Response Package for Additional Information for the Grassy Mountain Coal Project Environmental Assessment – Requested by the Agency on February 28, 2018

Benga Mining Limited
Grassy Mountain Coal Project

April 2018

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A. CANADIAN ENVIRONMENT ASSESSMENT AGENCY

1. Little Brown Myotis

EIS Guidelines, Section 6.1.7 & Section, 6.3.3; EIS Guidelines, Section 6.4; Consultant Report #9, Section 2.3.4 & Section 7; Canadian Environmental Assessment Agency's Request for Additional Information (SIR #38 - March 21, 2016 Letter – Revised Questions April 26, 2016 – Document 34 on the Agency's Website); Addendum to the Environmental Impact Statement – January 31, 2017; Agency's Request for Additional Information, May 11, 2017 - AIR #5.

http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_LittleBrownMyotisNorthernMyotisTricoloredBat_e_proposed.pdf

On May 16, 2017([1]), the Canadian Environmental Assessment Agency requested that Benga Mining provide additional information on the potential cumulative effects of the Grassy Mountain Coal Project. In the Addendum #3 submission of November 27, 2017, Benga Mining indicated that a response to this request would be provided to the Agency as a separate document in January 2018. The Agency is still expecting responses to the following information request.

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 Little Brown Myotis was emergency listed in 2014 under the Species At Risk Act as Endangered because their survival is imminently threatened by a deadly and highly contagious disease, white-nose syndrome. Hibernacula are used by Little Brown Myotis to survive when ambient temperatures decline and insects are unavailable and typically include caves, abandoned mines, hand-dug wells, cellars, or tunnels where light and noise levels are low. The Recovery Strategy for Little Brown Myotis (2015) identifies all hibernacula (found and not found) as critical habitat as they are necessary for the survival and recovery of the species. The loss of a hibernaculum could have regional population effects on Little Brown Myotis.

1 CEAR #53 – Canadian Environmental Assessment Agency's Request for Additional Information for the Environmental Impact Statement for the Grassy Mountain Coal Project – May 16, 2017.

Benga Mining's desktop assessment, indicates that there are no suitable karst formations, that old mine access has been sealed, and the elevation of the Project site is too high for hibernacula, however no hibernacula or swarming surveys were done to confirm this assessment. Although hibernacula for Little Brown Myotis are uncommon and hard to find, this endangered bat species has been observed in the area during the mist-netting surveys and terrain, and conditions may in fact be suitable for hibernacula. , In order to assess potential effects of the Project on Little Brown Myotis (including the destruction of critical habitat) and to assess the effectiveness of mitigation measures, confirmatory hibernacula and swarming surveys that would be indicative of hibernacula, including inspection of old mine shafts should be conducted during the course of the environmental assessment.

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

Response:

Benga completed a field program to identify potential areas within the Project's proposed mine permit boundary that may provide suitable areas for little brown myotis hibernacula. Please refer to Appendix A-1 – Bat Hibernacula Report for the results of this program and the response to this information request.

b) Using information obtained through the above mentioned surveys (in a) hibernacula surveys (in (a) above), estimate the number of little brown bats that will be affected for each hibernacula disturbed/destroyed due to the Project.

Response:

Please see response SIR CEAA 1(a).

c) If hibernacula are found in (a), through the use of surveys, identify hibernacula near, but unaffected by, the Project to which Project-impacted little brown bats could relocate.

Response:

Please see response SIR CEAA 1(a).

d) Based on the information obtained through a-c above, identify mitigation measures to reduce impacts on the potential destruction of little brown bat hibernacula.

Response:

Please see response SIR CEAA 1(a).

2. Outstanding Information Requirements – 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; Agency's Request for Additional Information, December 5, 2016 - AIR #26.

Response:

Please see Appendix A-2 - Cumulative Effects Assessment.

3. Outstanding Information Requirements – Summary of Effects

EIS Guidelines, Section 7; Volume 3, Appendix 2B and 2C; Agency's Request for Additional Information, December 5, 2016 - AIR #27. On December 5, 2016 (2), the Canadian Environmental Assessment Agency requested that Benga Mining provide further detail on the summary of effects assessment of the Grassy Mountain Coal Project. In the Addendum #4 submission of November 27, 2017, Benga Mining indicated that a response to this request would be provided to the Agency as a separate document in January 2018. The Agency is still expecting responses to the following information request.

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.

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:

Volume 3, Appendices 2B and 2C, have been replaced by a single, updated Appendix A-3 to clearly indicate which of the valued components listed have been carried forward to the cumulative effects/planned development assessment.

For clarification Tables 2B-1 and Table 2C-1, provided in the August 2016 Integrated Application Appendix 2B and Appendix 2C, respectively, were updated and replaced by a single comprehensive table as Appendix A-3.

2 CEAR #43 – Canadian Environmental Assessment Agency's Request for Additional Information for the Environmental Impact Statement for the Grassy Mountain Coal Project – December 5, 2016.

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 measures apply to old growth forests and contribute to a positive residual effect for this VC.

Response:

Appendix A-3 has been updated to align proposed mitigations with applicable impacts for each identified VC.

4. Extreme Weather Events and Climate Change

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, Canadian Environmental Assessment Agency's Request for Additional Information, December 05, 2016 - AIR #26.

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 December 2016, the Agency requested that Benga Mining provide information on potential future changes in precipitation extremes over the projected lifetime of the mine and the period of active management following closure. As noted by Environment Canada in their Technical Information Request #1, Benga Mining has characterized the average monthly precipitation climatology in the Project area for future potential climate scenarios, but has not provided a characterization of extreme precipitation events.

a) Assess the potential impacts of extreme precipitation events on the Project using the updated research and suggested data sets provided by Environment Canada (see attached).

Response:

In its response to SIR#25, Benga provided 1-day and 5-day maximum precipitation at two model gridpoints near the Project. These two tables address the issue of extreme precipitation intensity. The source of the information was the Canadian Centre for Climate Modelling and Analysis (2017) based on approaches used by Sillmann et al (2013a,b). Ensemble predictions from 29 climate models were used.

As part of the response package to the Agency's Request for Additional Information, December 05, 2016 –AIR #25; information provided in Appendix #25, Table 25A-7 (provided here for easy reference) indicates that median predicted "maximum 1-day precipitation" at both model

gridpoints generally decreases with time relative to the historical period in low and moderate emission scenarios but increases with time under RCP8.5. The changes are quantified in this IR's response Table CEAA 4-1. Considering the median predictions, the maximum predicted increase under any scenario in any period is 7%, while the maximum predicted decrease is 24%.

Table A25-7* 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

*Table previously provided in Benga's Response to Agency Conformity Information Requests (Benga, November 27, 2017)

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 CEAA 4-1 Change (%) from historical period in median predicted maximum 1-day precipitation

Location	RCP2.6			RCP4.5			RCP8.5		
	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
60 km W	-7	-11	-23	-6	-24	-11	-21	-7	2
39 km E	0	-8	-9	6	-9	-16	-10	7	-8

The predictions are within the 5th to 95th percentile changes in the historical period identified in Table 25A-7. For example, the 5th percentile observation is 24.1 mm while the lowest predicted median of the scenarios in any period is 28.9 mm, compared to the historical period median of 35.6 mm.

