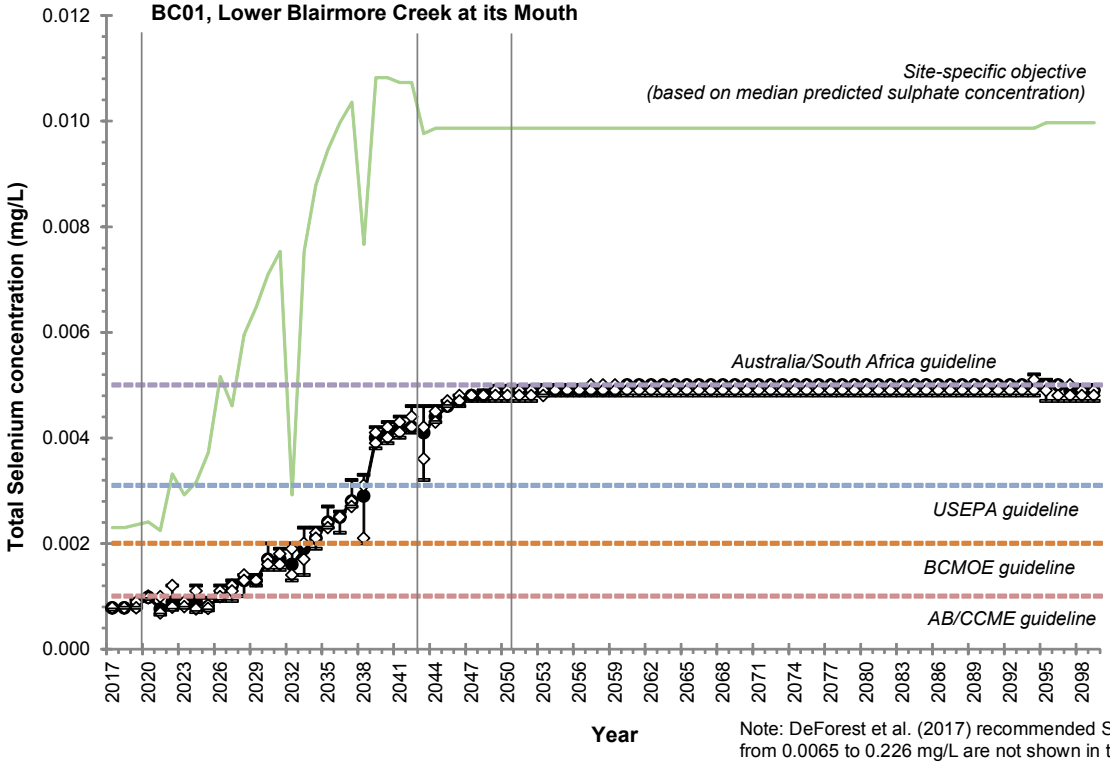

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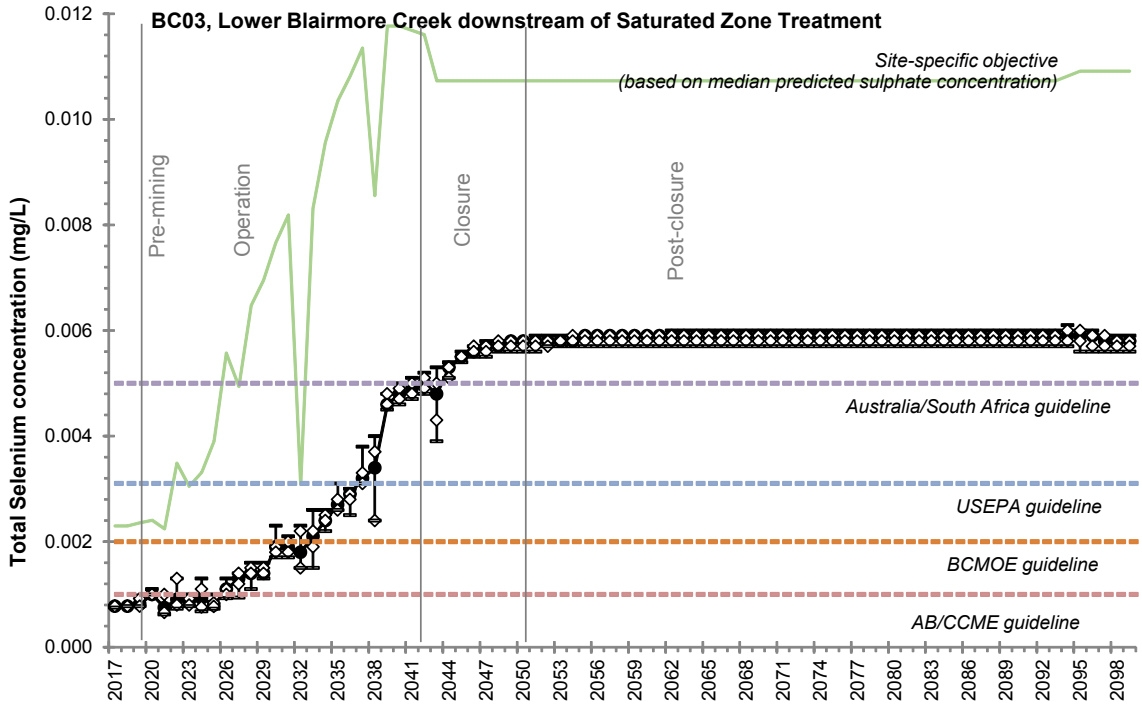

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LEGEND

- Maximum
- 75%ile
- Median
- 25%ile
- Minimum

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

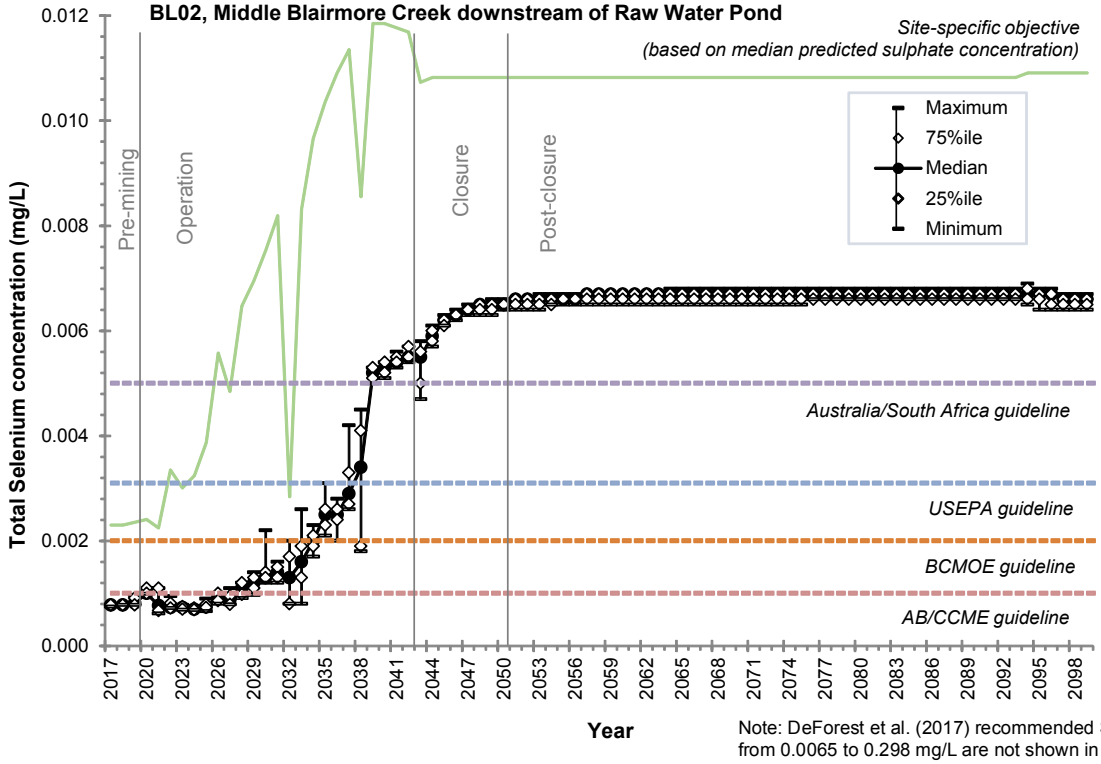
PREDICTED SELENIUM CONCENTRATIONS IN THE LSA NODES AS COMPARED TO PUBLISHED WATER QUALITY GUIDELINES

MEMS, 2017

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	JL
CHECKED BY:	CH
DATE:	NOVEMBER 17, 2017
FIGURE	6-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Groundwater\SIRs\Fig 6-2a Predicted Selenium Concentrations 14-00201.mxd



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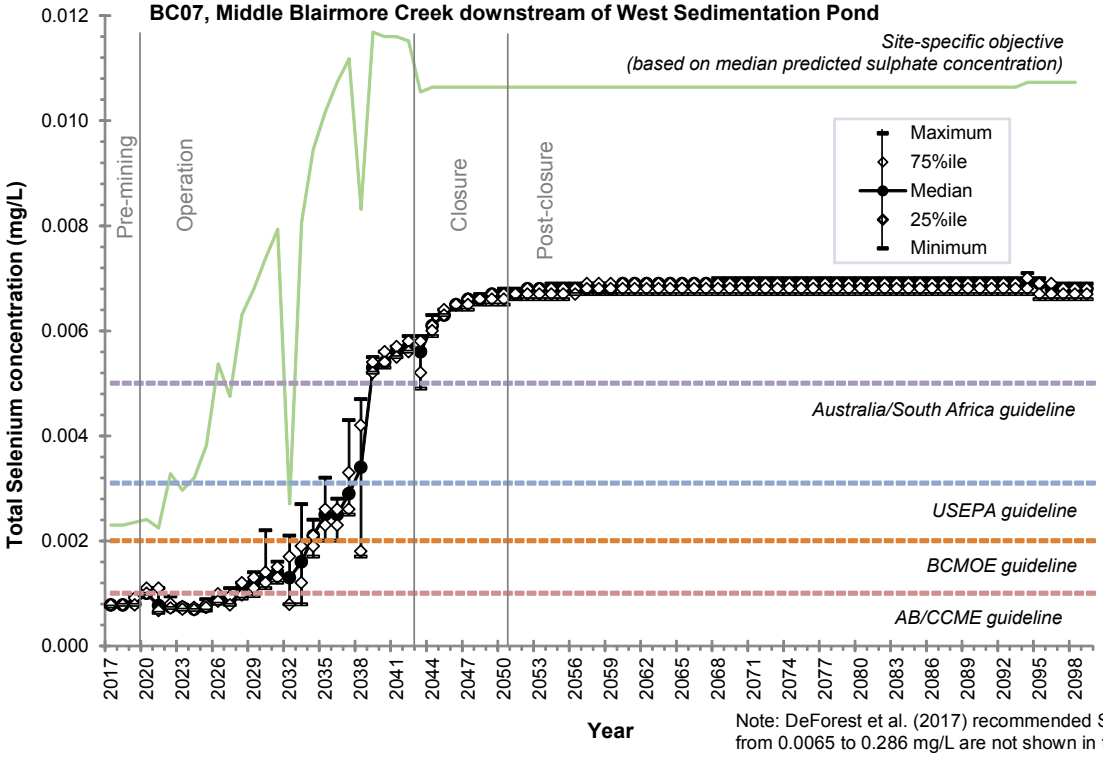

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LEGEND

Maximum
75%ile
Median
25%ile
Minimum

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

PREDICTED SELENIUM CONCENTRATIONS IN THE LSA NODES AS COMPARED TO PUBLISHED WATER QUALITY GUIDELINES

MEMS, 2017

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	JL
CHECKED BY:	CH
DATE:	NOVEMBER 17, 2017
FIGURE	6-3

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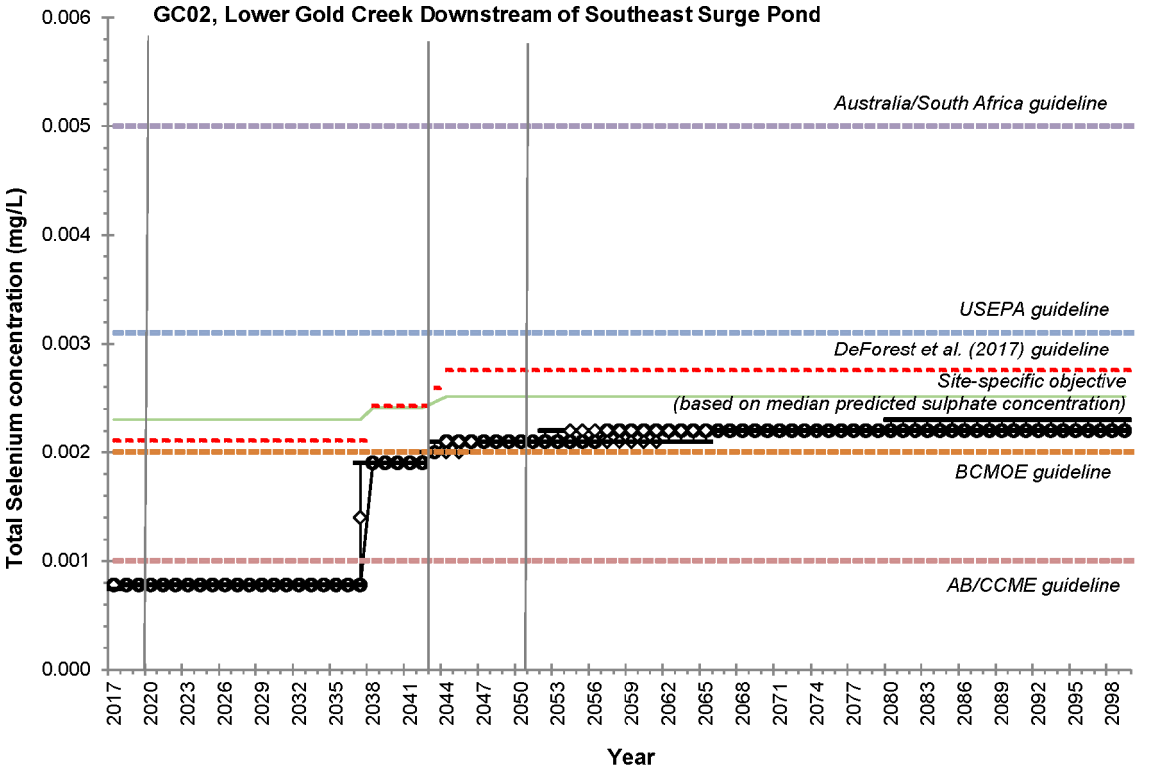
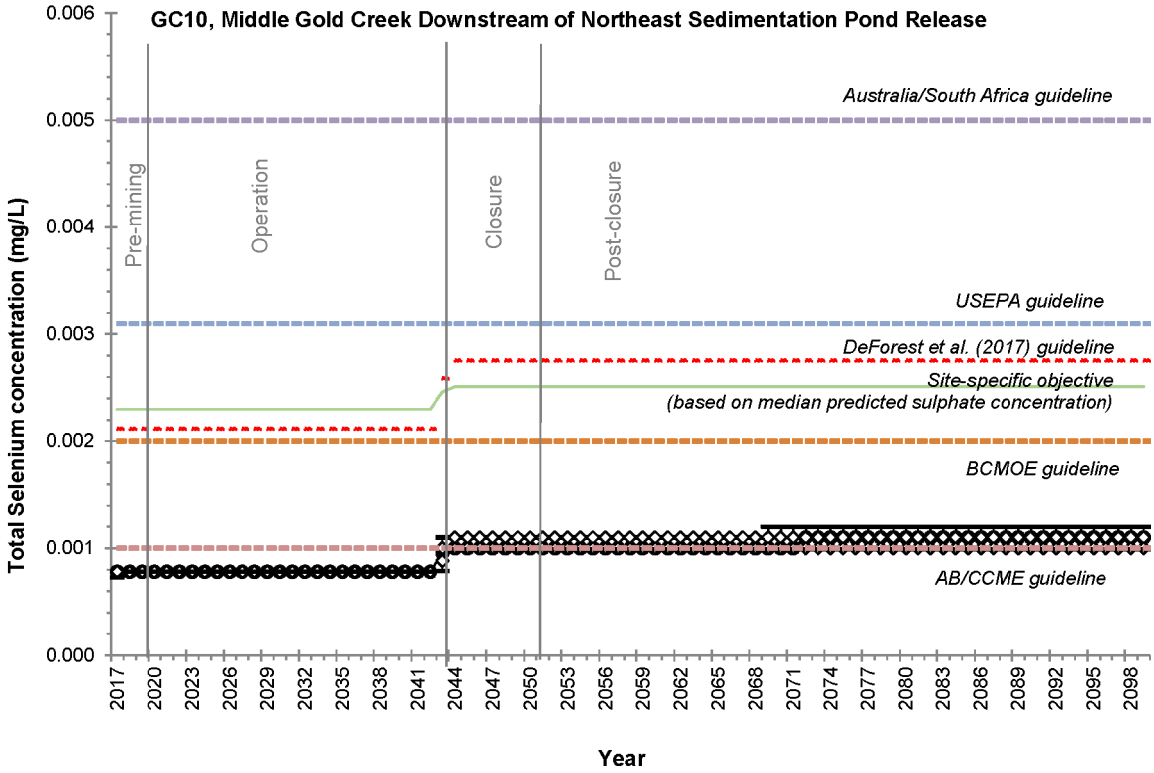