The median "maximum 5-day precipitation" (provided again for reference in Table 25A-8) generally decreases with time at both gridpoints in all emission scenarios, as quantified in Table CEAA 4-2. Considering the median predictions, the maximum predicted increase under any scenario in any period is 6%, while the maximum predicted decrease is 15%.

Table A25-8* 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

*Table previously provided in Benga's Response to Agency Conformity Information Requests (Benga, November 27, 2017)

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 CEAA 4-2 Change (%) from historical period in median predicted maximum 5-day precipitation

Location	RCP2.6			RCP4.5			RCP8.5		
	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
60 km W	-4	-5	-15	6	-11	2	4	1	-4
39 km E	-4	-6	-15	-3	-4	-21	4	-3	-15

Extreme precipitation frequency was addressed with the information presented in Table 25A-10 which documented changes in the number of days with heavy precipitation (*e.g.* as analyzed by Sillmann *et al* 2013b). The changes are listed in Table CEAA 4-3 where the trends with time

and emission scenario are less clear than they are for extreme precipitation intensity. Generally, the model gridpoint east of the Project nearer the foothills experiences a decrease in the number of intense precipitation days. The gridpoint west of the Project experiences increases, no change and decreases. Considering both gridpoints, the Project area could experience changes ranging from an increase by one day to a decrease by one day in the number of extreme precipitation events.

Table A25-10* 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

*Table previously provided in Benga's Response to Agency Conformity Information Requests (Benga, November 27, 2017)

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 CEAA 4-3 Change (%) from historical period in median predicted days with >20 mm precipitation

Location	RCP2.6			RCP4.5			RCP8.5		
	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
60 km W	33	-17	-33	17	0	17	0	0	0
39 km E	-25	-50	-50	0	-50	-50	-50	-25	-25

These predictions are not necessarily consistent with the global scale indicators and maps presented in Kharin *et al* (2013) and in the supplemental material because the areas involved in the Project area predictions are very small compared to the global maps. In addition, Karin *et al* (2013) base their conclusions on precipitation extremes on a return period analysis (ΔP20), not on short term precipitation amounts and frequencies presented here. The two are related but Kharin comments only on the relationship between increased extreme precipitation intensity and decreasing ΔP20 on a global scale, not in regions where extreme intensity is predicted to decrease.

b) As appropriate, update Benga Mining's Table 25-5 Changes in Natural Hazards Over Time and Associated Risk.

Response:

Table CEAA 4-4 provides an update to the projected changes in natural hazards over time and associated risks related to extreme short-term precipitation events (a comprehensive list of other types of natural hazards was provided in the response to the Agency's Request for Additional Information, December 05, 2016 –AIR #25). Based on the predictions in Tables CEAA 4-1 and CEAA 4-2, the intensity of extreme precipitation events (one to five days in duration) are expected to decrease. The frequency of extreme (>20 mm) precipitation events is expected to be approximately unchanged.

The updated Table CEAA 4-4 reflects a reduced risk of flooding – reduced intensity and unchanged frequency in model gridpoints near the Project. To the extent that short-term precipitation extremes influence landslides, the predicted reduced intensity of extreme predictions and unchanged frequency would reduce the risk of landslides.

Regardless of the general trends, climate models indicate the potential for both increases and decreases in precipitation extremes and their frequency of occurrence, and Benga will need to design, operate and decommission the Project with this in mind.

Table CEAA 4-4 Changes in Natural Hazards Over Time and Associated Risks

Natural Hazard	Change?	Confidence	Risk to Project	Risk to Public	Risk to Environment	Mitigation
Extreme Precipitation – Severity	Yes, per Tables 4-1 and 4-2	Moderate	Generally reduced intensity of flooding risk	Low	Low	None
Extreme Precipitation – Frequency	Yes, per Table 4-3	Low - Moderate	Generally unchanged frequency of flooding risk	Low	Low	None

References

Canadian Centre for Climate Modelling and Analysis (2017). http://climate-modelling.canada.ca/climatemodeldata/climdex/index.shtml. ETCCDI Extremes Indices Archive.

Kharin.V.V., Zwiers, F.W., Zhang, X. and Wehner, M. 2013. Changes in temperature and precipitation extremes in the CMIP5 ensemble. Climatic Change, 119, pp. 345-357.

Kharin.V.V., Zwiers, F.W., Zhang, X. and Wehner, M. 2013. Changes in temperature and precipitation extremes in the CMIP5 ensemble. Supplementary Material. https://link.springer.com/article/10.1007%2Fs10584-013-0705-8

Sillmann, J., V. V. Kharin, F. W. Zwiers, X. Zhang, and D. Bronaugh, 2013a: Climate extremes indices in the CMIP5 multi-model ensemble. Part 1: Model evaluation in the present climate. J. Geophys. Res., doi:10.1002/jgrd.50203.

Sillmann, J., V. V. Kharin, F. W. Zwiers, X. Zhang, and D. Bronaugh, 2013b: Climate extremes indices in the CMIP5 multi-model ensemble. Part 2: Future projections. J. Geophys. Res., doi:10.1002/jgrd.50188.

5. Scheduling Details

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; EIS Section A.6 and Figure A.1.0-2; Agency Request for Additional Information, December 5, 2016 - AIR #21; Addendum #4 to the Environmental Impact Statement, Attachment 2, AIR #21

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.

On January 13, 2016, the Canadian Environmental Assessment Agency requested that Benga provide a description of the components associated with the proposed Project, including:

a) all physical works associated with the Project (e.g., buildings, bridges, culverts, railways, roads, and transmission lines) including their purpose, approximate dimensions, and capacity (e.g. number and size of trucks or train cars/day, size or scale of disposal areas, volume of haul and overburden, camp size and number of occupants, length and routing of conveyor, length and routing of transmission lines); and

b) a description of the timeframe in which the development of each project component is to occur and the key Project phases.

On December 5, 2016, the Canadian Environmental Assessment Agency requested that Benga Mining provide a schedule of the Project construction and operation activities, including, at a minimum, the time of year, frequency and duration of the activities.

In response to the January and the December requests, on November 27, 2017 Benga Mining pointed to Section A.6 and Figure A.1.0-2 of the EIS (updated August 15, 2016), and provided Figure 21-1 in Attachment 2 of the Addendum #4 to the Environmental Impact Statement.

The Alberta Energy regulator submitted its Supplemental information Request on December 20, 2017. As part of SIR #52, the AER also requested that Benga Mining provide an updated detailed schedule for mine construction and operation, considering the updated application and construction schedule.

The information provided by Benga Mining to date does not include a consolidated and detailed accounting and schedule for all Project works and activities. For example, Project components related to the golf course redesign, the potential decommissioning oil and gas infrastructure, the detailed geotechnical campaign, the construction of camp infrastructure, and the installation of water crossings were not included on Figure 21-1 in Attachment 2 of Addendum #4 to the Environmental Impact Statement. Also, although Figure 21-1 presents timing and duration for some activities and components, it does not provide a description of frequency for the activities.

a) Provide a detailed, up-to-date schedule for the construction and operation of all Project components. The Project components should include, at minimum, the components included in Figure 21-1 of Attachment 2 of Addendum #4 to the Environmental Impact Statement, as well as works and activities planned for the golf course redesign, the potential decommissioning oil and gas infrastructure, the detailed geotechnical campaign, the construction camp infrastructure, and the installation of water crossings components.