LEGEND

- Maximum
- 75%ile
- Median
- 25%ile
- Minimum

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

PREDICTED SELENIUM CONCENTRATIONS IN THE LSA NODES AS COMPARED TO PUBLISHED WATER QUALITY GUIDELINES

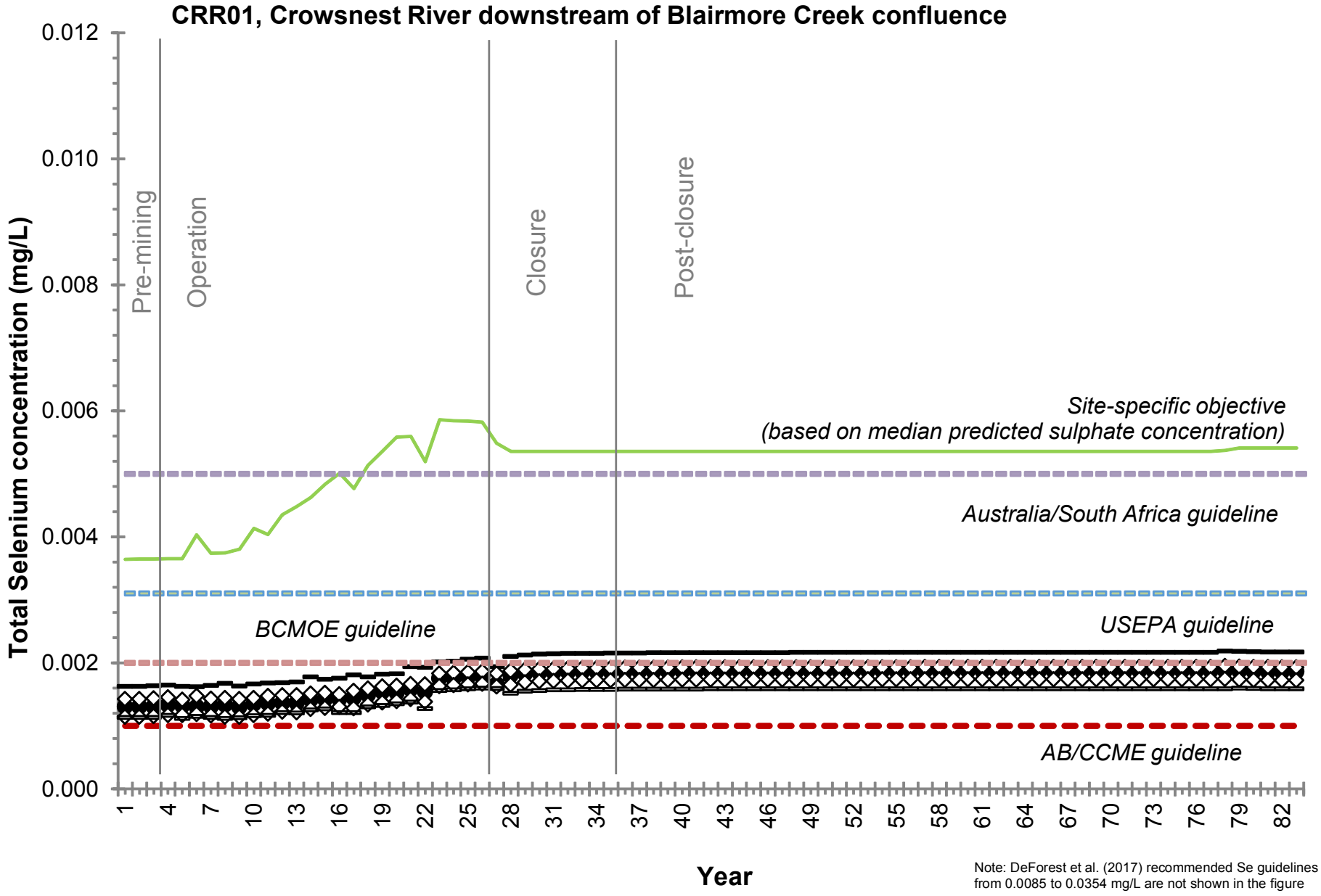
MEMS, 2017

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	JL
CHECKED BY:	CH
DATE:	NOVEMBER 17, 2017
FIGURE	6-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Groundwater\SIR\Fig 6-2c Predicted Selenium Concentrations 14-00201.mxd

CRR01, Crowsnest River downstream of Blairmore Creek confluence



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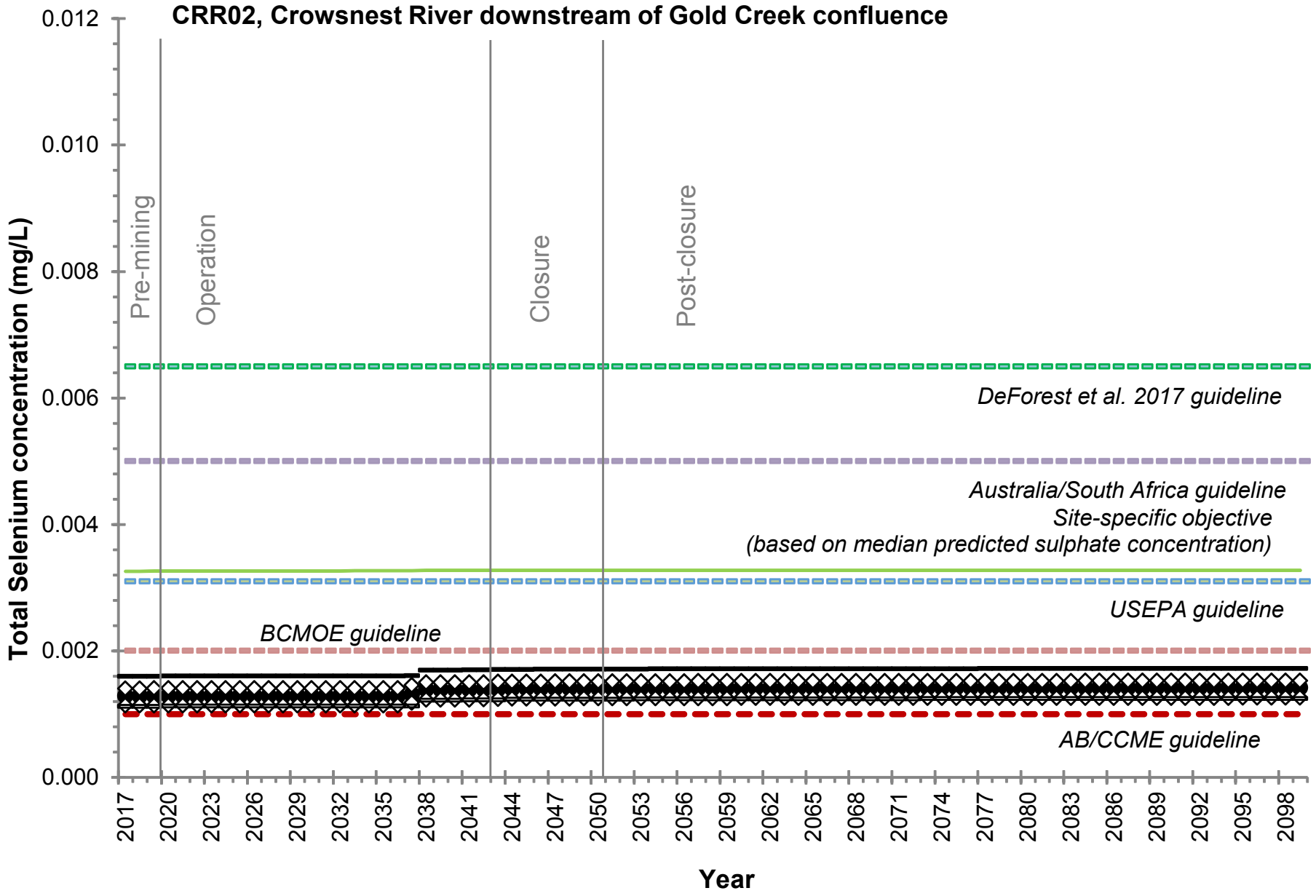
CRR02, Crowsnest River downstream of Gold Creek confluence



LEGEND

- Maximum
- 75%ile
- Median
- 25%ile
- Minimum

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MODELLED SELENIUM CONCENTRATIONS IN THE CROWSNEST RIVER NODES (RSA) AS COMPARED TO PUBLISHED WATER QUALITY GUIDELINES

MEMS, 2017

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	JL
CHECKED BY:	CH
DATE:	NOVEMBER 17, 2017
FIGURE	6-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Groundwater\SIRs\Fig 6-3 Modelled Selenium Concentrations 14-00201.mxd

GRASSY MOUNTAIN COAL PROJECT

Figure 21-1 Project Schedule

		2018				2019				2020				2021				2022				Year 20XX																									Final Closure
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	
Pre-development Activities	**Infrastructure Corridor**																																													
	Main Access Road Construction																																													
	Transmission Line Installation																																													
	Telecommunications Line Installation																																													
	Overland Conveyor Installation																																													
	Mine Infrastructure																																													
	Topsoil Salvage																																													
	Mine Infrastructure Building Construction																																													
	Coal Processing Plant Construction																																													
	Rail Loop Construction																																													
	Rail Loadout Building Construction																																													
	Explosives Plant Construction																																													
	Clean Coal Pile Area Construction																																													
	Raw Coal Pile Area Construction																																													
	Open Pit Development																																													
	Topsoil Salvage																																													
	South Rock Disposal Area Preparation																																													
	Mine rock Pre-stripping																																													
	Mine rock placement (external)																																													
	Water Management																																													
	Loadout Sediment Pond Construction																																													
	Raw Water Surge Pond Construction																																													
	West Surge Pond																																													
	South East Surge Pond Construction																																													
	Plant Site Sediment Pond Construction																																													
Mine Operation Activities	**Open Pit Mining**																																													
	Topsoil Salvage																																													
	Mine Rock Removal																																													
	Coal Mining																																													
	Coal Processing																																													
	Mine Rock Placement (External)																																													
	Mine Rock Placement (Backfill)																																													
	Rock disposal area re-sloping																																													
	Rock disposal area topsoil replacement																																													
	Water Management																																													
	West Sediment Pond Construction																																													
	East Sediment Pond Construction																																													
	Northwest Surge Pond Construction																																													
	Northeast Sediment Pond Construction																																													
	Saturated Zone 1 (SZ1465) Construction																																													
	Saturated Zone 2 (SZ1636) Construction																																													
	Saturated Zone 3 (SZ1700) Construction																																													
Mine Closure Activities	**Open Pit Closure**																																													
	Rock disposal area re-sloping																																													
	Rock disposal area topsoil replacement																																													
	Mine Infrastructure Removal																																													
	Coal handling plant dismantling																																													
	Mine Infrastructure Area removal																																												
	Rail loop closure																																													
	Water Management																																													
	Close NE sediment pond																																													
	Close East sediment pond																																													
	Close West sediment pond																																													
	Close SW surge pond																																													
	Close Plant Site Sediment Pond																																													
	Close Loadout Sediment pond																																													
	Close SE surge pond																																													
	Close NW surge pond																																													
	Close Raw Water surge pond																																													

R4 W5M

R3 W5M

T9

T8

T7

Proposed Mine Permit Boundary

Ultimate Pit Extent

North Rock Disposal Area

North East Sediment Pond

North West Surge Pond

North West Sediment Pond

South East Sediment Pond

Central Rock Disposal Area

South West Sediment Pond

South East Surge Pond

Coal Handling Processing Plant and Infrastructure

Proposed Water Pipeline/ Service Road

Coal Handling Processing Plant Sediment Pond

Topsoil Stockpiles

Raw Water Pond

Covered Conveyor, Access Road and Powerline ROW

South Rock Disposal Area

Proposed Golf Course

Proposed Rail Loadout

Proposed Helipad Access

Proposed Rail Loop

Road Access

Forestry Trunk Road

Daisy Creek

Nez Percé Creek

Blairmore Creek

Moorin Creek

Gold Creek

Green Creek

Caudron Creek

McGillivray Creek

Coleman

Blairmore

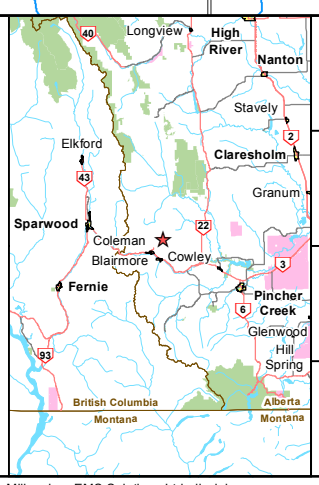
Frank

Bellevue

Project Footprint	Hectares
Ultimate Pit Extent	632.4
Ultimate Rock Disposal Area Extent	589.9
Topsoil Storage	37.9
Construction Camp	1.9
Ponds and Ditches	74.6
Coal Handling Processing Plant and Infrastructure	94.1
Covered Conveyor, Access Road and Powerline ROW	15.2
Proposed Golf Course Area	38.1
Proposed Haul Road	0.3
Proposed Water Pipeline/Service Road	1.5
Railway Loop	33.1
Proposed Helipad Access	1.6
Total:	**1520.7**

LEGEND

- Explosives Storage Facility
- Primary Highway
- Secondary Highway
- Road Access
- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Railway Loop
- Proposed Helipad Access
- Access Road
- Rail Loadout
- Proposed Haul Road
- Existing Railway
- 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



RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

LOCATION OF THE EXPLOSIVES STORAGE FACILITY FOR THE PROJECT

AltaLIS, 2017; Deswik, 2016; Golder, 2016; MEMS, 2017; Riversdale, 2017

Datum/Projection: UTM NAD 83 Zone 11

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201

DRAWN BY: JL

CHECKED BY: CH

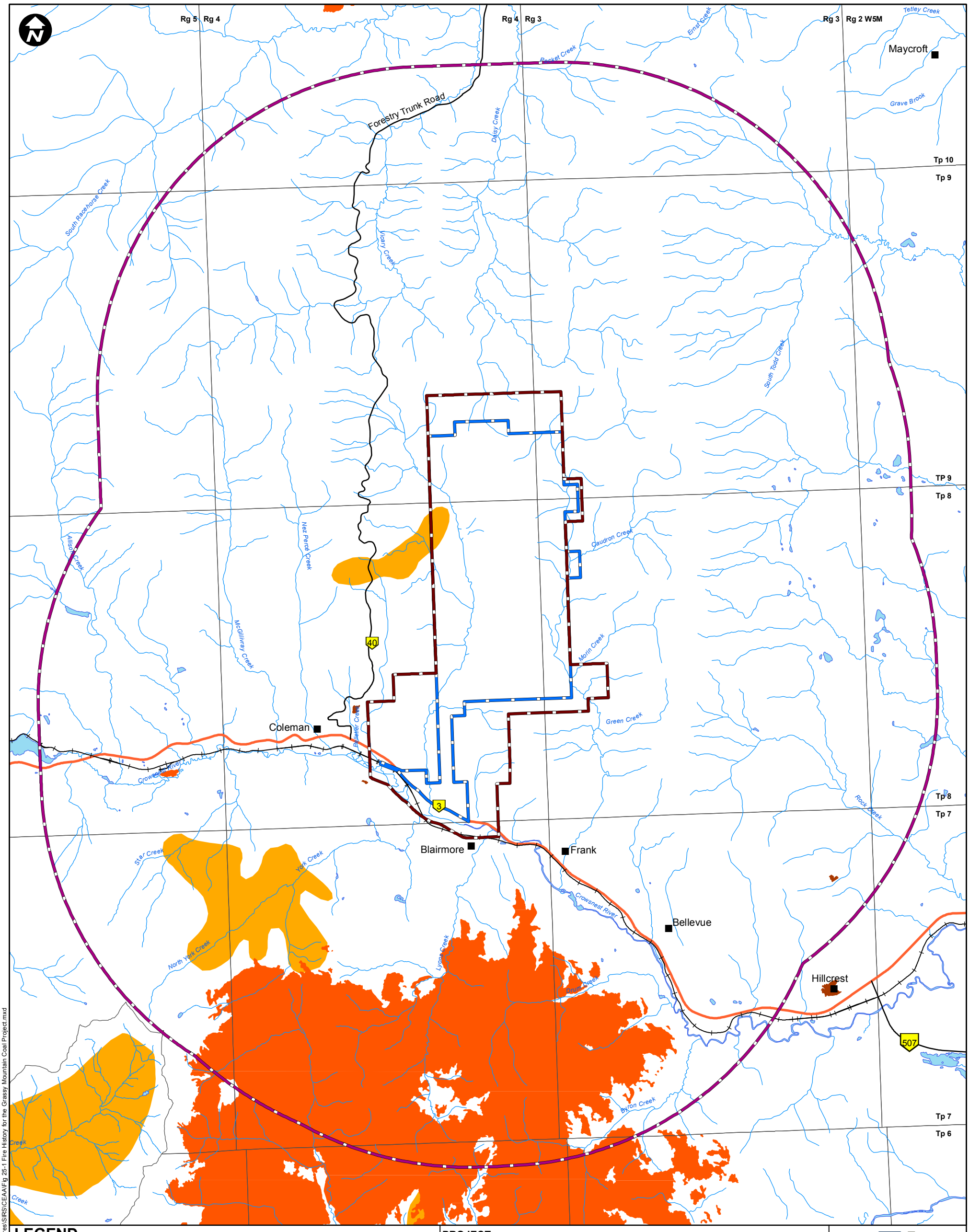
DATE: NOVEMBER 15, 2017

FIGURE

23-1

0 1 2 Kilometres

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Public Events\Fig 23-1 Location of the Explosives Storage Facility 14-00201.mxd



LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Waterbody
- Wildlife Regional Study Area
- Wildlife Local Study Area
- Proposed Mine Permit Boundary

Fire History

- 1930-1939
- 2000-2009
- 2010-2019

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

FIRE HISTORY FOR THE GRASSY MOUNTAIN COAL PROJECT

NOTES

AltaLIS, 2017; Geobase, 2015; MEMS, 2016;
Natural Resources Canada, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	RM
DATE:	MAY 4, 2017

0 2 4 8
Kilometres

FIGURE

25-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 25-1 Fire History for the Grassy Mountain Coal Project.mxd

Appendix 14A

Updated Wildlife Risk Assessment

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1.0 WILDLIFE RISK ASSESSMENT (WRA) UPDATE

In response to CEAA Additional Information Requests (AIRs) 14 and 15, the wildlife screening risk assessment (WRA) was updated to include the following dietary exposure pathways: ingestion of plants and berries and ingestion of fish and prey.

1.1 COC PERSISTENCE AND BIOACCUMULATION SCREENING

The WRA update included assessment of all chemicals of concern (COCs) with potential to bioaccumulate in plant or animal tissue, as identified in the human health risk assessment (HHRA) (Consultant Report [CR]#12, Section 5.1.1). The COCs identified as having the potential to bioaccumulate are noted in bold underline in CR #12, Table 5.1.1-2.

Any chemicals that met one of the following criteria were selected as COCs for the WRA update:

- Molecular weight >200 g/mol;
- Henry's Law constant <1.0x10-5 atm-m^3/mol;
- Vapour pressure <1.0x10-3 mm Hg; and
- Log octanol-water partition coefficient (log Kow) >3.5 (indicating a potential to bioaccumulate).

All metal COCs were included by default. The applied physical-chemical properties of the COCs are summarized in Table 14A-1. The COPC identified for assessment in the multi media model are bolded.

Table 14A-1 Physical-Chemical Properties of COCs

COPC	Molecular Weight	Vapour Pressure	Log K_{ow}	Henry's Law Constant
	g/mol	mm Hg	unitless	atm·m^3/mol
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	1.54E+02	2.20E-03	3.92E+00	1.80E-04
Acenaphthylene	1.52E+02	6.70E-03	4.00E+00	1.10E-04
Anthracene	1.78E+02	6.50E-06	4.54E+00	5.60E-05
Benz[a]anthracene	2.28E+02	2.10E-07	5.91E+00	1.20E-05
Benzo(a)pyrene	2.52E+02	5.50E-09	6.13E+00	4.60E-07
Benzo(b)fluoranthene	2.52E+02	5.00E-07	5.80E+00	6.60E-07
Benzo(g,h,i)perylene	2.76E+02	1.00E-10	6.50E+00	3.30E-07
Benzo(k)fluoranthene	2.52E+02	9.70E-10	6.00E+00	5.80E-07

Table 14A-1 Physical-Chemical Properties of COCs

COPC	Molecular Weight	Vapour Pressure	Log K_{ow}	Henry's Law Constant
	g/mol	mm Hg	unitless	atm·m^3/mol
Chrysene	2.28E+02	6.20E-09	5.60E+00	5.20E-06
Dibenzo(a,h)anthracene	2.78E+02	9.60E-10	6.75E+00	1.40E-07
Fluoranthene	2.02E+02	9.20E-06	5.22E+00	8.90E-06
Fluorene	1.66E+02	6.00E-04	4.18E+00	9.60E-05
Indeno(1,2,3-cd)pyrene	2.76E+02	1.30E-10	7.53E+00	3.50E-07
Naphthalene	1.28E+02	8.50E-02	3.37E+00	4.40E-04
Phenanthrene	1.78E+02	1.20E-04	4.57E+00	4.20E-05
Pyrene	2.02E+02	4.50E-06	5.18E+00	1.20E-05
Volatile Organic Compounds				
Acetaldehyde	4.41E+01	9.00E+02	4.50E-01	6.70E-05
Acrolein	5.61E+01	2.70E+02	1.00E-01	1.20E-04
Formaldehyde	3.00E+01	3.90E+03	3.50E-01	3.40E-07
Benzene	7.81E+01	9.48E+01	-	5.40E-03
Propylene	4.21E+01	7.50E+03	2.20E+02	9.60E-04
Toluene	9.21E+01	2.84E+01	-	6.64E-03
Xylenes	1.10E+02	7.99E+00	-	5.18E-03

BOLD – parameter has potential for bioaccumulation

The CCME (2010) factsheet for polycyclic aromatic hydrocarbons (PAHs) indicated the "*risks to herbivores…from PAH uptake into plant tissue are likely to be very low relative to the risks associated with the incidental ingestion of soil.*" Furthermore, it was stated that "plants exhibit very limited ability to accumulate PAHs from soils" (Simonich and Hites 1995, cited in CCME 2010), and neither low nor high molecular weight PAH compounds accumulate within plant tissue (CCME 2010). Based on the CCME (2010) review, it was determined that there was minimal risk of exposure of PAHs to wildlife through ingestion of plants or berries. Ingestion of plants or berries is also not expected to be a significant source of exposure for arsenic (CCME 2001), uranium (CCME 2007a), or vanadium (CCME 1997a). For the above COCs that do not accumulate in plants, only ingestion of fish and prey in carnivorous species were evaluated as operative exposure pathways. A review by CCME (2015) found "no evidence of any significant bioaccumulation or biomagnification of beryllium in food chains", and therefore beryllium was not assessed further.

1.2 WILDLIFE RECEPTORS

Potential wildlife receptors in the Study area were identified in the baseline wildlife survey (CR #9, Sections 2.4.2 and 24.3). From these lists of species, surrogate mammalian and avian species were selected for the WRA based on the species' value to the nearby communities, dietary composition, contaminant sensitivity, and the availability of exposure characteristics, with priority given to species at risk and migratory birds. Representative wildlife receptors from both terrestrial and aquatic ecosystems with the potential to be exposed to contaminants were selected (Table 14A-2). Receptor characteristics for all surrogate species were obtained from Environment Canada (2012) and are summarized in Table 14A-3. The minimum body weight reported for each species in the literature was applied, resulting in the maximum possible dose per kilogram of body weight.

Table 14A-2 Identification of Surrogate Species

Species	Justification for Inclusion	Group
Meadow vole	Prey species	Prey
Moose	Valued Ecosystem Component	Herbivorous mammal
Red fox	Availability of characteristics	Carnivorous mammal
Mink	Availability of characteristics	Piscivorous mammal
American robin	Availability of characteristics	Herbivorous bird
Spotted sandpiper	Migratory species	Insectivorous bird
Bald eagle	Valued Ecosystem Component	Carnivorous bird

Table 14A-3 Wildlife Receptor Characteristics

Parameter	Meadow Vole	Moose	Red Fox	Mink	American Robin	Spotted Sandpiper	Bald Eagle
Body Mass (kg)	0.0349	400	3.8	0.82	0.079	0.037	4.7
Migration Factor	1	1	1	1	1	0.6	1
Class	Herbivore	Herbivore	Carnivore	Piscivore	Herbivore	Insectivore	Piscivore
Food Ingestion Rate (kg/kg/day)	0.33	0.02	0.09	0.14	1.21	0.18	0.12
Soil Ingestion Rate (kg/kg/day)	0.00792	0.0004	0.00252	0	0.0484	0	0
Water Ingestion Rate (kg/kg/day)	0.21	0.05	0.09	0.03	0.14	0.17	0.04
Dietary composition:							
Plants (%)	100	80	15	0	60	0	0
Invertebrates (%)	0	0	25	10	40	60	0

Table 14A-3 Wildlife Receptor Characteristics

Parameter	Meadow Vole	Moose	Red Fox	Mink	American Robin	Spotted Sandpiper	Bald Eagle
Vertebrates (%)	0	0	60	25	0	0	35
Aquatic Plants (%)	0	20	0	0	0	5	0
Aquatic Invertebrates (%)	0	0	0	0	0	30	0
Fish (%)	0	0	0	65	0	5	65
Bioavailability Factor - Food	1	1	1	1	1	1	1
Bioavailability Factor - Water	1	1	1	1	1	1	1
Bioavailability Factor - Soil	1	1	1	1	1	1	1
Exposure Term	1	1	1	1	1	1	1

All values from Environment Canada (2012)

1.3 WILDLIFE EXPOSURE PATHWAYS

Exposure was assessed based on the exposure pathways identified in the previous WRA (CR #12, Appendix H, Table H.3), and included ingestion of surface water, soil, plants and berries, fish, and prey.

Exposure doses were calculated for the Baseline and Application cases using identical inputs and equations as in the HHRA (CR #12, Appendix E), along with the receptor characteristics from Environment Canada (2012). For the Baseline Case, potential exposure via consumption of vegetation was estimated using the analytical results of the Baseline Monitoring Program (CR #12, Appendix G). Where there were enough samples, the 95th percentile background soil concentrations were applied to the Baseline and Application scenarios, identical to the methodology used in the HHRA. Where media concentrations were measured as below detection limit, the input value used for the exposure modelling was the highest of either half the detection limit or the concentration predicted via deposition and uptake in the multi-media model (CR #12, Section 5.2).

Chemical concentrations in environmental media were estimated as part of the human health risk assessment (CR #12, Appendix E). The estimated concentrations from the Regional Study Area – Maximum Point of Impingement (RSA-MPOI) applied in the human health risk assessment were directly applied for the WRA. These included concentrations for soil, dust, vegetation, prey tissue, fish tissue, and surface water. It should be noted that applying the RSA-MPOI concentrations is extremely conservative when evaluating population level endpoints for ecological receptors.

The following equations from CR #12, Appendix E were used to calculate wildlife exposure doses:

- Ingestion of surface water – Equation 16;
- Ingestion of soil – Equation 15;
- Ingestion of plants and berries – Equation 18;
- Ingestion of fish – Equation 18; and
- Ingestion of prey – Equation 18.

Food ingestion rates were calculated as a fraction of the total food ingestion rates recommended by Environment Canada (2012) based on species dietary composition. A summary of the calculated exposure doses is included for each species in the Baseline and Application cases as Tables 14A-5 and 14A-6, respectively.

1.4 WILDLIFE RISK CALCULATIONS

Potential risk to wildlife receptors was determined by comparing the ratio of predicted total exposure to the daily threshold exposure doses (DTEDs). DTEDs were obtained from a literature review of several sources, including Environment Canada, CCME, the U.S. EPA, and Oak Ridge National Laboratory (ORNL). For the spotted sandpiper, more sensitive DTED values were applied to be protective of individual migratory birds rather than bird populations. In the selection of the DTEDs, priority was given to Environment Canada's (2012) recommended values, and a summary of applied DTEDs and the reasoning behind the selection of each value is included in the Wildlife DTED (Section 2.0 of this document).

The predicted hazard quotients for all COPCs, for all surrogate wildlife species, were below 1.0 in the Baseline and Application cases (Tables 14A-4 and 14A-5).

Table 14A-4 Baseline Case Exposure and Hazard Quotients

Parameter	Moose		Red Fox		Mink		American Robin		Spotted Sandpiper		Bald Eagle	
	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ
acenaphthene	4.51E-08	6.4E-10	3.30E-08	4.7E-10	4.61E-08	4.5E-12	1.73E-06	2.5E-08	1.10E-07	2.4E-10	3.96E-08	5.4E-12
acenaphthylene	4.23E-08	2.1E-08	1.93E-08	9.6E-09	1.32E-07	4.5E-10	9.08E-07	4.5E-07	3.52E-07	2.6E-08	1.13E-07	5.2E-10
anthracene	1.03E-06	5.1E-09	4.08E-07	2.0E-09	2.88E-05	8.7E-11	7.02E-06	3.5E-08	1.78E-05	1.1E-08	2.47E-05	1.1E-10
benz[a]anthracene	1.45E-06	7.3E-08	1.21E-06	6.0E-08	8.96E-09	7.6E-12	6.50E-05	3.3E-06	2.98E-07	2.1E-09	7.74E-09	9.4E-12
benzo(a)pyrene	2.25E-06	1.1E-06	1.89E-06	9.5E-07	5.51E-07	8.0E-11	1.02E-04	5.1E-05	2.48E-07	1.4E-08	4.72E-07	9.7E-11
benzo(b)fluoranthene	2.39E-07	1.2E-08	1.69E-07	8.5E-09	2.86E-06	5.5E-12	9.08E-06	4.5E-07	9.00E-07	4.4E-09	2.45E-06	7.1E-12
benzo(g,h,i)pyrene	7.47E-07	3.7E-07	5.97E-07	3.0E-07	1.10E-08	4.7E-09	3.13E-05	1.6E-05	8.96E-07	6.4E-08	1.26E-08	5.7E-09
benzo(k)fluoranthene	1.97E-08	9.8E-10	8.08E-09	4.0E-10	5.56E-07	8.5E-12	4.19E-07	2.1E-08	2.19E-07	1.2E-09	4.76E-07	1.0E-11
chrysene	2.88E-07	1.4E-08	2.10E-07	1.0E-08	1.93E-06	7.4E-12	1.13E-05	5.6E-07	8.19E-07	4.5E-09	1.65E-06	9.7E-12
dibenz(a,h)anthracene	1.38E-04	6.9E-05	1.16E-04	5.8E-05	4.43E-07	3.6E-09	6.24E-03	3.1E-03	6.00E-07	4.0E-08	3.82E-07	4.3E-09
fluoranthene	1.19E-06	2.4E-08	9.59E-07	1.9E-08	1.46E-06	1.0E-11	5.13E-05	1.0E-06	1.05E-06	2.6E-09	1.26E-06	1.1E-11
fluorene	3.30E-07	6.6E-09	1.40E-06	2.8E-08	1.13E-06	2.4E-11	2.91E-05	5.8E-07	7.44E-07	1.9E-09	9.68E-07	3.0E-11
indeno(1,2,3-c,d)pyrene	7.75E-06	3.9E-06	6.37E-06	3.2E-06	1.50E-07	1.1E-10	3.43E-04	1.7E-04	3.06E-06	2.2E-07	1.28E-07	1.4E-10
phenanthrene	2.06E-06	1.5E-08	1.55E-06	1.1E-08	6.12E-06	2.8E-11	8.28E-05	5.9E-07	4.29E-06	3.9E-09	5.25E-06	3.4E-11
pyrene	1.64E-06	6.5E-08	2.54E-06	1.0E-07	7.91E-07	1.6E-11	8.91E-05	3.6E-06	6.51E-07	3.3E-09	6.78E-07	1.9E-11
formaldehyde	4.26E-08	2.8E-07	6.63E-08	4.4E-07	2.13E-07	1.3E-07	4.07E-07	2.7E-06	1.67E-07	7.9E-07	1.93E-07	1.8E-07
aluminium	7.33E-03	3.8E-04	4.61E-02	2.4E-03	1.17E-06	6.0E-08	8.86E-01	8.1E-03	9.61E-09	8.8E-11	1.40E-06	1.3E-08
antimony	3.99E-05	3.2E-04	3.36E-05	2.7E-04	1.15E-06	8.6E-08	1.81E-03	1.4E-02	1.66E-07	4.3E-07	9.91E-07	1.1E-07
arsenic	2.32E-04	1.8E-04	2.12E-04	1.7E-04	1.89E-05	5.6E-08	1.07E-02	2.1E-03	2.18E-06	6.0E-08	1.63E-05	1.8E-08
barium	1.97E-02	3.9E-03	4.49E+00	8.8E-01	3.26E+00	5.4E-01	9.68E+01	4.6E-01	2.13E+01	1.0E-01	4.27E-01	1.7E-06
cadmium	5.60E-05	1.2E-04	5.12E-05	1.1E-04	3.57E-04	2.9E-07	2.58E-03	1.3E-04	3.62E-05	5.3E-07	3.06E-04	8.7E-09

Table 14A-4 Baseline Case Exposure and Hazard Quotients

Parameter	Moose		Red Fox		Mink		American Robin		Spotted Sandpiper		Bald Eagle	
	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ
Chromium	2.65E-04	9.7E-08	2.94E-04	1.1E-07	3.48E-05	2.4E-10	1.29E-02	2.6E-03	7.56E-06	7.0E-07	3.01E-05	1.7E-07
cobalt	3.06E-04	4.2E-05	2.90E-04	4.0E-05	1.34E-06	1.2E-07	1.42E-02	1.9E-03	5.04E-06	5.5E-07	1.55E-06	1.6E-07
copper	1.08E-03	1.9E-04	9.96E-04	1.8E-04	4.25E-04	1.1E-06	4.99E-02	9.5E-03	5.81E-05	2.8E-06	3.66E-04	1.5E-06
lead	4.74E-04	5.9E-06	4.37E-04	5.5E-06	1.40E-06	1.4E-08	2.19E-02	1.2E-02	9.51E-06	3.7E-06	1.73E-06	8.2E-07
manganese	1.19E-03	4.2E-06	3.72E-02	1.3E-04	2.09E-02	7.4E-05	8.04E-01	8.2E-04	1.65E-01	9.0E-04	9.99E-06	1.0E-08
mercury	5.39E-06	5.3E-06	4.83E-06	4.8E-06	5.72E-08	5.7E-08	2.46E-04	2.7E-04	1.07E-07	8.8E-08	6.97E-08	7.7E-08
molybdenum	6.79E-05	2.6E-05	6.06E-05	2.3E-05	1.73E-07	6.6E-08	3.11E-03	8.8E-05	1.06E-06	2.6E-08	2.27E-07	6.4E-09
nickel	1.05E-03	4.2E-05	9.61E-04	3.8E-05	5.81E-04	1.1E-07	4.86E-02	4.5E-04	7.21E-05	1.3E-07	5.00E-04	3.3E-08
selenium	5.16E-05	1.6E-04	4.56E-05	1.4E-04	4.72E-05	4.4E-07	2.36E-03	7.9E-03	5.51E-06	2.4E-06	4.05E-05	6.4E-07
thallium	2.11E-05	7.0E-04	1.83E-05	6.1E-04	1.51E-05	1.7E-06	9.60E-04	3.2E-02	1.84E-06	9.7E-06	1.30E-05	2.2E-06
uranium	8.47E-05	1.7E-04	7.17E-05	1.5E-04	1.99E-07	4.1E-07	3.83E-03	2.4E-04	1.32E-06	7.2E-08	2.66E-07	1.7E-08
vanadium	1.01E-03	4.8E-04	1.01E-03	4.8E-04	5.80E-06	2.8E-06	4.78E-02	4.2E-03	1.54E-05	1.2E-06	7.27E-06	6.4E-07
zinc	5.55E-03	5.6E-04	5.05E-03	5.0E-04	8.09E-02	3.1E-06	2.55E-01	1.9E-03	8.08E-03	1.1E-06	6.94E-02	3.0E-07

Table 14A-5 Application Case Exposure and Hazard Quotients

Parameter	Moose		Red Fox		Mink		American Robin		Spotted Sandpiper		Bald Eagle	
	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ
acenaphthene	4.72E-08	6.7E-10	3.33E-08	4.8E-10	5.97E-08	5.9E-12	1.73E-06	2.5E-08	1.42E-07	3.1E-10	5.13E-08	7.0E-12
acenaphthylene	4.90E-08	2.4E-08	2.00E-08	1.0E-08	1.70E-07	5.9E-10	9.10E-07	4.6E-07	4.56E-07	3.4E-08	1.46E-07	6.8E-10
anthracene	1.03E-06	5.1E-09	4.08E-07	2.0E-09	2.88E-05	8.8E-11	7.02E-06	3.5E-08	1.78E-05	1.1E-08	2.47E-05	1.1E-10
benz[a]anthracene	1.48E-06	7.4E-08	1.23E-06	6.2E-08	1.16E-08	8.5E-12	6.61E-05	3.3E-06	3.87E-07	2.8E-09	1.00E-08	1.1E-11
benzo(a)pyrene	2.27E-06	1.1E-06	1.90E-06	9.5E-07	7.15E-07	8.4E-11	1.02E-04	5.1E-05	3.22E-07	1.8E-08	6.13E-07	1.0E-10

Table 14A-5 Application Case Exposure and Hazard Quotients

Parameter	Moose		Red Fox		Mink		American Robin		Spotted Sandpiper		Bald Eagle	
	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ
benzo(b)fluoranthene	2.54E-07	1.3E-08	1.72E-07	8.6E-09	3.71E-06	6.9E-12	9.22E-06	4.6E-07	1.17E-06	5.8E-09	3.18E-06	9.0E-12
benzo(g,h,i)pyrene	7.65E-07	3.8E-07	5.98E-07	3.0E-07	1.14E-08	4.7E-09	3.14E-05	1.6E-05	1.16E-06	8.3E-08	1.30E-08	5.7E-09
benzo(k)fluoranthene	2.30E-08	1.1E-09	8.23E-09	4.1E-10	7.21E-07	8.8E-12	4.26E-07	2.1E-08	2.84E-07	1.5E-09	6.18E-07	1.1E-11
chrysene	3.26E-07	1.6E-08	2.31E-07	1.2E-08	2.50E-06	9.4E-12	1.24E-05	6.2E-07	1.06E-06	5.9E-09	2.14E-06	1.2E-11
dibenz(a,h)anthracene	1.38E-04	6.9E-05	1.17E-04	5.8E-05	5.73E-07	3.6E-09	6.27E-03	3.1E-03	7.79E-07	5.2E-08	4.93E-07	4.3E-09
fluoranthene	1.21E-06	2.4E-08	9.66E-07	1.9E-08	1.90E-06	1.2E-11	5.15E-05	1.0E-06	1.36E-06	3.4E-09	1.63E-06	1.4E-11
fluorene	3.43E-07	6.9E-09	1.40E-06	2.8E-08	1.46E-06	3.0E-11	2.91E-05	5.8E-07	9.66E-07	2.5E-09	1.26E-06	3.9E-11
indeno(1,2,3-c,d)pyrene	7.85E-06	3.9E-06	6.41E-06	3.2E-06	1.94E-07	1.2E-10	3.45E-04	1.7E-04	3.97E-06	2.8E-07	1.66E-07	1.4E-10
phenanthrene	2.15E-06	1.5E-08	1.57E-06	1.1E-08	7.94E-06	3.6E-11	8.35E-05	6.0E-07	5.57E-06	5.1E-09	6.81E-06	4.4E-11
pyrene	1.65E-06	6.6E-08	2.55E-06	1.0E-07	1.03E-06	1.9E-11	8.93E-05	3.6E-06	8.46E-07	4.3E-09	8.80E-07	2.2E-11
formaldehyde	5.33E-08	3.6E-07	8.44E-08	5.6E-07	2.77E-07	1.7E-07	4.36E-07	2.9E-06	2.17E-07	1.0E-06	2.50E-07	2.3E-07
aluminium	7.33E-03	3.8E-04	4.61E-02	2.4E-03	1.17E-06	6.1E-08	8.86E-01	8.1E-03	1.25E-08	1.1E-10	1.40E-06	1.3E-08
antimony	9.59E-05	7.7E-04	8.09E-05	6.5E-04	2.79E-06	2.1E-07	4.35E-03	3.5E-02	4.03E-07	1.0E-06	2.40E-06	2.7E-07
arsenic	5.42E-04	4.3E-04	4.74E-04	3.8E-04	4.48E-05	1.3E-07	2.48E-02	4.8E-03	5.15E-06	1.4E-07	3.85E-05	4.2E-08
barium	4.72E-02	9.3E-03	2.44E-01	4.8E-02	1.28E+00	1.3E-02	5.74E+00	2.8E-02	6.39E-01	2.5E-03	1.04E+00	4.0E-06
cadmium	1.33E-04	2.9E-04	1.17E-04	2.6E-04	8.64E-04	7.1E-07	6.07E-03	3.0E-04	8.76E-05	1.3E-06	7.41E-04	2.1E-08
chromium	6.15E-04	2.2E-07	5.91E-04	2.2E-07	8.40E-05	5.6E-10	2.88E-02	5.8E-03	1.82E-05	1.7E-06	7.27E-05	4.1E-07
cobalt	7.25E-04	9.9E-05	6.45E-04	8.8E-05	3.23E-06	3.0E-07	3.32E-02	4.4E-03	1.22E-05	1.3E-06	3.74E-06	3.7E-07
copper	2.57E-03	4.6E-04	2.26E-03	4.0E-04	1.03E-03	2.6E-06	1.17E-01	2.2E-02	1.41E-04	6.8E-06	8.86E-04	3.5E-06
lead	1.13E-03	1.4E-05	9.91E-04	1.2E-05	3.40E-06	3.3E-08	5.15E-02	2.9E-02	2.30E-05	9.0E-06	4.18E-06	2.0E-06
manganese	1.19E-03	4.2E-06	3.72E-02	1.3E-04	2.10E-02	7.4E-05	8.06E-01	8.2E-04	1.65E-01	9.1E-04	9.99E-06	1.0E-08
mercury	1.42E-05	1.4E-05	1.24E-05	1.2E-05	1.50E-07	1.5E-07	6.43E-04	7.1E-04	2.84E-07	2.4E-07	1.83E-07	2.0E-07
molybdenum	1.63E-04	6.3E-05	1.41E-04	5.4E-05	4.19E-07	1.6E-07	7.40E-03	2.1E-04	2.57E-06	6.4E-08	5.49E-07	1.6E-08
nickel	2.52E-03	1.0E-04	2.20E-03	8.8E-05	1.41E-03	2.6E-07	1.15E-01	1.1E-03	1.75E-04	3.2E-07	1.21E-03	7.9E-08