   Supplement the schedule with a consolidated table outlining all Project works and activities, with their timeline (timing, duration, frequency) as well as their purpose, approximate dimensions, and capacity, as applicable.

Response:

Actual timing of construction and operations will depend on the timing of regulatory approvals and market conditions. For the purpose of this response an updated schedule has been provided in Appendix A-4, which replaces the previous version (i.e., Figure 21-1) in Addendum 4 (November 2017 – Agency IR Responses), Attachment 2, IR#21. The schedule provided in Appendix A-4 outlines the Project-related works and activities (work breakdown structure), including timeline (*i.e.*, timing, duration, frequency) as well as purpose, and reference to applicable sections in the application that provide supporting information for each activity.

It is important to note that the schedule provided in Appendix D is illustrative in terms of pertinent project activates and continues to be appropriate for the project if taken in that context. As the timing of regulatory approvals are not known at this time, Benga commits to developing a final, more detailed engineering based schedule (beyond top task headings), that takes in to account all pertinent environmental mitigations and seasonal timing restrictions identified in the final Project approval terms and conditions.

B. ENVIRONMENT AND CLIMATE CHANGE CANADA

1. Effects of Extreme Precipitation in Hydrological Analysis

EIS Guideline, Section 6.6.2 – Effects of the Environment on the Project, Page 35

Revised EIS, Volume 4, Consultant Report #4, Section 2.2.2 – Precipitation Data, Page 11

Section 6.6.2 of the EIS Guidelines for this project specifies that the assessment will address how local conditions and natural hazards, such as severe and/or extreme weather conditions and external events (e.g. flooding, drought, ice jams, landslides, avalanches, erosion, subsidence, fire, outflow conditions, and seismic events) could adversely affect the Project, and how this in turn could result in impacts to the environment. While Benga Mining has characterized the average monthly precipitation climatology in the Project area using eleven precipitation stations within a 90 km radius of the Project site, a characterization of extreme precipitation was not found.

The available periods of record examined at most of the stations analyzed in the section 2.2.2 of the consultant's report typically ended around 2007. It is ECCC's understanding that data is available beyond 2007. The Connelly Creek and Beaver Mines reported data up to Dec 2011 and March 2012, respectively. The Oldman and South Saskatchewan River basins have experienced a number of intense rainstorms in the last 15 years, resulting in major large-scale flooding (Szeto et al., 2011; Shook, 2016). In June 2013, heavy rainfall combined with rapidly melting alpine snow triggered a catastrophic flooding event throughout much of southern Alberta (Pomeroy et al., 2016). A map illustrating the areal extent of the flooding and the accumulated precipitation is found at: http://www.environment.alberta.ca/forecasting/data/precipmaps/event_Jun19_22.PDF

Consequently, Benga Mining's assessment of the impacts of extreme precipitation on the Project may be underestimated and should include recent data in order to adequately characterize extreme events and associated potential adverse effects on the Project.

Over the past decade, Alberta Agriculture and Forestry has installed a meso-network of near real- time all-season weather stations that includes precipitation data at both hourly and daily intervals. Individual station data can be accessed through the following link: http://www.agriculture.alberta.ca/acis/.

References:

Pomeroy et al. (2016). *Canadian Water Resources Journal*, Doi: 10.1080/07011784.2015.1089190

Shook (2016) *Canadian Water Resources Journal*, Doi: 10.1080/07011784.2014.1001439

Szeto et al. (2011). *Atmosphere-Ocean*, Doi: 10.1080/07055900.2011.623079

b) Describe the precipitation data used to characterize extreme events. Indicate how the extreme precipitation data were incorporated into the hydrological analyses to capture the potential adverse effects on the Project.

Response

Precipitation data were collected from 18 regional meteorological stations within 100 km of the project area. Maximum annual 24-hour precipitation from each year of record for all regional stations was compiled and a frequency analysis was performed to determine the 24-hour rainfall for each return period. A linear regression relationship was developed for each return period, relating the 24-hour rainfall to elevation of each station. Based on these linear relationships and the elevation of the Project, the 24-hour rainfall depths for the Project were estimated as an area averaged depth, for return periods from the 2-year to the 200-year.

Rainfall intensity for a range of durations shorter than 24 hours was calculated using duration factors obtained from the Rainfall Frequency Atlas for Canada (Hogg & Carr, 1985). The 1000-year return period rainfall depth was extrapolated using a logarithmic relationship between return period and rainfall for each storm duration.

Probable maximum precipitation (PMP) was calculated using the Hershfield methodology (WMO 2009) using a 37-year length reanalysis precipitation record. Reanalysis combines satellite information, land records and numerical models that simulate the earth's climatic conditions for the complete planet through a defined grid of 0.75 x 0.75 degrees latitude and longitude, at the site, these values from reanalysis tended to be more conservative than the resultant from Coleman ECCC station (ID 3051720) and consequently were used instead of ECCC station.

Extreme precipitation data were used in the peak flow estimation for inflow design floods at each water storage facility, including the sediment ponds, the surge ponds and the Raw Water Pond. As part of the detailed engineering design phase (2018), a rainfall-runoff model for peak flows was developed based on a calibrated Curve Number for the region to generate instantaneous peak flows and total storm volumes for a range of return periods.

c) Incorporate extreme precipitation data and analysis from nearby stations in the Alberta Climate Information Service meso-network through at least 2015 into the assessment of the impacts of extreme precipitation on the project.

Response:

Alberta Climate Information Service meso-network includes information from April 2005 up to date. The closest stations to the site are Pelletier Creek (1646 masl) and Crownest (1303 masl), unfortunately Crownest presents less than 10 years, which make it not suitable for a frequency analysis. Pelletier Creek has 13 years of information and it is presented in Table ECCC 1-1.

With this available information, a frequency analysis was implemented for maximum in 24 hrs and the results were compared with the site IDF as presented in Table ECCC 1-1. This table suggests that site IDF is aligned and more conservative than the closest station from Alberta

Climate Information Service and consequently, it is not suggested to update these short precipitation values.

Table ECCC 1-1 Frequency Analysis comparison between Pelletier Creek (305NJ61) and site IDF

Return Period [yrs]	Max. Precip. 24 hrs [mm]	
	Pelletier Creek (305NJ61)	IDF Site (SRK 2016)
2	44.5	50.4
5	64.7	72.0
10	79.0	86.4
20	93.2	100.8
25	97.9	105.6
50	112.5	120.0
100	127.6	136.8
200	143.2	153.6
1000	181.8	187.7

2. Contradiction in Climate Change Projections

EIS Guideline, Section 6.6.2 – Effects of the Environment on the Project, Page 35

Revised EIS, Volume 1, Section C,10.2.1-Sensitivity to Climate Change, Page 176

FRT Conformity SIR, Round 2 (December 05, 2016), # 25 - Extreme Weather Events and Climate Change

Benga Mining, Conformity SIR Response, Attachment 2, Page 2-96 to 2-114; Appendix 25, Page A-1 to A25- 123)

In their conformity response to CEAA IR 25, Benga Mining states that summer temperatures are projected to increase more than winter temperatures (p.2-100). This does not correspond with projections for broader western North America (IPCC, 2013, Annex I) or for Alberta as a whole. For example, multi-model ensemble data from the Canadian Climate Data and Scenarios website (CCDS) [i] show greater projected temperature increases for the period 2046-2065 for winter (range: 1.3oC to 4.8oC) than summer (range: 0.9oC to 3.8oC) averaged over Alberta. Benga Mining does not discuss the lack of agreement with other studies for the region.

In their conformity response to CEAA IR 25, Benga Mining indicates that total annual precipitation is projected to decrease (p.2-102). This does not correspond with projections more broadly for Alberta as a whole. For example, multi-model ensemble simulations from

CCDS[3] show a projected increase in annual precipitation for mid-century (2046-2065) that ranges from 1.0% to 16% (based on an ensemble of 29 models, 3 RCPs, and 25th, 50th and 75th percentiles) averaged over Alberta.

Additionally, the Projected decrease reported by Benga Mining does not coincide with the information they provided in the EIS documents. Specifically, they noted a 3% increase in annual precipitation was projected for Pincher Creek by the 2050s (Section C.10.2, p. C-176). Benga Mining does not discuss the lack of agreement between the two sets of projections.

The projected decrease in annual precipitation noted by Benga Mining is then used to inform their discussion and conclusions on potential changes in natural hazards associated with climate change (Table 25-4). Specifically, they note that future decreases in precipitation will likely result in reduced soil erosion, streamflow, and that "increased temperature and decreased annual precipitation may lead to drying that increases slope stability and reduces the risk of rockslides and mudslides" (p.2- 99).

References:

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.

IPCC, 2013: 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, 1535 pp.

Taylor, K.E., R.J. Stouffer, and G.A. Meehl, 2012: An Overview of CMIP5 and the Experiment Design. Bulletin of the American Meteorological Society, 93, 485–498. doi: 10.1175/BAMS-D-11-00094.1.

Zhang, X., F. W. Zwiers, G. Li, H. Wan, A. J. Cannon, 2017: Complexity in estimating past and future extreme short-duration rainfall. Nature Geoscience, doi: 10.1038/ngeo2911.

3 The projected seasonal temperature and annual precipitation changes for the province of Alberta are based on area-averaged climate model simulations from the Coupled Model Inter-comparison Project, Phase 5 (CMIP5; Taylor et al., 2012) and are available from: http://climate-scenarios.canada.ca/?page=main. The reported ranges represent the 25th, 50th and 75th percentile from three Representative Concentration Pathways (RCPs) representing low, medium and high plausible future global anthropogenic forcing (RCPs 2.6, 4.5 and 8.5) from simulations from 29 models. Changes are expressed relative to the 1986-2005 reference period.

a) Utilize projections from a larger area (more than one or two gridboxes) to evaluate potential future climate change in the region (either from the published literature or from evaluation of ensemble datasets) in instances where these climate change projections are used to evaluate potential future climate change related impacts on the Project, or potential impacts of the Project on the environment.

Response:

Comparison to Province-wide Predictions

Benga maintains that utilizing future climate predictions as near to the Project location as possible increases the likelihood that local changes are identified, whether or not local changes are reflective of Alberta as a whole or western North America. Sub-regional effects may be important, as identified in the response to Conformity SIR#25 where Westerling *et al.* (2006) and Riley and Loehman (2016) noted increased wildfire activity over recent decades reflected sub-regional responses to changes in climate.

The reviewer noted the trend in broader scale temperature, for example, is different than the local scale predictions provided in the response to Conformity SIR#25 (Table A25-2). Table ECCC 2-1 (http://climate-scenarios.canada.ca/index.php?page=download-cmip5) can be compared to Table A25-2 and presents the temperature change averaged over all of Alberta. The originating datasets are the same; the difference is the spatial averaging scale.

Table ECCC 2-2 presents the difference between projected temperature changes in Table A25-2 and Table ECCC 2-1. It indicates the site-specific temperature changes in Table A25-2 are generally (not always) smaller than comparable Alberta-wide changes and the differences are most apparent in the high-emission scenario where the site-specific changes are much less than Alberta-wide changes.

With respect to seasonal changes, Table ECCC 2-2 indicates that site-specific predicted increases are less in winter than Alberta-wide predictions in the lower-emission scenario, and higher in summer, as noted by the reviewer. For the highest emission scenario, the general trend is that Alberta-wide temperature changes are greater than the site-specific changes in all seasons.

Benga notes that although climate predictions at individual model grid points may not be robust and that averages over larger areas may provide more stability; however, differences between province-wide and site-specific predictions are real and indicate that climate change impacts are somewhat different in central and northern Alberta than they are in the southern part of the province. Predicted temperature increases are generally less near the Project than they are over Alberta as a whole - averaging over large areas washes out local impacts that may be important.

Table ECCC 2-1 Alberta Averaged Temperature change (deg. C)									
	RCP2.6			RCP4.5			RCP8.5		
Percentile	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100
	Winter								
25	0.6	1.3	1.3	0.7	2.2	2.1	1.0	2.7	5.5
50	1.2	1.9	2.2	1.2	2.9	3.6	1.8	3.7	6.9
75	1.5	2.2	2.2	1.4	2.9	3.7	1.7	3.7	6.5
	Summer								
25	0.8	0.9	0.8	0.9	1.5	1.8	1.1	2.3	4.4
50	1.1	1.5	1.4	1.1	2.2	2.7	1.4	3.2	5.9
75	1.4	2.1	2.1	1.4	2.6	3.5	1.6	3.8	6.8
	Annual								
25	0.8	1.1	1.1	0.8	1.7	2.0	1.0	2.3	4.7
50	1.2	1.6	1.7	1.1	2.3	2.9	1.4	3.2	5.8
75	1.5	2.1	2.1	1.4	2.7	3.6	1.7	3.6	6.4

Table ECCC2-2 Site-specific change in Table A25-2 and Alberta-wide change in Table 2-1									
	RCP2.6			RCP4.5			RCP8.5		
Percentile	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100
	Winter								
25	-0.13	-0.60	-0.44	-0.11	-1.10	-0.10	-0.45	-0.90	-3.23
50	-0.3	-0.8	-0.9	-0.1	-1.3	-1.5	-0.6	-1.7	-4.1
75	-0.06	-0.74	-0.15	-0.10	-1.10	-0.90	-0.15	-1.35	-3.31
	Summer								
25	0.15	0.45	0.75	0.05	0.05	0.35	0.15	-0.52	-1.52
50	0.0	-0.1	0.3	0.0	-0.5	-0.4	0.0	-1.1	-2.5
75	-0.35	-0.65	-0.45	-0.25	-0.85	-1.15	-0.25	-1.75	-3.45
	Annual								
25	0.15	0.21	0.44	0.26	-0.12	0.07	0.12	-0.44	-1.94
50	-0.1	-0.2	-0.1	0.1	-0.6	-0.6	-0.1	-1.2	-2.9
75	-0.26	-0.64	-0.33	-0.22	-0.92	-1.26	-0.24	-1.44	-3.25

Even considering the uncertainties in climate modelling, the climate changes that may affect Project operations are considered better represented in the response to Conformity SIR#25 than they are here. However, for information purposes , province-wide change predictions for changes in precipitation (Table ECCC 2-3) and snow depth (Table ECCC 2-4) are provided.