Table 14A-5 Application Case Exposure and Hazard Quotients

Parameter	Moose		Red Fox		Mink		American Robin		Spotted Sandpiper		Bald Eagle	
	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ	Exposure	HQ
selenium	1.23E-04	3.7E-04	1.06E-04	3.2E-04	1.15E-04	1.1E-06	5.60E-03	1.9E-02	1.34E-05	5.7E-06	9.83E-05	1.5E-06
thallium	5.05E-05	1.7E-03	4.32E-05	1.4E-03	3.67E-05	4.0E-06	2.29E-03	7.6E-02	4.47E-06	2.4E-05	3.15E-05	5.4E-06
uranium	2.04E-04	4.2E-04	1.73E-04	3.5E-04	4.84E-07	9.9E-07	9.22E-03	5.8E-04	3.20E-06	1.8E-07	6.45E-07	4.0E-08
vanadium	2.39E-03	1.1E-03	2.18E-03	1.0E-03	1.36E-05	6.5E-06	1.10E-01	9.6E-03	3.73E-05	2.9E-06	1.70E-05	1.5E-06
zinc	1.32E-02	1.3E-03	1.16E-02	1.2E-03	1.95E-01	7.4E-06	6.02E-01	4.6E-03	1.95E-02	2.7E-06	1.67E-01	7.1E-07

2.0 WILDLIFE DAILY THRESHOLD EXPOSURE DOSES

2.1 METHODOLOGY

Wildlife oral toxicity reference values (TRVs) published by CCME, ORNL, and U.S. EPA were identified. The general approaches taken by these agencies include:

1. CCME – Values used by CCME to develop soil quality guidelines are the LOAEL for the species determined to be most at threat (based on sensitivity to contaminant and the ratio of ingestion rate to body weight), considering a minimum of two oral mammalian studies and one oral avian study, preferably including a grazing herbivore with a high ingestion rate to body weight ratio. Uncertainty factors between one and five may be applied. Only one DTED is typically specified and used to derive soil quality guidelines, unless the chemical biomagnifies and higher trophic levels are also evaluated (CCME 2006).
2. ORNL – No-observed-adverse-effect level (NOAEL) and lowest-observed-adverse-effect level (LOAEL) values were obtained from studies by ORNL. One avian and one mammal study were identified as critical studies based on endpoints and relevance to wildlife; in some cases, NOAELs and LOAELs were extrapolated from available data (Sample *et al.* 1996). Based on the methodologies employed, the LOAELs specified by ORNL are expected to have a similar level of protection to the CCME values.
3. U.S. EPA – many studies were reviewed by U.S. EPA to develop ecological soil screening levels. The toxicity benchmark was set as the lower of the geometric mean of growth and reproduction NOAEL values, or the highest bounded NOAEL that is less than the lowest bounded LOAEL (U.S. EPA 2003). The U.S. EPA values are generally more conservative than the CCME values.

In general, values developed or endorsed by Environment Canada, including those published by CCME, are given preference. However, CCME evaluate only the most sensitive receptor for the food ingestion pathway, and therefore generally only specify either a mammalian DTED or an avian DTED instead of both. Due to the physiological differences between mammals and birds, separate mammalian and avian DTEDs are specified herein where possible. The selected DTED values are summarized below in Table 14A-6.

Also, since the reviews undertaken by U.S. EPA and ORNL may incorporate additional studies or newer data, values published by other agencies are evaluated even where CCME has specified a value. Each COC is evaluated on a case-by-case basis below.

Table 14A-6 Summary of DTED Values

Chemical	Mammalian DTED		Avian DTED	
	Value (mg/kg/d)	Test Species	Value (mg/kg/d)	Test Species
Hydrocarbons				
Acenaphthene	70	mouse	70	mouse
Anthracene	200	mouse	200	mouse
Benz(a)anthracene	20	mouse	20	mouse
Benzo(b)fluoranthene	20	mouse	20	mouse
Benzo(k)fluoranthene	20	mouse	20	mouse
Benzo(a)pyrene	2	mouse	2	mouse
Chrysene	20	mouse	20	mouse
Fluoranthene	50	mouse	50	mouse
Flourene	50	mouse	50	mouse
Phenanthrene	140	rat	140	rat
Pyrene	25	mouse	25	mouse
Naphthalene	28.6	rat	28.6	rat
Inorganics				
Aluminum	19.3	mouse	109.7	dove
Antimony	0.059	rat	0.0059	rat/UF
Arsenic	1.26	mouse	2.24	chicken
Barium	5.1	rat	208.26	chick
Cadmium	0.456	sheep	20 1.47[a]	mallard duck
Chromium	2737 Cr(III) 3.28 Cr(VI)	various	5 2.66[a]	various
Cobalt	7.33	various	7.61	various
Copper	5.6	pig	5.23	hen
Lead	80	rat	1.8	quail

Table 14A-6 Summary of DTED Values

Chemical	Mammalian DTED		Avian DTED	
	Value (mg/kg/d)	Test Species	Value (mg/kg/d)	Test Species
Manganese	284 51.5[a]	rat various	977 179[a]	quail various
Mercury (inorganic)	1.01	mink	0.9	quail
Molybdenum	2.6	mouse	35.3 3.5[a]	chicken
Nickel	25	rat	107 77.4[a]	mallard
Selenium	0.33	rat	0.3	chicken
Thallium	0.03	sheep	NA	--
Uranium	0.49	rabbit	16	black duck
Vanadium	2.1	rat	11.4	mallard duck
Zinc	10	sheep	131 66.1[a]	chicken

a – sensitive species
NA – not applicable, see chemical summary

2.2 THREATENED/ENDANGERED SPECIES

The level of protection considered to be appropriate for the protection of ecological systems in general may not be sufficiently protective of threatened or endangered species in all cases. If the effect on which the DTED is based is significant (mortality or reproduction effects), additional conservatism may be required. The U.S. EPA toxicity reference values are expected to be sufficiently protective of threatened and endangered species, since they are set below the level at which any effects are observed in a large database of studies. In the absence of U.S. EPA values, uncertainty factors may be applied on a case-by-case basis as described below.

None of the mammals evaluated in the present risk assessment are threatened or endangered species.

2.3 CHEMICAL-SPECIFIC SUMMARIES

2.3.1 Hydrocarbons

CCME (2008) published oral wildlife DTEDs for a variety of PAHs, as shown below (Table 14A-7). These values are applied herein. Where values were not available the most conservative DTED, based on benzo(a)pyrene, was applied.

Table 14A-7 Summary of PAH DTED Values

PAH	DTED (mg/kg-BW/day)	Species	Critical Effect
Acenaphthene	70	mice	hepatotoxicity
Anthracene	200	mice	no effect
Benz(a)anthracene	20	mice	immunotoxicity
Benzo(b)fluoranthene	20	mice	immunotoxicity
Benzo(k)fluoranthene	20	mice	immunotoxicity
Benzo(a)pyrene	2	mice	reproductive
Chrysene	20	mice	immunotoxicity
Fluoranthene	50	mice	nephrotoxicity
Fluorene	50	mice	haematological effects
Phenanthrene	140	rats	lethality
Pyrene	25	mice	nephrotoxicity
Naphthalene	28.6	rats	body weight

Very limited toxicity data are available for avian receptors. U.S. EPA (2007b) identified two studies; one of these studies established a NOAEL of 1,653 mg/kg/d for naphthalene based on a bobwhite; the second established a NOAEL of 2 mg/kg/d and LOAEL of 20 mg/kg/d for 7,12-dimethylbenz(a)anthracene for growth effects on European starlings. The use of the mammalian DTEDS for avian receptors, along with a DTED of 20 mg/kg/d for 7,12-dimethylbenz(a)anthracene, is therefore recommended.

2.3.2 Inorganics

The TRVs for inorganic COCs for avian and mammalian species are summarized in Table 14A-8.

Table 14A-8 TRVs for Inorganic Compounds

	Source	DTED (mg/kg-BW/day)	Species	Critical Effect	Comments
Aluminum					
Avian	ORNL (Sample *et al*. 1996)	109.7	ringed dove	reproductive effects	No LOAEL available; used the NOAEL instead. Only one dose level administered The ORNL value is applied herein for all avian receptors, since no effects were observed at this dose
Mammalian	ORNL (Sample *et al*. 1996)	19.3	mice	reproductive effects	Only one dose level administered; BW = 0.03 kg The ORNL value is applied herein for mammalian receptors. It should be noted that aluminum often has low bioavailability, and total aluminum concentrations are poorly correlated with toxicity (U.S. EPA, 2003b).
Antimony					
Avian	None identified	-	-	-	Since the ORNL value is based on mortality, the U.S. EPA value is applied instead. No avian TRVs were identified for antimony; the mammalian DTED is therefore applied with an additional uncertainty factor of 10.
Mammalian	ORNL (Sample *et al*. 1996)	0.125	mice	longevity	Used the NOAEL instead of the LOAEL as the toxicological endpoint was mortality; only one dose level administered; BW = 0.03 kg
	U.S. EPA (2005)	0.059	rats	reproductive effects	NOAEL used; LOAEL = 0.59
Arsenic					
Avian	ORNL (Sample *et al*. 1996)	5.14	mallard ducks	mortality	Used the NOAEL instead of the LOAEL as the toxicological endpoint was mortality.
	U.S. EPA (2005b)	2.24	chickens	reproductive effects, growth and mortality	NOAEL; LOAEL NR. Since the ORNL value is based on mortality, the U.S. EPA value is for all avian receptors
Mammalian	CCME 2001	4	rabbit	mortality	LD_{50} with UF of 2; BW = 3 kg
	ORNL (Sample *et al*. 1996)	1.26	mice	reproductive effects (litter size)	Only one dose level administered; BW = 0.03 kg. CMME has specified a DTED for this substance; however, since this value is based on mortality, the ORNL value is applied instead for added conservatism.
	U.S. EPA (2005b)	1.04	dogs	growth	NOAEL used; LOAEL = 1.66
Barium					
Avian	ORNL (Sample *et al*. 1996)	208.26	chicks	NOAEL (mortality)	BW = 0.121 kg. Only a single avian TRV was identified for barium; since it is based on a NOAEL, it is applied for all avian receptors
Mammalian	ORNL (Sample *et al*. 1996)	5.1	rats	NOAEL	BW = 0.435 kg. Since the ORNL value is based on an approach similar to the CCME method, and since both values were based on NOAELs, the ORNL value is applied.
	U.S. EPA (2005c)	51.8	NA	NOAEL	Geometric mean of NOAELS
Cadmium					
Avian	ORNL (Sample *et al*. 1996)	20	mallards	reproductive effects	The ORNL value is applied herein, since the level of protection is similar to CCME guidelines. However, the U.S. EPA value is applied for threatened/endangered avian receptors.
	U.S. EPA (2005)	1.47	NA	NOAEL	Geometric mean of NOAELs

Table 14A-8 TRVs for Inorganic Compounds

	Source	DTED (mg/kg-BW/day)	Species	Critical Effect	Comments
Mammalian	CCME 1999a	0.456	sheep	clinical signs/lesions	BW = 45 kg. CCME has specified a mammalian DTED, and this value is lower than those specified by ORNL or U.S. EPA; therefore, the CCME value is applied herein.
	ORNL (Sample *et al*. 1996)	10	rats	reproductive effects	BW = 0.303 kg
	U.S. EPA (2005d)	0.77	rats	growth	NOAEL used; LOAEL = 7.7
Chromium					
Avian	U.S. EPA (2005e)	2.66 – Cr(III)	NA	-	Geometric mean of NOAELs
	ORNL (Sample *et al*. 1996)	5 – Cr(III)	black duck	reproduction	NOAEL = 1 mg/kg/d. The ORNL value is applied herein, since the level of protection is similar to CCME guidelines. The U.S. EPA value is applied for threatened/endangered species, however
Mammalian	U.S. EPA (2005e)	2.40 – Cr(III) 9.24 – Cr(VI)	NA	-	Geometric mean of NOAELs
	ORNL (Sample *et al*. 1996)	2737 – Cr(III)	rat	reproduction/longevity	NOAEL
	ORNL (Sample *et al*. 1996)	3.28 – Cr(VI)	rat	body weight, food consumption	NOAEL. The ORNL values are applied herein, since the level of protection is similar to CCME guidelines. Since these values are NOAEL-based, they are applied for all mammalian receptors.
Cobalt					
Avian	U.S. EPA (2005f)	7.61	NA	-	Geometric mean of NOAELs. Only a single TRV was identified; this value is NOAEL-based and is applied for all avian receptors.
Mammalian	U.S. EPA (2005f)	7.33	NA	-	Geometric mean of NOAELs. Only a single TRV was identified; this value is NOAEL-based and is applied for all mammalian receptors.
Copper					
Avian	CCME (1997b)	5.23	hens	reduced weight gain	Document suggests sheep may need site-specific consideration. Since CCME has defined a DTED for avian species, and this value is very similar to the U.S. EPA value and lower than the ORNL value, the CCME DTED is applied herein for avian species.
	ORNL (Sample *et al.*, 1996)	47	chicks	growth and mortality	-
	U.S. EPA (2007c)	4.05	chicken	food conversion efficiency	-
Mammalian	ORNL (Sample *et al*. 1996)	11.7	mink (1 kg)	kit mortality	Based on NOAEL since critical effect is mortality
	U.S. EPA (2007c)	5.6	pig	mortality	The U.S. EPA value is more recent and more conservative, and is therefore applied herein.

Table 14A-8 TRVs for Inorganic Compounds

	Source	DTED (mg/kg-BW/day)	Species	Critical Effect	Comments
Lead					
Avian	CCME 1999b	1.8	quail	egg production	CCME has specified an avian DTED for lead; this value is very similar to the U.S. EPA value, and is therefore applied for all avian receptors herein.
	U.S. EPA (2005g)	1.63	chickens	reproductive effects	NOAEL used; LOAEL = 3.26
Mammalian	ORNL (Sample *et al*. 1996)	80	rats	reduced offspring weight and kidney damage	BW = 0.35 kg. The ORNL value is applied as a mammalian DTED, since the methods used by ORNL are similar to those used by CCME.
	U.S. EPA (2005g)	4.7	rats	growth	NOAEL used; LOAEL = 8.9
Manganese					
Avian	ORNL (Sample *et al*. 1996)	977	Japanese quail	growth and behaviour	No LOAEL available; used the NOAEL instead. The ORNL value is applied herein, since the level of protection is similar to CCME guidelines. However, the U.S. EPA value is applied for threatened/endangered avian receptors.
	U.S. EPA (2007d)	179	NA	-	Geometric mean of NOAELs
Mammalian	ORNL (Sample *et al*. 1996)	284	rats	reproductive effects	BW = 0.35 kg. The ORNL value is applied herein, since the level of protection is similar to CCME guidelines. However, the U.S. EPA value is applied for threatened/endangered avian receptors.
	U.S. EPA (2007d)	51.5	NA	-	Geometric mean of NOAELs
Mercury (inorganic)					
Avian	ORNL (Sample *et al*. 1996)	0.9	Japanese Quail	reproduction	Mercuric chloride. The ORNL value is the only avian TRV identified, and is therefore applied herein
Mammalian	CCME (Environment Canada 1999)	0.38	pigs (80 kg)	clinical toxicological signs	Organic mercury
	ORNL (Sample *et al*. 1996)	1.01	mink (1 kg)	reproduction	Mercuric chloride; based on NOAEL since no effects observed. The CCME value is based on organic mercury; the ORNL value is therefore considered more appropriate as a DTED for inorganic mercury.
Molybdenum					
Avian	ORNL (Sample *et al*. 1996)	35.3	chickens	reproductive effects	The ORNL value is applied as an avian DTED herein; however, since the observed effect is considered significant, an NOAEL of 3.5 mg/kg/d is applied as a DTED for threatened/endangered species
Mammalian	ORNL (Sample *et al*. 1996)	2.6	mice	reproductive effects	Only one dose level administered, BW = 0.03 kg. The ORNL value is applied as a mammalian DTED.
Nickel					
Avian	ORNL (Sample *et al*. 1996)	107 (LOAEL) 77.4 (NOAEL)	mallard duckling	growth and mortality	BW = 0.782 kg. Since the ORNL value was derived using similar methods to CCME, it is applied herein; the NOAEL-based value is applied for threatened and endangered species.
	U.S. EPA (2007d)	6.71	NA	-	Geometric mean of NOAELs
Mammalian	CCME (Environment Canada 1999)	25	rat	growth and liver enzymes	Since CCME has specified a DTED, and it is lower than the ORNL value, the CCME value is applied.

Table 14A-8 TRVs for Inorganic Compounds

	Source	DTED (mg/kg-BW/day)	Species	Critical Effect	Comments
	ORNL (Sample *et al*. 1996)	80	rat	reproduction	BW = 0.35 kg
	U.S. EPA (2007d)	1.7	mouse	reproduction	NOAEL
Selenium					
Avian	CCME 2007f	0.3	chickens	hatchability	CCME has specified an avian DTED for selenium, and this value is lower than the ORNL value and similar to the U.S. EPA value. The CCME value is therefore applied herein for all bird species. Additional conservatism for threatened/endangered species is not considered warranted due to the very narrow range between the required nutritional dose and toxic dose for this substance, and since the NOAEL-based U.S. EPA value is virtually identical to the CCME value.
	ORNL (Sample *et al*. 1996)	1	mallard ducks	reproductive effects	-
	U.S. EPA (2007f)	0.290	chickens	mortality	NOAEL
Mammalian	ORNL (Sample *et al*. 1996)	0.33	rats	reproductive effects	Selenium in the form of potassium selenate; BW = 0.35 kg. The ORNL value was applied since the methodology was like the CCME approach.
	U.S. EPA (2007)	0.143	pig	body weight	NOAEL
Thallium					
Avian	No avian TRVs for thallium were identified; use of the mammalian TRV is therefore recommended.				
Mammalian	CCME (Environment Canada 1999)	0.03	sheep (30 kg)	body weight, loss of wool	Since CCME has specified a DTED, and this value is lower than the ORNL value, the CCME value is applied herein.
	ORNL (Sample *et al*. 1996)	0.074	rat (0.365 kg)	reproduction	-
Uranium					
Avian	CCME (2007a)	16	black duck	NOAEL	CCME and ORNL identified identical DTEDs for avian receptors; this value is applied for all avian receptors since it is NOAEL-based.
	ORNL (Sample *et al*. 1996)	16	black duck	NOAEL	BW = 1.25 kg; includes factor of 10 for subchronic study
Mammalian	CCME (2007a)	0.49	rabbits	renal toxicity	CCME has specified a DTED for uranium, which is applied herein.
	ORNL (Sample *et al*. 1996)	6.13	mouse	reproduction	BW = 0.028 kg
Vanadium					
Avian	ORNL (Sample *et al*. 1996)	11.4	mallard duck	NOAEL	BW = 1.17 kg. Only a single TRV was identified; since it is NOAEL-based, it is applied for all avian receptors.

Table 14A-8 TRVs for Inorganic Compounds

	Source	DTED (mg/kg-BW/day)	Species	Critical Effect	Comments
Mammalian	ORNL (Sample *et al*. 1996)	2.1	rat	reproduction	BW = 0.26 kg. Since the ORNL value is derived using an approach similar to the CCME method, this value is applied herein.
	U.S. EPA (2005h)	4.16	mouse	mortality	NOAEL
Zinc					
Avian	ORNL (Sample *et al*. 1996)	131	chickens	reproductive effects	The ORNL value is derived using a similar methodology to CCME, and is therefore applied as the DTED. Since the effect (reproduction) is significant, the U.S. EPA value of 68.1 mg/kg/d is applied for threatened/endangered species.
	U.S. EPA (2007a)	66.1	NA	-	Geometric mean of NOAELS
Mammalian	CCME (Environment Canada 1999)	10	sheep	reproduction	BW = 80 kg. CCME has established a mammalian DTED for zinc; this value is applied herein.
	ORNL (Sample *et al*. 1996)	320	rats	reproductive effects	BW = 0.35 kg
	U.S. EPA (2007a)	75.4	NA	-	Geometric mean of NOAELS

3.0 REFERENCES

Canadian Council of Ministers of the Environment (CCME). 1997a. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Vanadium.

Canadian Council of Ministers of the Environment (CCME). 1997b. Canadian Soil Quality Guidelines for Copper – Environmental and Human Health. Prepared by the CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 1999a. Canadian soil quality guidelines for the protection of environmental and human health: Cadmium (1999). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 1999b. Canadian Soil Quality Guidelines for Lead – Environmental and Human Health. Prepared by the CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2001. Canadian soil quality guidelines for the protection of environmental and human health: Arsenic (inorganic) (1997). Updated In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. PN 1332.

Canadian Council of Ministers of the Environment (CCME). 2007a. Canadian soil quality guidelines for the protection of environmental and human health: Uranium (2007). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2007b. Canadian Soil Quality Guidelines for Uranium: Environmental and Human Health. Scientific Supporting Document. PN 1371.

Canadian Council of Ministers of the Environment (CCME). 2008. Canadian Soil Quality Guidelines for Carcinogenic and Other Polycyclic Aromatic Hydrocarbons (Environmental and Human Health Effects). Scientific Supporting Document. PN 1401.

Canadian Council of Ministers of the Environment (CCME). 2010. Canadian soil quality guidelines for the protection of environmental and human health: Carcinogenic and Other PAHs. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2015. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Beryllium.

Environment Canada. 1999a. Canadian Soil Quality Guidelines for Inorganic Mercury. Scientific Supporting Document. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada. Ottawa.

Environment Canada. 1999b. Canadian Soil Quality Guidelines for Nickel. Scientific Supporting Document. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada. Ottawa.

Environment Canada. 1999c. Canadian Soil Quality Guidelines for Zinc. Scientific Supporting Document. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada. Ottawa.

Environment Canada. 1999d. Canadian Soil Quality Guidelines for Thallium. Scientific Supporting Document. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada. Ottawa.

Environment Canada. 2012. Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance Module 3: Standardization of Wildlife Receptor Characteristics. March 2012.

Health Canada. 2010b. *Federal Contaminated Sites Risk Assessment in Canada Part V: Guidance on Detailed Quantitative Human Health Risk Assessment of Chemicals (DQRA$_{CHEM}$)*. Contaminated Sites Division. Ottawa.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. US Department of Energy, Office of Environmental Management. Oak Ridge National Laboratory. ES/ER/TM-86/R3.

U.S. Environmental Protection Agency (U.S. EPA). 2003. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-55.

U.S. Environmental Protection Agency (US EPA). 2005a. Ecological Soil Screening Levels for Antimony – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-61.

U.S. Environmental Protection Agency (US EPA). 2005b. Ecological Soil Screening Levels for Arsenic – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-62.

U.S. Environmental Protection Agency (US EPA). 2005c. Ecological Soil Screening Levels for Barium – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-63.

U.S. Environmental Protection Agency (US EPA). 2005d. Ecological Soil Screening Levels for Cadmium – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC.

OSWER Directive 9285.7-65.

U.S. Environmental Protection Agency (US EPA). 2005e (revised 2008). Ecological Soil Screening Levels for Chromium – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-66.

U.S. Environmental Protection Agency (US EPA). 2005f. Ecological Soil Screening Levels for Cobalt – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-67.

U.S. Environmental Protection Agency (US EPA). 2005g. Ecological Soil Screening Levels for Lead – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-70.

U.S. Environmental Protection Agency (US EPA). 2005h. Ecological Soil Screening Levels for Vanadium – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-75.

U.S. Environmental Protection Agency (US EPA). 2007a. Ecological Soil Screening Levels for Zinc – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-73.

U.S. Environmental Protection Agency (US EPA). 2007b. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-78.

U.S. Environmental Protection Agency (US EPA). 2007c. Ecological Soil Screening Levels for Copper – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-68.

U.S. Environmental Protection Agency (US EPA). 2007d. Ecological Soil Screening Levels for Manganese – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-71

U.S. Environmental Protection Agency (US EPA). 2007e. Ecological Soil Screening Levels for Nickel – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-67.

U.S. Environmental Protection Agency (US EPA). 2007f. Ecological Soil Screening Levels for Selenium – Interim Final. Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-72.

Appendix 22A

Discipline Specific Assessment Criteria

1.0 AIR QUALITY

The Air Quality assessment approach is provided in Consultant Report (CR) #1A, Section 2.0. Table 22A-1 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified air quality valued components (VCs).

Table 22A-1 Evaluation Criteria for Air Quality

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	Disturbance is predicted to be somewhat above typical background conditions, but within the Alberta Ambient Air Quality Objectives (AAAQO) and the Canadian Ambient Air Quality Standards (CAAQS) for relevant regulated compounds as presented in CR #1A, Table 2.4-1 (Alberta Environment and Sustainable Resource Development [AESRD] 2013a; Canadian Council of Ministers of the Environment [CCME] 2012). In the absence of AAAQOs and federal standards, British Columbia Ambient Air Quality Objective (BCAAQO) (British Columbia Ministry of Environment [BCMOE] 2014) were used for 24-hour PM_{10}. When disturbance is predicted to be somewhat above typical background conditions, but within the defined Acid Deposition Criteria (CR #1A, Section 2.4.2), Nitrogen Deposition Criteria (CR #1A, Section 2.4.3), and Emissions Standards (CR #1A, Section 2.4.4).
	Moderate	Disturbance predicted to be considerably above background conditions but still within the AAAQO and the CAAQS for relevant regulated compounds as presented in CR #1A, Table 2.4-1 (AESRD 2013a; CCME 2012). In the absence of AAAQOs and federal standards, BCAAQO (BCMOE 2014) were used for 24-hour PM_{10}. When disturbance is predicted to be considerably above typical background conditions, but within the defined Acid Deposition Criteria (CR#1A, Section 2.4.2), Nitrogen Deposition Criteria (CR #1A, Section 2.4.3), and Emissions Standards (CR #1A, Section 2.4.4).
	High	Disturbance predicted to exceed the AAAQO and the CAAQS for relevant regulated compounds as presented in CR #1A, Table 2.4-1 (AESRD 2013a; CCME 2012). In the absence of AAAQOs and federal standards, BCAAQO (BCMOE 2014) were used for 24-hour PM_{10}. When disturbance is predicted to exceed the defined Acid Deposition Criteria (CR #1A, Section 2.4.2), Nitrogen Deposition Criteria (CR #1A, Section 2.4.3), and Emissions Standards (CR #1A, Section 2.4.4).
Geographic Extent	Local	Effects occurring mainly within the defined air Local Study Area (LSA) (CR #1A, Figure 2.3-1).
	Regional	Effects extending outside of the air LSA to the defined air Regional Study Area (RSA) (CR #1A, Figure 2.3-1).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.

Table 22A-1 Evaluation Criteria for Air Quality

Criteria	Criteria Definition	
	National	Effects extending outside of the provincial surroundings, but within national boundary
	Global	Effects extending outside of national boundary.
Duration	Short	An effect that lasts approximately 1 to 5 years
	Medium	An effect that lasts between 6 and 25 years.
	Long	An effect that lasts between 26 and 50 years.
	Residual	An effect that lasts more than 50 years.
Frequency	Continuous	Effects occurring continually over assessment periods.
	Isolated	Effects confined to a specified period (*e.g.,* construction)
	Periodic	Effects occurring intermittently but repeatedly over assessment period (*e.g.,* routine maintenance activities).
	Occasional	Effects occurring intermittently and sporadically over assessment period
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish after a number of years.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Air Quality is considered poor to environmental resources, community, region or province.
	Neutral	Air Quality is considered consistent with background for environmental resources, community, region or province.
	Positive	Air Quality is considered pristine to environmental resources, community, region or province.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50 to 80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely
	Medium	Possible or probable
	High	Certain
Significance	Not significant	Effects are predicted to be within the AAAQO and the CAAQS for relevant regulated compounds as presented in CR #1A, Table 2.4-1 (AESRD 2013a; CCME 2012). In the absence of AAAQOs and federal standards, BCAAQO (BCMOE 2014) were used for 24-hour PM_{10}. When effects are predicted to be within the defined Acid Deposition Criteria (CR #1A, Section 2.4.2), Nitrogen Deposition Criteria (CR #1A, Section 2.4.3), and Emissions Standards (CR #1A, Section 2.4.4).

Table 22A-1 Evaluation Criteria for Air Quality		
Criteria	**Criteria Definition**	
	Significant	Effects of the Project are predicted to be outside of the AAAQO and the CAAQS for relevant regulated compounds as presented in CR #1A, Table 2.4-1 (AESRD 2013a; CCME 2012). In the absence of AAAQOs and federal standards, BCAAQO (BCMOE 2014) were used for 24-hour PM_{10}. When effects are predicted to be outside the defined Acid Deposition Criteria (CR #1A, Section 2.4.2), Nitrogen Deposition Criteria (CR #1A, Section 2.4.3), and Emissions Standards (CR #1A, Section 2.4.4).

2.0 NOISE

The Noise assessment approach is provided in CR #2A, Section 6.0. Table A22-2 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified noise VCs.

Table 22A-2 Evaluation Criteria for Noise		
Criteria	**Criteria Definition**	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	Disturbance is predicted to be a change above typical background conditions, but well below established requirements of the Alberta Energy Regulator (AER) Directive 038 on Noise Control as presented in CR #2A, Table 4.0-1 (AER 2007).
	Moderate	Disturbance predicted to be considerably above background conditions but still within established requirements of the AER Directive 038 on Noise Control as presented in CR #2A, Table 4.0-1 (AER 2007).
	High	Disturbance predicted to exceed the AAAQO and the CAAQS for relevant the established requirements of the AER Directive 038 on Noise Control as presented in CR #2A, Table 4.0-1 (AER 2007).
Geographic Extent	Local	An effect that occurs within the defined mine permit boundary (CR #2A, Figure 1).
	Regional	An effect is limited to a 1,500 m buffer around the mine permit boundary (CR #2A, Figure 1).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary.
	Global	Effects extending outside of national boundary.

Table 22A-2 Evaluation Criteria for Noise

Criteria	Criteria Definition	
Duration	Short	An effect that lasts within the development/construction phase.
	Long	An effect that lasts throughout the operation phase of the project.
	Extended	An effect that lasts after operation phase but diminishes at mine closure and site.
	Residual	An effect that lasts past mine closure and full site reclamation.
Frequency	Occasional	An effect that occurs intermittently and sporadically over assessment period.
	Periodic	An effect that occurs at intermittent intervals but routinely during any phase of the Project.
	Continuous	An effect that occurs constantly during any phase of the Project.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish after a number of years.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Noise levels area considered poor to environmental resources, community, region or province.
	Neutral	Noise levels are considered consistent with background for environmental resources, community, region or province.
	Positive	Noise levels are considered ideal to environmental resources, community, region or province.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50 to 80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely
	Medium	Possible or probable
	High	Certain
Significance	Not significant	Effects are predicted to be within the established requirements of the AER Directive 038 on Noise Control as presented in CR #2A, Table 4.0-1 (AER 2007).
	Significant	Effects of the Project are predicted to be outside the established requirements of the AER Directive 038 on Noise Control as presented in CR #2A, Table 4.0-1 (AER 2007).

3.0 HYDROGEOLOGY

The Hydrogeology assessment approach is provided in CR #3, Section 2.0. Table 22A-3 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified hydrogeology VCs.

Table 22A-3 Evaluation Criteria for Hydrogeology

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions are anticipated after mitigation.
	Low	Disturbance predicted to be somewhat above typical background conditions; residual effect is detectable but well within environmental standards. For groundwater quantity, this corresponds to a predicted drawdown of less than 5 m at the LSA boundaries (value determined based on the Groundwater Evaluation Guideline [AENV 2003], baseline groundwater information and on professional judgement). For groundwater quality, the environmental standards applied are the Alberta Tier 1 Guidelines (Alberta Environment and Parks [AEP] 2016) and background groundwater quality, whichever is greater.
	Moderate	Disturbance predicted to be considerably above background conditions, but within range of natural variability; residual effect is approaching environmental standard. For groundwater quantity, this corresponds to a drawdown of up to 15 m at the LSA boundaries (value determined based on the Groundwater Evaluation Guideline [AENV 2003], baseline groundwater information and on professional judgement). For groundwater quality, the environmental standards applied are the Alberta Tier 1 Guidelines (AEP 2016) and background groundwater quality, whichever is greater.
	High	Disturbance predicted to exceed established criteria, beyond the range of natural variability; residual effect exceeds environmental standards. For groundwater quantity, this corresponds to a drawdown of more than 15 m at the LSA boundaries (value determined based on the Groundwater Evaluation Guideline [AENV 2003], baseline groundwater information and on professional judgement). For groundwater quality, the environmental standards applied are the Alberta Tier 1 Guidelines (AEP 2016) and background groundwater quality, whichever is greater.
Geographic Extent	Local	An effect that occurs within the defined hydrogeology LSA (CR #3, Figure 1.1-1).
	Regional	An effect that occurs within the defined hydrogeology RSA (CR #3, Figure 1.1-1).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary.
	Global	Effects extending outside of national boundary.
Duration	Short	An effect that lasts within the development/construction phase.

Table 22A-3 Evaluation Criteria for Hydrogeology

Criteria	Criteria Definition	
	Long	Effect occurring during the development phase and continuing during operations of the facility.
	Extended	Effect occurring during the development phase and continuing during operations of the facility and keeping on occurring after facility closes but diminishing with time.
	Residual	Effect occurring during the development phase and continuing during operations of the facility and persisting after facility closes for a long period of time.
Frequency	Occasional	An effect that occurs intermittently and sporadically over assessment period.
	Periodic	An effect that occurs at intermittent intervals but routinely during any phase of the Project.
	Continuous	An effect that occurs constantly during any phase of the Project.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish after a number of years.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Changes in hydrogeology base flows and quality are considered poor to environmental resources, community, region or province.
	Neutral	Hydrogeology base flows and quality are considered consistent with background for environmental resources, community, region or province.
	Positive	Hydrogeology base flows and quality are considered to improve environmental resources, community, region or province.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50 to 80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely
	Medium	Possible or probable
	High	Certain
Significance	Not significant	Effect predicted to be within the range of natural variability (for groundwater level) and below guidelines or threshold levels (for groundwater chemistry), and contained within the LSA.
	Significant	Effect predicted to cause irreversible changes to the sustainability or integrity of a resource. Changes are predicted to adversely affect groundwater levels or groundwater quality outside of the LSA.

4.0 HYDROLOGY

The Hydrology assessment approach is provided in CR #4, Section 6.0. Table 22A-4 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified hydrology VCs.

Table 22A-4 Evaluation Criteria for Hydrology

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	Disturbance predicted to be different from typical background conditions, but within established 7Q10 protective standards or to cause no detectable change in surface flow monitoring parameters.
	Moderate	Disturbance predicted to be considerably different from typical background conditions, but still within established 7Q10 protective standards or the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).
	High	Disturbance predicted to reduce flows below 7Q10 protective standards or increase flows well above the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).
Geographic Extent	Local	An effect that occurs within the defined hydrology LSA (CR #4, Figure 3).
	Regional	An effect that occurs within the defined hydrology RSA (CR #4, Figure 3).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary
	Global	Effects extending outside of national boundary.
Duration	Short	An effect that lasts within the development/construction phase.
	Long	Effect occurring during the development phase and continuing during operations of the facility, but not after closure of the mine.
	Extended	Effect occurring during the development phase and continuing during operations of the facility and keeping on occurring after facility closes but diminishing with time.
	Residual	Effect occurring during the development phase and continuing during operations of the facility and persisting after facility closes for a long period of time.
Frequency	Occasional	An effect that occurs intermittently and sporadically over assessment period.
	Periodic	An effect that occurs at intermittent intervals but routinely during any phase of the Project.
	Continuous	An effect that occurs constantly during any phase of the Project.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.

Table 22A-4 Evaluation Criteria for Hydrology		
Criteria	**Criteria Definition**	
	Reversible in long-term	Effects which remain after cessation of activities but diminish with time.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Compromises quality or extent of aquatic habitat due to loss of or excessive flow.
	Neutral	No change to quality or extent of aquatic habitat.
	Positive	Improves quality or extent of aquatic habitat due to loss of or excessive flow.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50 to 80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely (less than 1% probability of occurring).
	Medium	Possible or probable (between 1% and 95% probability of occurring).
	High	Certain (greater than 95% probability of occurring).
Significance	Not significant	Effects are predicted to be within established 7Q10 protective standards or the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).
	Significant	Effects of the Project are predicted to be outside the established 7Q10 protective standards or the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).

5.0 WATER QUALITY

The Water Quality assessment approach is provided in CR #5, Section 2.0. Table 22A-5 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified water quality VCs.