Median and 75th percentile precipitation (Table ECCC 2-3) increases compared to the base period (1986-2005) in all emission scenarios and all time periods. Table ECCC 2-3 does not have an exact counterpart to the information provided in response to Conformity SIR#25. Nonetheless Table A25-9 indicates that median predicted precipitation at the two model grid points nearest the Project decreases in all time periods and all emission scenarios.

Province-wide winter snow depth changes (Table ECCC 2-4) show little change for 25th and 75th percentile predictions, but a substantial reduction in median depths. Snow depth reductions are generally larger with time and for high-emission scenarios.

The implication from these comparisons is that site-specific predictions offer insights that are not available from province-wide averages. A consideration of the predictions offered in response to Conformity SIR#25 is taken to provide the best currently available indications of future climate on which to base Project planning.

Table ECCC 2-3 Alberta averaged precipitation change (%)

	RCP2.6			RCP4.5			RCP8.5		
Percentile	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100
	Winter								
25	-1.8	2.5	2.0	0.6	5.7	5.7	0.2	5.2	12.2
50	3.1	6.7	7.9	5.9	10.8	11.6	4.3	10.8	20.4
75	9.9	13.1	12.6	10.8	15.2	17.6	8.7	17.9	28.8
	Summer								
25	0.8	0.9	0.8	0.9	1.5	1.8	1.1	2.3	4.4
50	1.1	1.5	1.4	1.1	2.2	2.7	1.4	3.2	5.9
75	1.4	2.1	2.1	1.4	2.6	3.5	1.6	3.8	6.8
	Annual								
25	-2.9	-1.4	-0.3	-3.5	-4.2	-2.9	-5.1	-3.4	-7.8
50	3.3	4.4	5.9	2.3	2.3	4.1	1.7	2.8	2.4
75	9.1	10.0	12.0	8.4	8.4	10.9	8.0	9.2	12.9

Table ECCC 2-4 Alberta averaged snow depth change (cm)

	RCP2.6			RCP4.5			RCP8.5		
Percentile	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100
	Winter								
25	-0.101	-0.158	-0.174	-0.097	-0.185	-0.244	-0.121	-0.259	-0.431
50	-2.098	-3.459	-4.074	-2.080	-4.712	-6.463	-3.170	-6.214	-10.664
75	-0.005	-0.014	-0.017	-0.005	-0.023	-0.036	-0.011	-0.038	-0.078
	Summer								
25	-0.021	-0.027	-0.029	-0.018	-0.029	-0.031	-0.018	-0.029	-0.031
50	0.000	0.000	-0.001	0.000	-0.001	-0.001	0.000	-0.001	-0.001

Table ECCC 2-4 Alberta averaged snow depth change (cm)

	RCP2.6			RCP4.5			RCP8.5		
Percentile	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100	2016-2035	2046-2065	2081-2100
75	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
	Annual								
25	-1.313	-1.793	-1.655	-1.268	-2.022	-2.603	-1.617	-2.446	-3.919
50	-1.309	-1.853	-2.016	-1.198	-2.505	-3.216	-1.744	-3.231	-5.325
75	-0.356	-0.470	-0.561	-0.212	-0.894	-1.079	-0.426	-1.010	-1.784

3. Methodology for Estimating Future Changes in Evaporation

EIS Guideline, Section 6.6.2 – Effects of the Environment on the Project, Page 35

FRT Conformity SIR, Round 2 (December 05, 2016), # 25 - Extreme Weather Events and Climate Change

Benga Mining, Conformity SIR Response, Attachment 2, Page 2-96 to 2-114; Appendix 25, Page 25A-4 to 25A-5

In Table 25-4 and Table 25-5, Benga Mining indicates that the evaporation rate for the area may increase 0-5%. The methods used to calculate this projected value are not detailed and are given only for the future period of 2016-2035. The magnitude of projected climate warming increases towards the end of the century and the other projections provided by Benga Mining extend to the 2050s (Benga Mining indicates that final closure of the Project is expected in ~2055, p.2-90).

a) Provide information on the methodology used to estimate future changes in evaporation including uncertainty for the anticipated duration of all phases of the Project and the post-closure period.

Response:

The predicted range of evaporation change – 0 to 5% - for the 2016-2035 period, relative to 1986–2005, was taken from the CMIP5 multi-model ensemble (using 40 models) under RCP4.5 as presented in Figure 11.14 in Kirtman *et al* (2013).

The following approach is used to estimate changes in other time periods, and to confirm the Kirtman *et al* (2013) predictions:

- Use the projected changes in annual mean temperature in Table A25-2
- Note that evaporation rates in global warming simulations increase at 1 to 3%/◦K (Lu and Ming 2009).

Table ECCC 3-1 summarizes the predictions for the model time periods considered in A25-2, for the high and low evaporation rate increases of 1%/◦K and 3%/◦K, and shows that evaporation increases as temperature increases with time within emission scenarios and with higher emission

scenarios. The predictions using the approach of Lu and Ming (2009) are consistent with the values provided in Table 25-4, *i.e.*, a range of 0-5% change in the 2016-2035 period. In the post closure period under RCP4.5, evaporation changes are expected to be 2-7% higher than the base period.

Table ECCC 3-1 also provides information on uncertainty, in terms of the effects of emission scenario and the evaporation rates as a function of temperature. It also provides predictions of the 25th and 75th percentile changes in evaporation, in addition to median changes.

Table ECCC 3-1 Change in Projected Annual Evaporation (% Change from 1986-2005) for Three Time Periods

	CMIP5 Scenario		**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**
	Mean temperature change (Table A25-2)									
	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
	Change in Evaporation (%)									
1%	Median	1.1	1.4	1.6	1.2	1.7	2.3	1.3	2.0	2.9
3%	Median	3.4	4.2	4.9	3.5	5.0	6.8	3.9	6.0	8.7
1%	25th	1.0	1.3	1.5	1.1	1.6	2.1	1.1	1.9	2.8
3%	25th	2.9	3.9	4.6	3.2	4.7	6.2	3.4	5.6	8.3
1%	75th	1.2	1.5	1.8	1.2	1.8	2.3	1.5	2.2	3.2
3%	75th	3.7	4.4	5.3	3.5	5.3	7.0	4.4	6.5	9.5

Data source: 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.

References

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.

Lu, J., and M.Cai, 2009: Stabilization of the atmospheric boundary layer and the muted global hydrological cycle response to global warming. J. Hydrometeor, **10**, 347-352, doi: 10.1175/2008JHM1058.1.

4. Effects of Extreme Flows on Hydrological Modelling

EIS Guideline, Section 6.2.2 – Predicted Changes to Ground Water and Surface Water, Page 28

EIS Guideline, Section 6.6.2 – Effects of the Environment on the Project, Page 35

Revised EIS, Appendix 10B, Section3.3.2 – Model Description-Scenarios, Page 12

Addendum to EIS, Consultant Report #6, Section 4.2.2 - Secondary Effect Pathways, Page 51

Hydrologic information presented in the consultant report and EIS derives from monthly flows; the model used a daily time step and results were reported as monthly averages. The consultant used three scenarios to capture uncertainty and provide a range of potential outcomes. The scenarios involved using average hydrological conditions (Scenarios 1 and 3) or a distribution of the total annual precipitation with monthly probability distributions downscaled to daily time steps (Scenario 2). Hydrological input into the scenarios is uncertain because it pertains to ungauged portions of the Crowsnest River watershed. The EIS notes that the Base Case (Scenario 1) provides an "order-of- magnitude estimate".

There is uncertainty that the extreme flow events are accounted for. In addition, using monthly flow averages may not necessarily reflect flow conditions occurring over shorter time periods (e.g. daily, weekly).

a) Provide a rationale for the selection of the hydrological model and time step used to simulate runoff/water balance used for the water quality modelling.

Response:

The water balance model for the Grassy Project was developed to evaluate potential effects of the Project on the water balances of the project area and downstream creeks on a monthly timescale. The use of a monthly timestep means that the water and load balance assessment evaluates effects on over longer averaging periods rather than complex interactions at higher temporal or spatial resolution.

The relatively coarse resolution of the water and load balance assessment was defined intentionally to evaluate potential changes to a system as opposed to characterizing the full range of flow and water quality conditions that could be encountered in the receiving environment, now and in the future. Potential changes were evaluated by keeping all hydrological variables constant except for the attributes of the system that are known to change, such as catchment boundaries and land use.

For example, development of the mine will necessitate diversion of surface runoff away from Blairmore Creek and into the sedimentation or surge ponds. The effect of this is modelled by removing a portion of the surface flow contribution to the creek. According to the model, a 20% reduction in catchment area would cause a 20% reduction in flow on a monthly basis. Because of the monthly temporal resolution, any complexities associated with orographic effects, aspect, land cover/evapotranspiration, local infiltration and groundwater discharge, time of concentration, etc. are assumed to be constant across each subcatchment.

Evaluation of individual hydrological variables require a watershed model, which operate on timescales of hours or days and relies on meteorological data (historical or synthetic), land cover data, topography and other inputs to parameterize various hydrological processes. Watershed models evaluate watershed characteristics at a greater level of temporal and spatial resolution but also introduce uncertainties with every term included in the model. In watershed models, each hydrological process is characterized by mathematical relationships and adjusted by selecting input parameters to match specific catchment characteristics. In most instances, the different input parameters have to be assumed. Therefore, although watershed models are more complex, the added complexity does not necessarily translate to improved accuracy of model predictions. Typically, complex watershed models require a substantial body of monitoring data collected over several years to allow for meaningful model calibration.

In the absence of monitoring data sufficient for calibration, the results of a watershed model could be expressed as ranges of flow (and flow changes) commensurate with the model uncertainty. However, expressing results as potential ranges of outcomes still does not provide any information on the probability distribution of the outcome within those ranges. Results of watershed models are often presented at face value with little no information concerning uncertainty, which infers a level of precision that is not warranted or supported by the model inputs or conceptual model.

The hydrological model used for the Grassy Project brings the water balance evaluation back to a more conceptual level where general water balance changes can be evaluated. For example, the conceptual model that a 20% reduction in catchment area causes a 20% reduction in flow on a monthly basis is a reflection of the order-of-magnitude of the potential change as a central tendency.

5. Impacts of Extreme Weather on Water Management Ponds

EIS Guideline, Section 6.2.2 – Predicted Changes to Ground Water and Surface Water, Page 28

Revised EIS, Volume 1, Section C.5.4 - Licencing and Water Transfer Options, Page 98; Section C.5.5 -Management Structure Design Specifications, Page 101

Benga Mining provides details on the water management plans, and specifications for the water management structures, which have been designed based on predicted estimates of the inflow design flood. The structures include surge ponds which will collect selenium-affected water, sediment ponds for treatment for suspended solids, and the raw water/southeast ponds which will capture water from the south rock disposal area. Water from the surge ponds will require additional management that includes storage and transfer to saturated zones for selenium attenuation. Effective treatment will rely on adequate retention time in the saturated zones, which could be affected by retention time in the surge ponds.

a) Provide information on how hydrological extremes were considered in the design/management of the sediment, surge and raw water ponds.

Response:

The Project's water management ponds were designed to satisfy both environmental and dam integrity requirements under extreme weather conditions up to the precipitation design events. The following two requirements are satisfied:

- **Environmental performance**: the environmental performance is set to limit the likelihood of discharging of off-spec water to the downstream watercourses. The general practice for the sedimentation ponds (*i.e.* ponds that only remove Total Suspended Solids (TSS)) is to design ponds to operate and remove TSS up to a 10-year 24-hour event to the level suggested by Alberta Energy Regulator (AER 2014). For water impoundments that are subject to other types of contaminations, such as ponds with potential selenium contamination, a more stringent environmental requirement is used. For these type of impoundments, the design for environmental protection is based on a 100-year 24-hour precipitation event.
- **Structural integrity**: Canadian Dam Association (CDA) guidelines (CDA 2007, 2013) and Technical Bulletin (CDA, 2014) are used to ensure structural integrity of the dams with extreme precipitation up to the design event. The CDA guidelines are used to estimate required impoundment and discharge (*i.e.* spillway) capacities. The inflow design flood (IDF) depends on the dam consequence of failure. According to the CDA, dams must either be able to completely store the IDF volume, have a spillway designed to pass the peak rate of IDF or use a combination of flood storage and passage. Flood events typically range from 100-year to probable maximum events.

Table ECCC 5-1 presents a summary of environmental and dam integrity requirements that are used in the design of dams for the Project.

Table ECCC5-1 Summary of Design Criteria for Surge Ponds, Sediment Ponds and Raw Water Pond for Grassy Mountain Coal Project

Dam/Pond	Dam Integrity Requirements		Environmental Design Flood
	Dam Class	Design Flood Annual Evidence Probability	
East Sediment Pond	Very High	2/3 between 1000-year and PMF	10-year
Northeast Sediment Pond	Very High	2/3 between 1000-year and PMF	10-year
West Sediment Pond	Significant	Between 100-year and 1000-year	10-year
Site Sediment Pond	Low	1 in 100-year	10-year
Northwest Surge Pond	Significant	Between 100-year and 1000-year	100-year
Raw Water Pond	High	1/3 between 1000-year and PMF	100-year
Southeast Surge Pond	Very High	2/3 between 1000-year and PMF	100-year
Southwest Surge Pond	Low	1 in 100-year	100-year

To size the surge ponds and raw water pond following considerations were made:

- Clear water depth: minimum 3 m clear water depth to allow pumping.
- Operational flexibility: a minimum 1.5 m depth above the lowest basin level.
- No release level: spillway at level to allow 1 in 100-year flood full storage above maximum operational pond level.
- Spillway size: to pass the maximum peak flow rates as CDA guidelines.
- Freeboard: minimum 1 m freeboard above maximum allowable pond level.

Figure 5-1 presents a simplified section summarizing the design approach for surge ponds and the Raw Water Pond.