Table 22A-5 Evaluation Criteria for Water Quality		
Criteria	**Criteria Definition**	
Magnitude	Nil	No change from baseline water quality conditions anticipated after mitigation.
	Low	Disturbance predicted to be somewhat above typical baseline conditions, but well within the Environmental Quality Guidelines for Alberta Surface Waters (AEP 2014) as presented in CR #5, Section 2.2.1, Table 3, as well

Table 22A-5 Evaluation Criteria for Water Quality		
Criteria	**Criteria Definition**	
		as proposed site-specific objectives for selenium and sulphate presented in CR #5, Appendix A1 and Section 4.1.1.3.
	Moderate	Disturbance predicted to be considerably above baseline conditions but still within the Environmental Quality Guidelines for Alberta Surface Waters (AEP 2014) as presented in CR #5, Section 2.2.1, Table 3, as well as proposed site-specific objectives for selenium and sulphate presented in CR #5, Appendix A1 and Section 4.1.1.3.
	High	Disturbance predicted to exceed the Environmental Quality Guidelines for Alberta Surface Waters (AEP 2014) as presented in CR #5, Section 2.2.1, Table 3, as well as proposed site-specific objectives for selenium and sulphate presented in CR #5, Appendix A1 and Section 4.1.1.3.
Geographic Extent	Local	Effects occurring mainly within the entire watershed of Blairmore Creek and Gold Creek (CR #5, Figure 3).
	Regional	Effects extending outside of the project boundary to the entire Crowsnest River watershed.
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary; not applicable for Surface Water Quality.
	National	Effects extending outside of the provincial surroundings, but within national boundary; not applicable for Surface Water Quality.
	Global	Effects extending outside of national boundary; not applicable for Surface Water Quality.
Duration	Short	An effect that lasts approximately 1 to 5 years.
	Long	An effect that lasts between 6 and 25 years.
	Extended	An effect that lasts between 25 and 50 years.
	Residual	An effect that lasts more than 50 years.
Frequency	Occasional	Effects occurring intermittently and sporadically over assessment period.
	Periodic	Effects occurring intermittently but repeatedly over assessment period (*e.g.,* routine maintenance activities).
	Continuous	Effects occurring continually over assessment periods.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish with time.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Water quality is considered poor to aquatic resource, community, region or province.
	Neutral	Water quality is considered consistent with background for aquatic resource, communities, region or province.
	Positive	Water quality is considered pristine to aquatic resource, community, region or province.

Table 22A-5 Evaluation Criteria for Water Quality		
Criteria	**Criteria Definition**	
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50-80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely
	Medium	Possible or probable
	High	Certain
Significance	Not significant	Predicted water quality is within the range of natural variability or below either Environmental Quality Guidelines for Alberta Surface Waters (AEP 2014) or proposed site-specific thresholds for selenium and sulphate presented in CR #5, Appendix A1 and Section 4.1.1.3.
	Significant	Predicted water quality is both outside the range of natural variability and exceeds either Environmental Quality Guidelines for Alberta Surface Waters (AEP 2014) or proposed site-specific thresholds for selenium and sulphate presented in CR #5, Appendix A1 and Section 4.1.1.3, with potential to cause irreversible effects on aquatic resources.

6.0 AQUATIC ECOLOGY

The Aquatic Ecology (fish and fish habitat) assessment approach is provided in CR #6 (January 2017 Addendum 1), Section 3.0. Table 22A-6 provides additional information regarding the evaluation criteria used for the assessment of significance of potential project impacts on identified aquatic ecology VCs.

The definitions for these scales are ecologically or logically based on the characteristics of the aquatic ecology, the associated assessment endpoints, measurement indicators, and regulatory guidelines. CR #6 (January 2017 Addendum 1) evaluated two primary pathways of effects:

- Changes to tributary and mainstem aquatic and/or riparian habitat; and
- Changes to hydrology in Gold and Blairmore creeks potentially affecting westslope cutthroat trout (WSCT) habitat.

The potential effects from these pathways are direct physical effects to aquatic and/or riparian habitat due to the Project Footprint and alterations to WSCT habitat due to flow alterations. The criteria definitions for these specific effects are regulatory driven, namely: Fisheries Act (CR #6 [January 2017 Addendum 1], Section 2.2.1), Species at Risk Act (CR #6 [January 2017 Addendum 1], Section 2.2.2). To assist in the evaluation of potential effects from changes to

tributary and mainstem aquatic and/or riparian habitat, the type of habitat potentially affected was considered in terms of ecological function and importance. This included assessing the fish-bearing status of the watercourses (CR #6 [January 2017 Addendum 1], Section 4.1.1.1) and assigning value to the riparian habitat (CR #6 [January 2017 Addendum 1], Section 4.2.4). To assist in the evaluation of potential effects from changes to hydrology in Gold and Blairmore creeks, the threshold of acceptable change in flow was established using regulatory guidance on environmental flows (CR #6 [January 2017 Addendum 1], Section 4.3.2).

Magnitude is a measure of the intensity of a residual environmental effect of the Project on WSCT. It represents the degree of change observed for a measurement endpoint relative to Base Case conditions, a guideline or objective. Magnitude is classified into four categories: nil, low, moderate, and high. Since effects threshold levels associated with the abundance and distribution of defined WSCT populations have not been estimated, the magnitude of residual effects is assessed qualitatively as per the definitions provided in the table, below. The magnitude of residual effects on WSCT habitat are assessed qualitatively, too, except where predicted changes from Base Case conditions could be quantified (*i.e.*, habitat alterations due to changes in hydrology, footprint-related effects to aquatic/riparian habitat).

A revised definition of the specific criteria used to evaluate the magnitude of aquatic effects is provided below. Regarding significance, magnitude, geographic extent, and duration (which includes reversibility) are the principal criteria used to predict significance. Other criteria (*e.g.*, frequency, probability of occurrence) are used as modifiers in the determination of significance. The determination of significance is used to identify predicted effects that have a sufficient magnitude, duration and geographic extent to cause fundamental changes to the abundance and distribution, habitat quantity and quality, and survival and reproduction that could contribute to a WSCT (VC) population becoming no longer capable of being self-sustaining or ecologically effective.

Table 22A-6 Evaluation Criteria for Aquatic Ecology

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	There is no measurable residual effect on fish (WSCT) and its habitat (including critical habitat) or change in habitat within the range of variation experienced by a defined population over its lifespan.
	Moderate	The residual effect on fish (WSCT) and its habitat (including critical habitat) is measurable, but within the anticipated resilience limits of the defined population.
	High	The residual effect on fish (WSCT) and its habitat (including critical habitat) is near or exceeding the anticipated resilience limits of the defined population.
Geographic Extent	Local	Any residual effect is limited to the aquatic LSA and includes direct and indirect effects from the Project (CR #6 [January 2017 Addendum 1], Figure 3.1).
	Regional	Any residual effect is limited to the RSA and can include cumulative effects from the Project and other developments RSA (CR #6 [January 2017 Addendum 1], Figure 1.1).
	Provincial	Any residual effect extending beyond the spatial boundaries of the assessment (*i.e.*, RSA), but within provincial boundary.
	National	Any residual effect extending beyond the provincial boundary, but within national boundary.
	Global	Any residual effect extending beyond the national boundary.
Duration	Short	A residual effect is reversible at the completion of the development/construction phase.
	Long	A residual effect is reversible within a defined length of time beyond closure and early decommissioning/reclamation activities.
	Extended	A residual effect occurring during the development phase and continuing during operations of the facility and continues after facility closes but diminishes over time.
	Residual	A residual effect is irreversible within the temporal boundary of the assessment (100+ years).
Frequency	Occasional	A residual effect that is confined to a specific discrete project phase or activity.
	Periodic	A residual effect that occurs at intermittent intervals but repeatedly over the temporal boundary of the assessment.
	Continuous	A residual effect that occurs continually over the temporal boundary of the assessment (*i.e.*, 100+ years).
Reversibility	Reversible in short-term	A residual effect that is reversible within the temporal boundary of the assessment.
	Reversible in long-term	A residual effect that is reversible, but remains within the temporal boundary of the assessment and diminishes over time.
	Irreversible	A residual effect that is not reversible within the temporal boundary of the assessment and does not diminish with time.

Table 22A-6 Evaluation Criteria for Aquatic Ecology

Criteria	Criteria Definition	
Ecological/Social Context	Negative	Compromises quality or quantity of aquatic and/or riparian habitat (including designated critical habitat) due to project activities.
	Neutral	No change to quality or quantity of aquatic or riparian habitat.
	Positive	Improves quality or quantity of aquatic and/or riparian habitat (including designated critical habitat) due to project activities.
Confidence Rating	Low	Low confidence in understanding of cause-effect relationships based on incomplete data pertinent to LSA (<50% confidence).
	Moderate	Reasonable understanding of cause-effect relationships using data collected in the LSA/RSA pertinent to the Project and supplemented with scientific literature from elsewhere (50 to 80% confidence).
	High	Based on sound and defensible understanding of the cause-effect relationships and data collected in the LSA/RSA pertinent to the Project and supplemented with scientific literature (>80% confidence).
Probability of Occurrence	Low	Residual effect is unlikely (less than 1% probability of occurring).
	Medium	Residual effect is possible or probable (between 1% and 95% probability of occurring).
	High	Residual effect is certain (greater than 95% probability of occurring).
Significance	Not significant	Low or moderate magnitude, short-term or reversible residual effects at the population and/or community scale and to designated critical habitat that are not predicted to decrease the resilience or prevent the maintenance of self-sustaining populations of WSCT.
	Significant	High magnitude, long-term or irreversible residual effects at the population and/or community scale and to designated critical habitat that are predicted to decrease the resilience or prevent the maintenance of self-sustaining populations of WSCT.

7.0 SOILS

The Soils assessment approach is provided in CR #7, Section 6.0. Table 22A-7 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified soils VCs.

Table 22A-7 Evaluation Criteria for Soils

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	Disturbance predicted to be somewhat above typical background conditions, but well within established or accepted protective standards[1] or to cause no detectable change in soil and terrain functions and processes.

Table 22A-7 Evaluation Criteria for Soils

Criteria	Criteria Definition	
	Moderate	Disturbance predicted to be considerably above background conditions but within accepted limits or standards,[1] or affected soil and terrain is altered but natural functions and processes continue, albeit in a modified way. Disturbance does not exceed historical range for total area of disturbance, size of disturbance, alteration of terrain, and soil productivity loss.
	High	Disturbance predicted to exceed established criteria[1] or scientific and socio-economic effects associated with potential adverse effect, or natural soil and terrain functions or processes are altered to the extent that they will temporarily or permanently cease.
Geographic Extent	Local	An effect that occurs within the defined hydrology LSA (CR #7, Figure 2.1-1).
	Regional	An effect that occurs within the defined hydrology RSA (CR #7, Figure 2.1-1).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary.
	Global	Effects extending outside of national boundary.
Duration	Short	An effect that lasts within the development/construction phase.
	Long	Effect occurring during the development phase and continuing during operations of the facility, but not after closure of the mine.
	Extended	Effect occurring during the development phase and continuing during operations of the facility and keeping on occurring after facility closes but diminishing with time.
	Residual	Effect occurring during the development phase and continuing during operations of the facility and persisting after facility closes for a long period of time.
Frequency	Occasional	An effect that occurs intermittently and sporadically over assessment period.
	Periodic	An effect that occurs at intermittent intervals but routinely during any phase of the Project.
	Continuous	An effect that occurs constantly during any phase of the Project.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish with time.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological Context	Negative	Net loss to the resource, community, region, or province.
	Neutral	No net benefit or loss to the resource, communities, region, or province.
	Positive	Net benefit to the resource, community, region, or province.

Table 22A-7 Evaluation Criteria for Soils		
Criteria	**Criteria Definition**	
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area (<50% confidence).
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area (50 to 80% confidence).
	High	Based on good understanding of cause-effect relationships and data pertinent to study (>80% confidence).
Probability of Occurrence	Low	Unlikely (less than 1% probability of occurring).
	Medium	Possible or probable (between 1% and 95% probability of occurring).
	High	Certain (greater than 95% probability of occurring).
Significance	Not significant	Effects are predicted to be within established 7Q10 protective standards or the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).
	Significant	Effects of the Project are predicted to be outside the established 7Q10 protective standards or the natural range of monthly flows as defined by the hydrology assessment for the Project (CR #4, Section 4.1).

[1] Established or accepted environmental protective standards and criteria outlined in the following acts, regulations and guidelines, but not limited to:

- Canadian Environmental Quality Guidelines (CCME 2011);
- Conservation and Reclamation Regulations (Alberta Regulation 115/1993);
- Alberta Acid Deposition Management Framework (AENV 2008);
- Wind erosion risk. Alberta (Coote and Pettapiece 1989);
- Soil sensitivity to acid deposition and the potential of soils and geology in Alberta to reduce the acidity of acidic inputs (Holowaychuk and Fessenden 1987);
- Soil Quality Criteria Relative to Disturbance and Reclamation (SQCWG 1987);
- Critical load for organic (peat) soils in Alberta (Turchenek *et al.* 1998);
- Revised Universal Soil Loss Equation for Application in Canada: A Handbook for Estimating Soil Loss from Water Erosion in Canada (Wall *et al.* 2002).

8.0 VEGETATION AND WETLANDS

The Vegetation and Wetlands assessment approach is provided in CR #8, Section 2.0. Table 22A-8 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified vegetation VCs.

As further clarification, for the vegetation assessment, the level of an environmental effect was determined after considering mitigation. Residual effects were considered those effects that may occur after mitigation (*i.e.*, project impacts that extend beyond the life of the project and not interim project impacts). Criteria used to assess the potential effects of the Project on vegetation and wetland resources included: geographic extent, duration, frequency, permanence, magnitude, direction, and level of confidence (Noble 2009). Table 22A-8 provides a brief summary of key criteria used for the evaluation of significance.

Assessment context, thresholds and disturbance regimes are described above and in CR #8. Baseline area and number of plant communities (ecosite phases, habitat types) are provided in CR #8, Section 3.1. Species of concern, rare plant abundance and distributions, traditional use species, rangeland, old growth and wetlands are provided in CR #8, Sections 3.2 to 3.7. Biodiversity metrics including distribution and abundance of forested and non-forested community patches are provided in CR #8, Section 3.8. Summary of project effects and impact assessment discussion for each VC is in CR #8, Section 4.0.

Table 22A-8 Evaluation Criteria for Vegetation and Wetlands

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation. Background includes natural fire regime, insect and disease.
	Low	Disturbance predicted to be somewhat above typical background conditions, but well within established or accepted protective standards and normal socio-economic fluctuations, or to cause no detectable change in ecological, social, or economic parameters. Assessment includes current (managed) fire regime, insect and diseases; current management planning and sustainable management (harvesting) impacts and ability of soil (salvaged and replaced) and terrain to support VC. Refer to supporting Table 22A-9.
	Moderate	Disturbance predicted to be considerably above background conditions but within scientific and socio-economic effects thresholds, or to cause a detectable change in ecological, social, or economic parameters within range of natural variability. Assessment includes natural and managed fire regime, insects and disease, and planned management impacts. Disturbance does not exceed historical range for total area of disturbance, size of disturbance and alteration of age class, habitat type and patch size or distribution. Terrain and soil (salvaged and replaced) productivity loss and or unable to support natural range of VC occurrence or extent. Refer to supporting Table 22A-9.
	High	Disturbance predicted to exceed established criteria or scientific and socio-economic effects thresholds associated with potential adverse effect, or to cause a detectable change in ecological, social, or economic parameters beyond the range of natural variability. Disturbance is greater than historical or predicted natural and managed disturbance regimes, and or sustainable management plans/practices. Greater than one standard deviation of known thresholds (one standard deviation used due to high natural variability in study area). Refer to supporting Table 22A-9.
Geographic Extent	Local	Effects occurring mainly within or close proximity to the proposed development area. Within Project LSA.

Table 22A-8 Evaluation Criteria for Vegetation and Wetlands

Criteria	Criteria Definition	
	Regional	Effects extending outside of the Project boundary to regional surroundings. Within Project RSA.
	Provincial	Effects extending outside of regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary.
	Global	Effects extending outside of national boundary.
Duration	Short	Effects occurring within development phase.
	Long	Effects occurring after development and during operation of facility.
	Extended	Effects occurring after facility closes but diminishing with time.
	Residual	Effects persisting after facility closed for a long period of time.
Frequency	Continuous	Effects occurring continually over assessment periods.
	Isolated	Effects confined to a specified period (*e.g.,* construction).
	Periodic	Effects occurring intermittently but repeatedly over assessment period (*e.g.,* routine maintenance activities).
	Occasional	Effects occurring intermittently and sporadically over assessment period.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish with time.
	Irreversible	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological/Social Context	Neutral	No net benefit or loss to the resource, communities, region, or province. Assessed relative to historical and planned disturbance, impacts on sustainability of the VC or reduction or loss including species of concern, and forest and non-forest patch size and distribution.
	Positive	Net benefit to the resource, community, region, or province. Assessed relative to historical disturbance and desired regional and local management outcomes for VC. Includes reversal of past losses, increased long term sustainability, and increased presence of VC (above background).
	Negative	Net loss to the resource, community, region, or province Assessed relative to permanent decline in VC function, value or ability to support traditional use or sustainable harvest/use.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area.
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area.

Table 22A-8 Evaluation Criteria for Vegetation and Wetlands		
Criteria	**Criteria Definition**	
	High	Based on good understanding of cause-effect relationships and data pertinent to study.
Probability of Occurrence	Low	Unlikely
	Moderate	Possible or probable
	High	Certain
Significance	Not significant)	Effects are predicted to be within the range of natural variability and below guideline or threshold levels. Thresholds include natural and managed fire regime, forest and regional management plans including forest age class distribution, and forest and non-forest patch size and distribution.
	Significant	Effects of the Project are predicted to cause irreversible changes to the sustainability or integrity of a population or resource.

Table 22A-9 Vegetation Valued Components, Indicators and decision methods			
VC	**Key Indicator**	**Rationale for Indicator**	**methods/criteria/thresholds/residual**
Vegetation Communities	Ecosite phases Communities of limited distribution	Baseline vegetation conditions are used for determining potential impacts to critical wildlife habitat, and other ecosystem components; and they are important for determining conservation and re-vegetation goals following Project closure.	Methods: • Mapping Criteria: • quantitative Threshold(s) used: • Yes. Loss of community • Yes. Natural disturbance (Fire) Residual effects if: • Unable to restore/reclaim • 100% loss in LSA or RSA • Reclaimed landscape will no longer support.