To size the sediment ponds following considerations were made:

- Sediment storage: volume equal to 50% of the 1 in 10-year flood volume.
- Clear water depth: minimum 1.5 m clear water depth above sediment level
- Permanent pond: controlled by the drain pipe level on the dam, permanent pond is sized to capture sediments in normal rainstorm conditions
- No uncontrolled release level: spillway at level to allow 1 in 10-year flood storage above permanent pond level
- Spillway size: to pass the maximum peak flow rates as CDA guidelines
- Freeboard: minimum 1 m freeboard above maximum allowable pond level

Figure 5-2 presents a simplified section summarizing the design approach for sediment ponds.

References:

Canadian Dam Association, 2014. Application of Dam Safety Guidelines to Mining Dams; Technical Bulletin; Canadian Dam Association, Edmonton, AB.

Canadian Dam Association, 2013. Dam Safety Guidelines – 2013 edition; Canadian Dam Association, Edmonton, AB.

Canadian Dam Association, 2007. Dam Safety Guidelines; Canadian Dam Association, Edmonton, AB.

Alberta Energy Regulatory, 2015. Alberta Coal Mining Wastewater Guidelines. March 2014.

BC Ministry of Environment, 2015. Technical Guidance 7, Environmental Management Act – Assessing the Design, Size, and Operation of Sediment Ponds Used in mining. December 2015.

6. Impacts of Ice on Hydrological Curves

EIS Guideline, Section 6.2.2 – Predicted Changes to Ground Water and Surface Water, Page 28

Revised EIS, Consultant Report #4, Section 3.2 - Local Data, Page 16; Section 3.4 - Tributaries and Headwaters, Page 19

Benga Mining has developed flow rating curves, and acknowledges uncertainty in the preliminary rating curves and inaccuracies at the upper range of estimation due to extrapolation above the measured range. This uncertainty is to be improved by ongoing hydrological data collection. One aspect that has not been addressed is that their approach seems to have ignored potentially significant ice effects, which may affect Benga Mining's calculated low winter flows significantly.

a) Discuss how the presence of ice may influence the flow rating curves that have been developed for various local (ungauged) stations.

Response:

During winter, ice-free conditions have been observed more often on Gold Creek (station GC-01) than along the length of Blairmore Creek due to the influence of groundwater contributions from Caudron Creek which maintains higher unit runoff and water temperatures during winter. At least ten water level and discharge measurements, distributed across a range of flows, are typically required to create a reliable rating curve (BC MOE 2009). Rating curves that are developed with fewer points, or with measurements across a narrow range of flows, should be interpreted with caution due to the limited information available to validate the curve.

A reliable stage-discharge relationship does not exist under ice-affected conditions, since ice cover introduces temporary channel cross-section changes leading to effects such as backwater and reductions in surface flow velocity and effective flow area. Project rating curves were developed from open-water stage-discharge measurements and were refined as more data became available throughout the period of baseline monitoring. Available winter stage-discharge measurements were added to the provisional rating curves, to which rating curve shifts were applied so that estimated flow hydrographs during winter better matched available flow measurements (*i.e.*, than if the open-water curves were applied without shift corrections). Flows affected by severe backwater (stage increases due to ice-jams) were removed until more information became available throughout the baseline period. Provisional grading of streamflow data was applied following recommended flagging procedures (*e.g.*, periods when flows were potentially affected by ice/backwater graded as 'B', or when flows were greater than two times the highest manual flow measurement or less than half of the lowest manual flow measurement graded as 'E').

A more recent update to the local streamflow data (including daily flows, rating curves etc) was provided in CR#6 Appendix A1 for the purpose of running the Project Instream Flow Assessment (as part of the Aquatic Ecology Effects Assessment, submitted January 31, 2017 subsequent to the initial hydrology baseline). This empirical hydrology baseline document outlines not only the extended dataset, but in greater details the hydrometric data production process and a qualitative assessment of each rating curve (*e.g.*, based on the number of measurements used in development of the curve, the fit of measurements to the curve, and the range of discharges covered by the measurements).

7. Gaps in Streamflow Data

EIS Guideline, Section 6.1.4 – Project Setting and Baseline Conditions, Ground Water and Surface Water, Page 23

Revised EIS, Consultant Report #4, Section 3.2 - Local Data, Page 16; Section 3.3 - Regional Data, Page 19

Benga Mining states that: "Hydrological analysis for the Project, such as runoff, baseflow and low flow within the mine project area were assessed using flows from the local gauging stations coupled with long-term regional records. Analysis of the relationship between the short-term datasets collected on site and the long term Crowsnest River at Frank station was used to validate the correlation between stream flow on the Project Site and regional stream flow." Benga Mining provides a summary of local streamflow data for the eight local gauging stations along the Crowsnest River, Blairmore Creek, Gold Creek, and two unnamed creeks (Table 8). The records of these stations are very short (started in 2013 or 2014). Regional streamflow data were available from Water Survey of Canada (WSC) records for eight stations in the area, with missing data patched using available data from the closest stations. Table 10 (page 19) lists the regional gauge stations.

a) Present regression graphs relating sporadically-measured local station flows to regional flows that are archived by WSC for the Crowsnest River and Gold Creek near Frank. Include respective correlation coefficients and 95% confidence intervals.

Response

The local station flows were compared with same-day regional station flows in a Pearson Correlation matrix, as shown in Figure 7-1. All comparisons present a Pearson correlation value of 0.70 or greater. This is sufficient to assume that the regional stations have similar seasonal and annual flow behavior as the local gauges.

Local streamflow data are also plotted against the regional station flows, in units of L/s/km^2, in Figure 7-2 and Figure 7-3, for Crowsnest River and Gold Creek, respectively. The 95% confidence interval bands are presented as grey bands along with the linear regression line

b) Provide correct gauge ID numbers in Table 10 (Column 1).

Response:

The correct gauge identification numbers for each regional station are presented in Table ECCC 7-1.

Table ECCC7-1 Corrected Gauging station identification numbers, Water Survey of Canada

Gauge ID	Regional Gauge Station
05AA030	GOLD CREEK NEAR FRANK
05AA008	CROWSNEST RIVER AT FRANK

Table ECCC7-1 Corrected Gauging station identification numbers, Water Survey of Canada	
Gauge ID	**Regional Gauge Station**
05AA027	RACEHORSE CREEK NEAR THE MOUTH
05AA023	OLDMAN RIVER NEAR WALDRON'S CORNER
08NK019	GRAVE CREEK AT THE MOUTH
08NK022	LINE CREEK AT THE MOUTH
08NK018	FORDING RIVER AT THE MOUTH
05BL022	CATARACT CREEK NEAR FORESTRY ROAD

8. Uncertainty Associated with Flow Estimates

EIS Guideline, Section 6.2.2 – Predicted Changes to Ground Water and Surface Water, Page 28

Revised EIS, Consultant Report #4, Sections 3.6-Base Flow, Page 22; Section 3.7 - Low Flows Analysis, Page 23; Section 3.8 - Peak Flow Analysis, Pages 23; Section 5.2 - Streamflow Changes, Page 26

Benga provides an analysis of the base, low and peak flows, and of the potential changes to stream flows along Gold and Blairmore creeks based on a number of assumptions.

a) Discuss and quantify the uncertainty associated with estimates of base, low, and peak flows described in sections 3.6, 3.7, and 3.8, respectively (for example, within a factor of 2, a factor of 5, 10, other?).