Table 22A-9 Vegetation Valued Components, Indicators and decision methods

VC	Key Indicator	Rationale for Indicator	methods/criteria/thresholds/residual
Rare Plants	*SARA*/COSEWIC listed species (*e.g.*, whitebark pine, limber pine) and all vegetation species included in Federal and/or Provincial Tracking Lists	A vegetation species is considered rare if it is uncommon or scarce. Rare species are generally considered threatened because of the inability for their small population size to recover from stochastic events. Rare plants contribute to biodiversity, may possess medicinal uses, are legally protected, and may be of spiritual or traditional value.	Methods: • Field investigation • Mapping • Records Criteria: • Quantitative • Qualitative (recovery plans for Whitebark pine, Limber pine) Threshold(s) used: • Yes. Removals relative to populations size. • Management objectives for listed species with recovery plans. Residual effects if: • 100% removal of potential from LSA • 100% loss historically known populations (LSA or RSA) • Reclaimed landscape will not support
Rangeland Resources	Fescue community grasslands	Rangelands are a source of water, wildlife, and forage for wildlife and livestock, and are important contributors of landscape-level biodiversity.	Methods: • Field investigation • Mapping • Records Criteria: • Quantitative • Qualitative (health, functions) Threshold(s) used: • Yes. Loss of community • Yes. Reduced area. Residual effects if: • 100% loss (LSA or RSA)) • Reduced abundance (LSA) • Unable to restore/reclaim • Reclaimed landscape will not support

Table 22A-9 Vegetation Valued Components, Indicators and decision methods

VC	Key Indicator	Rationale for Indicator	methods/criteria/thresholds/residual
Forest Resources	Timber productivity	Forests are a valuable resource because they help maintain air quality, store atmospheric carbon, provide habitat for wildlife, keep soil in place, filter and regulate water supplies, support recreational activities, and house valuable resources such as timber, fuel, and traditional medicinal, food and other use vegetation.	Methods: • Field investigation • Mapping • Records • Volume calculations Criteria: • Quantitative Threshold(s) used: • Yes. Loss of timber • Yes. Loss of productivity • Yes. Historical harvest Residual effects if: • Permanent reduction in growing stock (LSA) • Unable to restore/reclaim • Reclaimed landscape will not support sustainable resource use
Old Growth Forests	Age of a forest stand	Old growth forests have a complex structure which provides a large variety of habitat types for use by species with specialized requirements. These forests have the highest diversity of species, relative to other age classes, with representation of many rare species having their greatest abundance in old-growth stands. Vegetation species that require a long time for colonization and growth, such as lichens, are often only found in old-growth forest stands. Accumulation of large decaying wood, characteristic of old-growth stands, supports unique groups of wood-decomposing species, as well as shelter and food for many other species.	Methods: • Field investigation • Mapping • Records Criteria: • Quantitative Threshold(s) used: • Yes. Loss of age class • Yes. Historical harvest regime • Yes. Wildfire regime Residual effects if: • 100% removal (LSA or RSA) • Reclaimed landscape will not support return of old growth forest

Table 22A-9 Vegetation Valued Components, Indicators and decision methods

VC	Key Indicator	Rationale for Indicator	methods/criteria/thresholds/residual
Traditionally Used Species (TEK Vegetation)	Occurrence & distribution of vegetation valued by Aboriginal groups	Vegetation used by Aboriginal Groups for country foods, medicine, technology and other uses are valued and should be managed sustainably for future generations (UN 2008:11). The baseline abundance and distribution of TEK vegetation will serve as a benchmark for the sustainable management of TEK vegetation.	Methods: • Consultation with stakeholders (Treaty 7 First Nations) • Species of concern provided by Treaty 7 FN groups • Site visit • Records • Comparison with field survey and vegetation mapping • Predictive mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Yes. Loss of age class • Yes. Historical harvest regime • Yes. Wildfire regime Residual effects if: • 100% removal (LSA or RSA) • Permanent loss of TEK potential • Reclaimed landscape will not support TEK harvest
Wetlands	Obligate and facultative vegetation	Wetlands are highly valued and beneficial by virtue of their diverse functions that include water filtration; flood attenuation; wildlife habitat; moderating climates; storing nutrients and carbon; providing recreational and educational opportunities; and providing a source for subsistence and medicinal vegetation.	Methods: • Mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Yes. Loss of community type • Yes. Reduction of area Residual effects if: • Permanent reduction of wetland area • Unable to restore/reclaim

Table 22A-9 Vegetation Valued Components, Indicators and decision methods

VC	Key Indicator	Rationale for Indicator	methods/criteria/thresholds/residual
Biodiversity	Measures of abundance, distribution and variation in vegetation species and communities	Biodiversity is the degree of variation in biological species in a given area, and is a measure of the health of an ecosystem. Greater biodiversity implies greater health, and the reduction of biodiversity can adversely impact ecosystem integrity (composition, structure and functioning) and re-vegetation success.	Methods: • Mapping • Richness, relative abundance, diversity index • Predictive mapping (biodiversity potential) Criteria: • Quantitative • Qualitative (predictive mapping) Threshold(s) used: • Yes. Loss of species. • Yes. Loss of community type. • Yes. Natural disturbance (Fire) • Yes. Regional management objectives Residual effects if: • Permanent loss of species or community level diversity • Permanent loss of high biodiversity potential communities • Unable to restore/reclaim potential for return of high diversity communities

Table 22A-9 Vegetation Valued Components, Indicators and decision methods

VC	Key Indicator	Rationale for Indicator	methods/criteria/thresholds/residual
Habitat Fragmentation	Measure of all landscape areas that are divided by human disturbance	Forest fragmentation is one of the greatest threats to the biodiversity of forests. Fragmented areas are less likely to support viable populations (especially of large vertebrates) due to edge effects that alter conditions, including increases in some species and decreases in others. The effect of fragmentation on the vegetation and wildlife of a forest depends on a) the size of the patch, and b) its degree of isolation.	Methods: • Mapping • Predictive mapping • Fragmentation statistics Criteria: • Quantitative • Qualitative (relative to historical management and current regional forest management objectives) Threshold(s) used: • Yes. Regional management objectives • Yes. Natural disturbance regime (Fire) Residual effects if: • Permanent increase in fragmentation • Fragmentation exceeds regional management objectives • Unable to restore/reclaim contiguous patches (LSA) • Unable to restore landscape connectivity (LSA)

9.0 WIDLIFE

The Wildlife assessment approach is provided in CR #9, Section 2.0. Table 22A-10 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified wildlife VCs.

Table 22A-10 Evaluation Criteria for Wildlife

Criteria	Criteria Definition	
Magnitude	Nil	No change from background conditions anticipated after mitigation.
	Low	Disturbance predicted to be somewhat above typical background conditions, but well within established or accepted protective standards and normal socio-economic fluctuations, or to cause no detectable change in ecological, social or economic parameters. See supporting Table A22-11.

Table 22A-10 Evaluation Criteria for Wildlife

Criteria	Criteria Definition	
	Moderate	Disturbance predicted to be considerably above background conditions but within scientific and socio-economic effects thresholds, or to cause a detectable change in ecological, social or economic parameters within range of natural variability. See supporting Table A22-11.
	High	Disturbance predicted to exceed established criteria or scientific and socio-economic effects thresholds associated with potential adverse effect, or to cause a detectable change in ecological, social or economic parameters beyond the range of natural variability. See supporting Table A22-11.
Geographic Extent	Local	Effects occurring mainly within or close proximity to the wildlife local study area (CR #9, Section 3.2.1, Figure 1.2-2).
	Regional	Effects extending outside of the Project boundary to regional surroundings within the wildlife regional study area and the grizzly bear regional study area (CR #9, Section 3.2.1, Figure 1.2-2).
	Provincial	Effects extending outside of the regional surroundings, but within provincial boundary.
	National	Effects extending outside of the provincial surroundings, but within national boundary.
	Global	Effects extending outside of national boundary.
Duration	Short	Effects occurring within the construction phase.
	Long	Effects occurring after the construction phase and during operations.
	Extended	Effects occurring after the operational phase but diminishing with time.
	Residual	Effects persisting after the operational phase for a long period of time.
Frequency	Continuous	Effects occurring continually over assessment periods.
	Isolated	Effects confined to a specified period (*e.g.* construction).
	Periodic	Effects occurring intermittently but repeatedly over assessment period (*e.g.* routine maintenance activities).
	Occasional	Effects occurring intermittently and sporadically over assessment period.
Reversibility	Reversible in short-term	Effects which are reversible and diminish upon cessation of activities.
	Reversible in long-term	Effects which remain after cessation of activities but diminish with time.
	Irreversible - Rare	Effects which are not reversible and do not diminish upon cessation of activities and do not diminish with time.
Ecological / Social Context	Neutral	No net benefit or loss to the resource, communities, region or province.
	Positive	Net benefit to the resource, community, region or province.
	Negative	Net loss to the resource, community, region or province.
Confidence Rating	Low	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area.
	Moderate	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationship using data pertinent to study area.

Table 22A-10 Evaluation Criteria for Wildlife		
Criteria	**Criteria Definition**	
	High	Based on good understanding of cause-effect relationships and data pertinent to study.
Probability of Occurrence –	Low	Unlikely.
	Moderate	Possible or probable.
	High	Certain.
Significance	Not Significant	Effects are predicted to be within the range of natural variability and below guideline or threshold levels.
	Significant	Effects of the Project are predicted to cause irreversible changes to the sustainability or integrity of a population or resource.

Table 22A-11 Summary of Valued Components, Key Indicators , Rationale and Decision Methods Used to Support the Wildlife Assessment

VC	Key Indicator	Rationale	Methods/Criteria/Thresholds/Residual
Amphibians			
Columbian Spotted Frog	Occurrence (presence/ absence), habitat use, and distribution	Known to occur in WLSA; indicator of wetland/ aquatic/riparian-dependent species; sensitive to changes in water quality; relies on breeding ponds which are of limited availability and distribution; vulnerable to human disturbance; provincially listed species.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Breeding ponds/wetland habitats not reclaimed
Western Toad	Occurrence (presence/ absence), habitat use, and distribution	Known to occur in WLSA; indicator of wetland/ aquatic-dependent species; sensitive to changes in water quality, vulnerable to human disturbance; provincially and federally listed species.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Breeding ponds/wetland habitats not reclaimed

Table 22A-11 Summary of Valued Components, Key Indicators , Rationale and Decision Methods Used to Support the Wildlife Assessment

VC	Key Indicator	Rationale	Methods/Criteria/Thresholds/Residual
Birds			
Olive-sided Flycatcher	Relative abundance, habitat use, and distribution	Known to occur in WLSA; indicator of mature coniferous/riparian forests, burned woodlands, and edge habitat bird species; provincially and federally listed species.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative (recovery plan) Threshold(s) used: • Habitat loss • Noise levels Residual effects if: • Coniferous forests not reclaimed
Great Grey Owl	Occurrence (presence/ absence), habitat use, and distribution	Known to occur in WLSA; indicator of mature and old growth forest bird species; vulnerable to habitat loss and forestry practices; cultural importance to First Nations; provincially listed species.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Forests are not reclaimed
Mammals			
Little Brown Myotis	Relative abundance, habitat use, and distribution	Known to occur in WLSA; indicator of mature and old growth forest species; federally listed species.	Methods: • Field surveys Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Roosting habitats are not reclaimed

Table 22A-11 Summary of Valued Components, Key Indicators , Rationale and Decision Methods Used to Support the Wildlife Assessment

VC	Key Indicator	Rationale	Methods/Criteria/Thresholds/Residual
American Marten	Relative abundance, habitat use, and distribution	Known to occur in WLSA; important fur harvest and First Nations traditional use species, vulnerable to habitat fragmentation and human disturbance; indicator of late succession coniferous forest.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Coniferous forests are not reclaimed
Canada Lynx	Relative abundance, habitat use, and distribution	Known to occur in WLSA; important fur harvest and First Nations traditional use species; vulnerable to habitat fragmentation/ human disturbance; indicator of early succession forest species; provincially listed species.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss Residual effects if: • Forest habitats are not reclaimed
Grizzly Bear	Relative abundance, habitat use, and distribution	Known to occur in WLSA; culturally important to First Nations; potentially declining population in the Castle-Livingstone region; susceptible to industrial activities and vulnerable to conflicts with humans; provincially and federally listed species.	Methods: • Field surveys • Resource selection function modelling Criteria: • Quantitative • Qualitative (recovery/ management plans) Threshold(s) used: • Habitat loss • Linear feature density Residual effects if: • Grassland habitats are not reclaimed

Table 22A-11 Summary of Valued Components, Key Indicators , Rationale and Decision Methods Used to Support the Wildlife Assessment

VC	Key Indicator	Rationale	Methods/Criteria/Thresholds/Residual
Moose	Relative abundance, habitat use, and distribution	Known to occur in WLSA; important recreational hunting and traditional use species; culturally important to First Nations important prey for large predators; indicator of riparian and early to mid-successional habitats.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss • Linear feature density Residual effects if: • Winter core habitats are not reclaimed
Elk	Relative abundance, habitat use, and distribution	Known to occur in the WLSA; important recreational hunting species; culturally important to First Nations; important prey for large predators; indicator of grassland/early successional habitats.	Methods: • Field surveys • Habitat suitability modelling/ mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Habitat loss • Linear feature density Residual effects if: • Winter core habitats are not reclaimed

Table 22A-11 Summary of Valued Components, Key Indicators , Rationale and Decision Methods Used to Support the Wildlife Assessment

VC	Key Indicator	Rationale	Methods/Criteria/Thresholds/Residual
Wildlife Diversity	Measures of relative abundance, distribution and variation in wildlife species and wildlife habitat	Wildlife diversity reflects the variation in the number of wildlife species in a given area taking into account habitat types/landscape cover classes. It is a measure of ecosystem health with higher diversity ratings indicating healthier wildlife and vegetation communities. Lower diversity ratings indicate that vegetation integrity (composition, structure, and functioning) is affected which can affect wildlife use of reclaimed areas.	Methods: • Field surveys • Habitat mapping Criteria: • Quantitative • Qualitative Threshold(s) used: • Reduced wildlife abundance • Habitat loss Residual effects if: • Permanent loss of wildlife species diversity if habitats not reclaimed

10.0 HUMAN HEALTH RISK ASSESSMENT

The Human Health Risk assessment approach is provided in CR #12, Section 4.0. Table 22A-12 provides additional information regarding the evaluation criteria used for the assessment of significance of potential Project impacts on identified human health VCs.

Significance for Human Health and Wildlife was determined on the basis of an "acceptable level" of a specified risk, using quantitative risk assessment methodology. For the Project, the Human Health and Wildlife Risk assessment 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 (U.S. EPA 2005) was also consulted. The risk assessment used reasonable worst-case assumptions to ensure that risk estimates would be conservative.

The risk assessment included four main steps:

- Problem formulation: where chemicals of potential concern (COPCs), potential receptors and operative exposure pathways are identified. Determination of which COPCs could accumulate in other media (soil, water, food) was also conducted at this stage.
- Exposure assessment: including evaluation of concentrations of volatile COPCs in air to which receptors could be exposed, and an estimation of exposure through secondary exposure *via* other media.

- Toxicity assessment: where potential adverse effects of COPCs are identified and relationships between exposure and potential toxic effects established.
- Risk characterization: where the results of the exposure and toxicity assessments are used to determine the potential for adverse effects.

To further support the results of the Human Health Risk Assessment/Wildlife Risk Assessment, the following Evaluation Criteria were used.

Table 22-12 Evaluation Criteria for Human &Wildlife Health

Criteria	Criteria Definition	
Magnitude	Nil	The predicted hazard quotients (HQs)/incremental lifetime cancer risks (ILCR) are substantially less than 1.0, indicating the predicted exposure are substantially less than the toxicological reference values (TRVs).
	Low	The predicted HQs/ILCR are greater than 1.0 and less than 5.0, indicating the predicted exposure close to the TRVs.
	Moderate	The predicted HQs/ILCR are greater than 5.0 and less than 10, indicating the predicted exposure exceed TRVs.
	High	The predicted HQs/ILCR are greater than 5.0 and less than 10, indicating the predicted exposure exceed TRVs.
Geographic Extent	Local	Expected measurable changes are limited to the area immediately surrounding the Project within the LSA (CR #12, Appendix A, Figure A.1).
	Regional	Expected measurable changes extend beyond the immediate project area, and are within the RSA (CR #12, Appendix A, Figure A.1).
	Provincial	Expected changes extend beyond the RSA, but within provincial boundaries.
	National	Expected changes extend beyond provincial boundaries, but within national boundaries.
	Global	Effects extending outside of national boundary.
Duration	Short	When emissions occurred only within the development phase of the Project.
	Long	When emission occurred during the operation of the facility.
	Extended	When emissions continued immediately after closure.
	Residual	When emissions occurred after facility closure.
Frequency	Continuous	Chronic exposure durations.
	Isolated	Not applicable.
	Periodic	Acute exposure durations (1 hour).
	Occasional	Not applicable.
Reversibility	Reversible in short-term	Predicted effects associated with acute exposures.
	Reversible in long-term	Predicted effects associated with chronic exposures to non-carcinogens.

Table 22-12 Evaluation Criteria for Human &Wildlife Health		
Criteria	**Criteria Definition**	
	Irreversible	Predicted effects associated with chronic exposures to non-carcinogens (depending on the individual COPC critical toxic effect). Predicted effects of chronic exposure to carcinogens.
Ecological / Social Context	Negative	Potential health effects of the project are considered to have a negative impact to community in the region or province.
	Neutral	Potential health effects of the project are considered consistent with background for community in the region or province.
	Positive	Potential health effects of the project are considered to have a positive impact to community in the region or province.
Confidence Rating	Low	Qualitative rating based on an incomplete understanding of the representativeness of the assessment data (predicted air concentrations, receptor characterization and exposure parameters, and the toxicological data).
	Moderate	Qualitative rating based on degree of understanding of the representativeness of the assessment data (predicted air concentrations, receptor characterization and exposure parameters, and the toxicological data) (50 to 80% confidence).
	High	Qualitative rating based degree of understanding of the representativeness of the assessment data (predicted air concentrations, receptor characterization and exposure parameters, and the toxicological data) (>80% confidence).
Probability of Occurrence	Low	Unlikely
	Medium	Possible or probable
	High	Certain
Significance	Not significant	Effects predicted to be within the range of natural variability and below guidelines or threshold levels.
	Significant	An adverse health effect associated with exposure to Project emissions.

[1] Criteria provide general direction for the environmental assessment, some modification may and will occur within the individual disciplines

APPENDIX 24A:

PRELIMINARY EMERGENCY RESPONSE PLAN – DAMS

DRAFT

Submitted To: Benga Mining Limited

Project Number:

Date Issued:

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EXECUTIVE SUMMARY

Text

1.0 INTRODUCTION

This is a preliminary Emergency Response Plan (ERP) for the dams at the Benga Mining Limited (Benga) metallurgical coal mine in Blairmore, Alberta. The preliminary ERP covers the emergency responses to be implemented by Benga during the construction and operation of the dam.

The preliminary ERP document is a "live" document that needs to be reviewed and updated during construction and operation of the ponds to include new understanding of the site conditions with the dam developments.

1.1 Purpose

The preliminary ERP for dams is a reference manual to:

- Provide guidance to Emergency Response Team (ERT) members in preparing for and responding safely and effectively to the site emergencies related to an unlikely dam failure.
- Assist Site Management to respond to a potential dam breach emergency with the appropriate procedures and team.

1.2 Scope

The scope of the preliminary ERP is to develop, manage and execute emergency response services during the construction and operation of the dams.

The preliminary ERP describes procedures to be followed in the event of a dam related incident on site that requires initiation of the site ERP and, where appropriate, activation of the Emergency Preparedness Plan (EPP).

1.3 Authority and References

Regulatory and industry references used in the preparation of this updated Interim ERP include:

- Water Act
- Emergency Management Act
- Water (Ministerial) Regulation (AR 205/98) – Part 6 (Dam and Canal Safety)

- Alberta Environmental Regional Services (Water Management Operations) Emergency Preparedness for Flood Emergencies at Dams – Guideline (2003)
- Operation, Maintenance and Surveillance (OMS) Manual for RWP Dam
- RWP Dam Breach Study
- Dam Safety Guidelines 2007 and 2013 revision (Canadian Dam Association).

2.0 POTENTIAL FAILURE MODES

Public safety is paramount in the design, construction and operation of earthen dams. Although focus on sound design, quality assurance and quality control can reduce the risk of a dam failure, dam failures may still occur.

Potential Failure Modes (PFMs) describe how an element or a component failure must occur to cause loss of the sub-system or system function leading to a dam safety issue. Identifying the PFMs and planning for safeguards to prevent the PFMs, contingency plan to remediate the dam and emergency plans to control the risk of a PFM are the best approach to reduce the general risk. The PFMs considered during the design of the dams are outlined below.

- **Dam Overtopping**: In this failure mode, a dam's inadequate freeboard can lead to overflow of ponds over the embankment crest. Overtopping of the dam can quickly erode the dam earthfill and the dam's abutment. Overtopping and resulting erosion is one of the main causes of failure in earthen dams.
- **Dam Collapse:** In this failure mode, the dam and its foundation will not have adequate internal resistance against the applied forces. This failure mode can be further divided into the following failure scenarios:
  - **Slope instability**: Inadequate embankment slope stability while operating in accordance with the design intent under static or seismic loading;
  - **Seepage resistance failure**: Inadequate embankment and foundation resistance against the applied hydraulic forces during operation leading to lack of water tightness (excessive seepage flow), internal erosion and piping; and
  - **External erosion and cracking**: Inadequate embankment and foundation resistance against cracking, hydraulic fracturing and surface erosion during operation leading to lack of water tightness.

3.0 EMERGENCY RESPONSE ROLES AND RESPONSIBILITIES

Benga is responsible for the management of site-wide emergency services. To fulfill this responsibility, Benga will have a team of dedicated on-site emergency response professionals during construction and operation of the dams. During an emergency condition, the Benga ERT can be supported by various contactors and consultants. The roles and responsibilities during an emergency shall be clearly divided between:

- Benga site and management staff
- Construction Management Team
- Design consultant
- ERT

The contact procedure for an incident at the Benga site is presented in Figure 1 (To Be Developed). The contact information of various parties involved with an emergency response is listed in Table 1 (To Be Completed).

During dam construction, the Construction Management Team would be the first on scene after a dam safety incident. During operation, Benga site staff would be the first on scene after a dam safety incident.

Depending on the level of emergency, all or part of the emergency response flowchart will be followed.

Table 1: Emergency Contacts

Organization	Contact	Phone Number
24-hour Emergency Dispatch	-	911 (or other)
Emergency Response Team Captain (main)		
Emergency Response Team Captain (alternative)		
Site Construction Manager		
Site Technical Manager		
Site Geotechnical Lead		
Dam Design Lead (Terracon)		
Construction Management Team		
Municipality of Crowsnest Pass		
Alberta Environment Call centre (24-hour)		
Alberta Emergency Management Agency (24-hour)		
Alberta Environment – Dam safety		

4.0 ACTIVATION OF THE ERP

The ERP can be activated by Benga with input from the Construction Management Team and the design consultant. Generally, the ERP must be activated when:

- Hazardous condition: There is no immediate threat to the dam and downstream, but if the condition is left unattended, there is a risk of dam failure in the near future;
- Potential Flood Emergency Condition: There is a potential for dam failure causing potential flooding; or
- Imminent Flood Emergency: The dam breach is occurring or has occurred.

Depending on the level of emergency, all or part of the emergency response flowchart will be followed. Tables 2a, b, and c present the conditions that if observed at site they can be associated with various emergency levels listed above.

Table 2.a: Observed Conditions and Response Plan (Hazardous Condition)

Site Observations	Cause	Action
Sand boils in the toe ditch	High seepage gradient in the foundation due to filter drain failure or pipe drain blockage-	• Notify Benga site management • Perform camera survey of the off-take pipes • Increase monitoring frequency of area • Lower the pond level • Follow up with repair of damaged components
Sinkholes on the slope without excessive seepage	Internal erosion cause by a pipe failure	• Notify Benga site management • Increase monitoring frequency of area • Repair or replace the damaged pipe (if visible and accessible) • Abandon and seal the pipe and install a new pipe, if repairs are not possible • Backfill the sinkhole
Cracks or slumping on the slopes without excessive seepage flow	• Soil stress exceeding the design assumptions • Excessive foundation and dam settlements	• Notify Benga site management • Increase monitoring frequency of area • Stop construction in the area • Initiate investigation to determine cause and repair plan
Active erosion on the slopes by erosion gullies more than 3 m deep or 10 m wide	Surface erosion caused by prolonged concentrated surface water flow or broken water pipe	• Notify Benga site management • Increase monitoring frequency of area • Resurface the water path to the erosion area • Repair pipe breakages • Backfill with suitable material
Persistent freeboard violation	• Dam construction behind schedule • Excessive inflow • Inadequate outflow operation	• Notify Benga site management • Increase pond level monitoring frequency • Accelerate dam construction • Increase outflow

Table 2.b: Observed Conditions and Response Plan (Potential Flood Emergency)

Site Observations	Cause	Action
Large sinkholes on dam crest or downstream slope and seepage at foundation interface.	• Internal erosion cause by a pipe failure • Internal erosion caused by filter failure • Internal erosion cause any other piping failure in the dam or its foundation	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Increase monitoring frequency of area • Fill sinkholes • Install additional filter blankets at the downstream side
Tension cracks on slope or crest over a large section of the dam with toe heave.	• Soil stress exceeding the design assumptions	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Increase monitoring frequency of area • Suspend construction activities in the area • Evacuate all non-essential personnel and equipment from dam downstream and dam site • Apply additional loading at the dam toe area • Initiate investigation to determine cause and repair plan
Active retrogressive gullies on the dam's downstream slope exposing the core	Concentrated surface erosion by precipitation water flow or broken water pipe	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Increase monitoring frequency of area • Possible installation of filter blanket to stop continued migration of soil particles • Initiate investigation to determine cause and long-term repair plan
Slope movement in a significant area from toe to crest	Loading exceeds the soil strength	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Increase monitoring frequency of area • Initiate investigation to determine cause and long-term repair plan

Site Observations	Cause	Action
Slope movement even after suspended construction and loading		
Failure of a slope within the reservoir area	Soil stress exceeding the design assumptions	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Evacuate all non-essential personnel and equipment from dam downstream and dam site • Use all means to stop water flowing over the crest and replace the crest fill that was washed away by waive • Initiate investigation to determine cause and long-term repair plan

Table 2.c: Observed Conditions and Response Plan (Imminent Flood Emergency)

Site Observations	Cause	Action
Pond near the dam crest	• Excessive precipitation, snowmelt, wind and wave erosion	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Use all available means to prevent water from cresting (additional fill on crest, maximum out flow pump or additional pumps, etc.) • Consider an intentional breach option
Retrogressive slope failures at the dam's downstream	• Soil stress exceeding the design assumptions casing progressive slope failures	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Add fill to the downstream toe to stop or reduce progression of the failure if safe to do so • Consider an intentional breach option
Uncontrolled discharge of water from pond	Dam breach	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Failure in progress, do not attempt to fix the breach
Shell collapse with lateral movement of significant portion of the dam's shell	Loading exceeds the soil strength	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Use all available means to stop the flow if started • Add fill to the toe to improve dam stability under direction of a geotechnical engineer • Consider an intentional breach option
Crest failure to the pond	• Rapid drawdown failure	• Activate ERP and EPP for potential evacuation of downstream stakeholders • Evacuate all non-essential personnel and equipment to high grounds • Consider an intentional breach option

5.0 REFERENCES

1. Reference Text
2. Reference Text

6.0 CLOSURE

We trust this draft plan meets your present requirements. If you have any questions or comments, please contact the undersigned.

Yours Sincerely,
TERRACON GEOTECHNIQUE LTD.
APEGA PERMIT NO. 3407

Partnerships IN HEALTH AND SAFETY

Appendix 25A

Projection Data

Table 25A-1 Wildfire History for the Project (1931-2015)

Year	Total Area Burned (ha)		
	Mine Permit Boundary	Wildlife Local Study Area	Wildlife Regional Study Area
1931	--	--	1,256
1934	54	54	310
2003	--	--	6,528
2008	--	--	7.2
2010	--	--	2.6
2012	--	--	2.9
2013	--	--	0.7
Total Area Burned (ha)	54	54	8,107
Total Area Burned (%)	1.5	1.0	11.0
Total Area Burned/Year (ha/yr)	0.6	0.6	95.4
Total Area Burned/Year (%/yr)	0.02	0.01	0.13
Frequency (fires/year)	0.01	0.01	0.08
Fire Occurrence (fires/10^5 km^2/yr)	31.8	20.8	11.2

Table 25A-2 Summary of Change in Projected Temperature (°C Change from 1986-2005) for Winter (December-February), Summer (June-August), and Annual for Three Time Periods for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
Winter[2]									
Median	0.90	1.10	1.35	1.10	1.57	2.15	1.25	2.05	2.78
25th[3]	0.47	0.70	0.86	0.59	1.10	2.00	0.55	1.80	2.27
75th[3]	1.44	1.46	2.05	1.30	1.80	2.80	1.55	2.35	3.19
Summer[2]									
Median	1.10	1.45	1.65	1.15	1.75	2.35	1.40	2.10	3.40
25th[3]	0.95	1.35	1.55	0.95	1.55	2.15	1.25	1.78	2.88
75th[3]	1.05	1.45	1.65	1.15	1.75	2.35	1.35	2.05	3.35
Annual									
Median	1.13	1.41	1.62	1.16	1.67	2.27	1.29	2.00	2.91
25th[3]	0.95	1.31	1.54	1.06	1.58	2.07	1.12	1.86	2.76
75th[3]	1.24	1.46	1.77	1.18	1.78	2.34	1.46	2.16	3.15

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

2 Winter: December, January, February. Summer: June, July, August.

3 25th and 75th percentiles

Data Source: CCDS (2017)

Table 25A-3 Summary of Maximum Daily Temperature for the Grassy Mountain Coal Project

CMIP[5] Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	25.3	27.2	28.7	29.8	27.4	26.3	28.8	27.8	29.0	29.9
95th [2]	31.1	28.8	31.4	34.0	28.9	30.9	32.3	31.6	31.6	33.3
Maximum	31.8	29.0	31.6	34.9	29.0	32.2	32.4	31.7	32.2	33.3
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	30.1	32.6	33.1	33.8	32.7	31.2	33.2	32.3	34.1	34.1
95th [2]	35.2	32.9	34.9	38.4	34.3	35.2	36.2	36.1	36.0	36.6
Maximum	35.9	32.9	35.0	39.1	35.1	36.4	36.5	36.3	36.6	37.0

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).
2 95th percentiles
Data Source: CCCMA (2017)

Table 25A-4 Summary of Minimum Daily Temperature for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	-33.3	-29.1	-28.8	-26.3	-32.3	-29.6	-27.9	-30.9	-31.8	-29.7
5th[2]	-42.0	-39.2	-36.1	-38.3	-39.1	-34.4	-39.4	-39.8	-36.7	-34.6
Minimum	-43.4	-41.7	-37.3	-40.5	-42.2	-36.0	-44.1	-43.1	-37.1	-34.6
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	-34.4	-30.7	-29.3	-31.0	-32.2	-29.5	-29.2	-32.9	-33.2	-29.0
5th[2]	-42.0	-41.1	-36.0	-40.0	-41.8	-36.6	-40.9	-41.7	-37.5	-34.7
Minimum	-44.8	-42.5	-36.1	-40.7	-44.4	-37.9	-46.2	-45.1	-37.9	-35.1

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

2 5th percentile

Data Source: CCCMA (2017)

Table 25A-5 Summary of Reduction in Projected 20-year Return Period for Annual Daily Precipitation Extremes (% Reduction from 1986-2005) for Three Time Periods for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
10% Reduction in P_{20} per 1°C Local Warming									
Median	11.3	14.1	16.2	11.6	16.7	22.7	12.9	20.0	29.1
5th[3]	7.7	11.9	13.4	8.5	14.2	19.6	8.4	16.0	24.8
95th[3]	18.8	15.1	18.6	12.9	19.1	25.4	15.9	22.8	33.1
20% Reduction in P_{20} per 1°C Local Warming									
Median	22.6	28.3	32.4	23.1	33.4	45.3	25.9	39.9	58.2
5th[3]	15.4	23.8	26.7	17.1	28.4	39.2	16.8	32.0	49.5
95th[3]	37.7	30.3	37.3	25.8	38.3	50.7	31.7	45.6	66.2

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

2 Median (50th percentile) % reduction in return period for the equivalent extreme precipitation in historic ΔP_{20} in each year within the time period.

3 5th and 95th percentiles

Table 25A-6 Projected Return Period (Years) for Annual Daily Precipitation Extremes Equivalent to Historic (1986-2005) 20-year Return Period for Three Time Periods for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
Return Period for 10% Reduction in ΔP_{20} per 1°C Local Warming									
Median	17.7	17.2	16.8	17.7	16.7	15.5	17.4	16.0	14.2
5th[3]	16.2	17.0	16.3	17.4	16.2	14.9	16.8	15.4	13.4
95th[3]	18.5	17.6	17.3	18.3	17.2	16.1	18.3	16.8	15.0
Return Period for 20% Reduction in ΔP_{20} per 1°C Local Warming									
Median	15.5	14.3	13.5	15.4	13.3	10.9	14.8	12.0	8.4
5th[3]	12.5	13.9	12.5	14.8	12.3	9.9	13.7	10.9	6.8
95th[3]	16.9	15.2	14.7	16.6	14.3	12.2	16.6	13.6	10.1

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

2 Median (50th percentile) projected return period for the equivalent extreme precipitation in historic ΔP_{20} in each year within the time period.

3 5th and 95th percentiles

Table 25A-7 Summary of 1-Day Maximum Precipitation (mm) for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	35.6	38.2	33.9	29.3	35.8	28.9	34.1	30.1	35.4	39.1
5th[2]	24.1	24.5	18.9	19.8	27.6	20.6	24.2	21.1	25.6	19.8
95th[2]	65.7	43.7	50.9	48.2	57.3	42.3	48.7	33.9	52.8	47.5
Maximum	70.9	44.1	51.4	53.6	70.4	43.7	55.5	35.1	55.0	51.4
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	29.2	29.1	26.1	25.9	31.4	25.8	22.9	25.3	32.0	26.3
5th[2]	14.9	21.5	12.3	11.4	19.1	15.0	19.7	17.3	18.9	15.6
95th[2]	59.9	44.8	43.8	53.1	43.3	47.4	31.8	32.7	48.2	43.6
Maximum	61.7	45.7	47.7	59.5	47.8	52.9	33.1	33.1	51.1	47.5

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).
2 5th and 95th percentiles
Data Source: CCCMA (2017)

Table 25A-8 Summary of 5-Day Maximum Precipitation (mm) for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	68.1	71.3	67.9	60.9	75.9	63.4	72.9	74.0	71.7	68.7
5th[2]	51.8	51.7	45.4	45.6	51.9	47.5	60.0	51.7	56.3	49.4
95th[2]	130.3	101.8	89.7	86.3	87.6	81.5	83.7	99.8	103.2	96.8
Maximum	137.9	109.8	91.5	89.9	88.4	82.4	85.0	101.6	112.7	98.4
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	59.8	56.8	55.5	49.2	57.5	57.3	44.5	62.8	57.7	49.0
5th[2]	35.2	43.6	29.8	28.0	33.8	40.4	36.3	38.7	36.7	34.7
95th[2]	103.2	87.1	89.3	97.4	74.7	71.5	64.2	75.6	100.3	78.2
Maximum	109.7	92.7	93.0	97.6	80.6	72.2	64.9	75.9	113.2	81.1

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

2 5th and 95th percentiles

Data Source: CCCMA (2017)

Table 25A-9 Summary of Total Annual Precipitation on Wet Days (mm) for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	1,050.2	1,033.2	1,030.6	1,002.5	1,091.4	1,019.0	1,041.1	1,002.5	981.9	1,041.1
5th[2]	889.9	881.3	863.2	818.3	808.5	927.6	944.5	893.4	836.1	840.4
95th[2]	1,221.2	1,189.1	1,228.2	1,113.8	1,176.8	1,079.2	1,135.7	1,139.9	1,122.2	1,190.8
Maximum	1,387.5	1,254.7	1,248.9	1,122.4	1,201.7	1,116.8	1,151.0	1,146.6	1,136.7	1,225.1
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	592.4	570.0	545.4	502.5	607.5	583.5	572.9	568.8	533.6	515.8
5th[2]	440.6	493.5	456.7	413.4	440.4	505.6	488.8	464.3	432.4	418.3
95th[2]	735.5	677.8	640.5	700.6	652.0	660.2	716.9	655.0	685.5	680.7
Maximum	747.9	689.2	643.7	736.9	657.7	695.5	770.2	683.9	695.6	703.0

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

2 5th and 95th percentiles

Data Source: CCCMA (2017)

Table 25A-10 Summary of Number Days with >20 mm Precipitation for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	3	4	2.5	2	3.5	3	3.5	3	3	3
5th [2]	1	1	0	0.5	1	0.5	1	0.9	1	0.5
95th [2]	7.1	5.6	6.6	3.6	6	5	6	6.1	6.6	7.1
Maximum	8	6	7	4	6	5	6	7	7	8
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	2	1.5	1	1	2	1	1	1	1.5	1.5
5th [2]	0	0.5	0	0	0	0	0.5	0	0	0
95th [2]	4.1	5.1	4.6	2.6	3.6	3	3.6	4	4	3.1
Maximum	5	6	5	3	4	3	4	4	4	4

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

2 5th and 95th percentiles

Data Source: CCCMA (2017)

Table 25A-11 Summary of Maximum Consecutive Dry Days for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	12.5	12	10	12.5	14	12	15.5	12.5	15.5	11.5
5th[2]	8.9	8.5	7.5	9.5	9.4	9.0	10.3	8.9	11.5	8.4
95th[2]	18.3	16.1	18.1	18.2	23.6	19.1	18.7	20.1	22.6	16.6
Maximum	24	17	19	20	24	20	20	21	23	17
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	17.5	15.5	20	16.5	23	19.5	17	17	21	18.5
5th[2]	12.9	11.5	13.5	13.9	13.9	13.3	11.4	11.5	14.4	11.5
95th[2]	27.3	29.1	23.7	20.6	28.1	33.6	31.5	35.4	31.0	33.6
Maximum	32	34	25	21	29	34	36	43	31	34

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

2 5th and 95th percentiles

Data Source: CCCMA (2017)

Table 25A-12 Summary of Monthly Wind Speed (m/s) for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.5°N latitude and 245.5°E longitude										
Median	2.77	2.64	2.66	2.64	2.59	2.56	2.53	2.76	2.72	2.70
95th[2]	3.48	3.41	3.33	3.43	3.35	3.30	3.34	3.45	3.53	3.37
Maximum	3.92	3.60	3.52	3.74	3.72	3.42	3.52	3.63	3.81	3.52

1 CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).
2 95th percentile
Data Source: CCCMA (2017)

Table 25A-13 Change in Hourly Gust Frequency

	Wind Gust (km/h)			
	≥ 28	≥ 40	≥ 70	≥ 90
1994-2009 – Frequency of Gusts (# hours or days/yr)				
Hourly (# hours)	616	257	6	0.3
Daily	129	81	6	0.6
2046-2065 – % Change from 1994-2009 Hourly Gust Frequency				
Low Emissions	0	3	20	200
High Emissions	5	11	30	220

Source: Cheng *et al*. 2014. Project is located within Region W3.