Response:

Baseflows

Baseflow were defined with a runoff separation technique based on two parameters (Nathan and McMahon, 1990) , these two parameters were adjusted based on the best numerical representation of the observed low flows. Based on the actual methodology, there is no clear path to define uncertainty for the low flows conditions.

As the groundwater system is driven by recharge (*i.e.*, recharge from precipitation and discharges in valley creeks), the sensitivity of the groundwater model predictions (CR#3, Appendix C – Groundwater Numerical Report) to changes in baseflows were assessed through simulations of scenarios assigned with lower and higher recharge rates. The base case model considered a recharge equivalent to 28% of mean annual precipitation (MAP). The sensitivity models simulated scenarios with recharges equivalent to about 19% of MAP (*i.e.*, recharge reduced by +50%) and 42% of MAP (*i.e.*, recharge increased by +50%). This was considered to be a plausible range for the study area.

Low Flows

Uncertainty in the low flow estimations is analyzed as a reference from the results of the annual 7Q10 analysis at Crowsnest River at Frank (Consultant Report 4). In these results, the normal distribution presented the best fit to the data, and is presented as a solid black line. With the annual low flow values in Figure 8-1, based on the dry conditions, the range of interest is below the return period of 2 years; however, as a referenced, it is used the complete curve. The dashed lines present the 5th and 95th percentiles based on the actual flow values.

Uncertainty was calculated based on the variation between the 5th and 95th confidence interval curve and the Normal distribution. The variability between these two percentiles and the selected distribution ranges from -4% to +6%, as shown in Figure 8-2. Consequently, low flows can be expected to have a variability of plus or minus 5%.

Peak Flows:

Unit peak flows were generated from regional analysis using the index flood method as presented in Hydrology Baseline (SRK, 2015).

Uncertainty associated with the unit peak flows was considered by selecting the regional station with the highest unit peak flow (Cabin Creek Near the Mouth - 08NP004, red dot in the center of the Figure 8-3), which was the pivot point/station to define the envelope curve for the index flood method regression. From the mean annual runoff analysis, additional stations were added to properly interpret the peak flows at the site.

The best fit distribution to the annual maximum unit peak flows at station Cabin Creek Near the Mouth - 08NP004 was the Log Normal distribution. Similarly, to the low flow analysis, the 5th and 95th distribution results were plotted with the Log Normal distribution to assess variability. Figure 8-30-2 presents the Log Normal distribution with the 5th and 95th percentile confidence bands, along with annual maximum unit peak flows for the complete period of record.

Uncertainty was calculated based on the variation between the 5th and 95th percentile curve and the Normal distribution curve. The variability between these two percentiles and the selected distribution ranges from -12% to +18%, as shown in Figure 8-4. Based on this assessment, the peak flow should have a variability of +/- 15%.

b) Discuss and quantify the uncertainty associated with estimates of streamflow changes presented in Section 5.

Response:

Uncertainty associated to the streamflows are related with the uncertainty of the rating curves as well as the relationships between the local and regional flows, further refinement and broader understanding of flow uncertainty will occur during construction and operation monitoring.

9. Effects of Flow Changes on Sediment Transport Modelling

EIS Guideline, Section 6.3.1 – Predicted Effects on Valued Components, Fish and Fish Habitat, Page 29

Revised EIS, Consultant Report #4, Section 3.9- Sediment Concentrations, Page 24

Benga provides a discussion of the suspended sediment transport in Gold and Blairmore creeks, and in the Crowsnest River at Frank, and states that uncertainties exist, particularly with respect to flows and sediment regimes for Gold and Blairmore creeks.

a) Discuss implications of uncertainties in estimates of flow and flow changes to sediment transport modelling, as well as to water quality and instream flow needs.

Response:

Based on the information collected at Crowsnest River at Frank gauging station, there is a tendency for higher amount of sediment in suspension with increased streamflow. Average monthly concentration of suspended sediment is plotted against associated monthly streamflow in Figure 9-1, where the grey band represent the 95% confidence interval.

Uncertainty associated with the estimation of suspended sediment based on streamflow is high, and with available information cannot been clearly defined. From the available information, a typical proportional relationship can be established between suspended sediment and surface flow.

10. Canadian Ambient Air Quality Standards for Nitrogen Dioxide (NO2)

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1a, Section 2.4.1 - Ambient Air Quality Objectives and Guidelines, page 9

Revised EIS, Consultant Report #1b, Section 6.0 – Dispersion Model Prediction, Page 6

On November 3, 2017, the CCME established Canadian Ambient Air Quality Standards (CAAQS) for NO2. The Federal Government has formally established the CAAQS for NO2 through publication on the Canada Gazette using the authority of the Canadian Environmental Protection Act, 1999.

The CAAQS for NO2, as announced and agreed, are more stringent than the objectives/standards used for the EIS submission and the Air Quality Assessment in Consultant Report #1a and #1b. The CAAQS were developed for the purpose of protection human health and the environment. They are supported by air quality management levels, which call for progressively more rigorous actions by jurisdictions as air quality approaches or exceeds the CAAQS; thereby ensuring that the CAAQS are not treated as “pollute-up-to” levels.

Reference:

Canadian Council of Ministers. (2017). *Current Priorities: Canadian Ambient Air Quality Standards*. Retrieved January 24, 2018, from Canadian Council of Ministers:

http://www.ccme.ca/en/current_priorities/air/caaqs.html

a) Assess the potential for the Project to contribute to ambient concentrations of NO2 that exceed the 1-hour and annual CAAQS.

Response:

Table ECCC 10-1 outlines the new CAAQS for NO_2 that were endorsed by CCME on November 3, 2017. One hour NO_2 concentrations should be based on the 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations and annual concentrations should be based on annual average of all 1-hour concentrations over one year. The conversion used from ppb to µg/m^3 assumes an ambient pressure of 1 atmosphere and a temperature of 25 degrees Celsius.

CCME (2012) indicates the CAAQS are not intended to be used for fence line reporting. These standards will be used to characterize air quality and potential air quality impacts in areas where people live or where other sensitive receptors are likely to be found. Guidance from the Alberta Environment and Parks (AEP) also suggests the new CAAQS are to be used for management and/or monitoring, not for predictive modeling.

Table ECCC10-1 NO_2 CAAQS for 2020 and 2025

Averaging Period	2020 CAAQS	2025 CAAQS
1 - hour NO_2	60 ppb (~ 113 µg/m^3)	42 ppb (~ 79 µg/m^3)
Annual NO_2	17 ppb (~ 32 µg/m^3)	12 ppb (~ 23 µg/m^3)

Source: https://www.ccme.ca/en/current_priorities/air/caaqs.html

Table ECCC 10-2 compares model predictions for NO_2 (when the OLM is used to convert NOx predictions to NO_2) to the CAAQS 2025 standards. Predictions are included at the MPOI and MPB where access is restricted, but these values are not compared to the CAAQS. The table indicates:

- Exceedances of the 2025 CAAQS were predicted at the special receptors for both Baseline and Application cases.
- The prediction at the special receptor maximum does not change with the addition of the Project.
- The maximum frequency of NO_2 hourly exceedance was predicted to occur 5.3% of the time in the 5-year period at Blairmore as a result of emissions from the community and highway. At that location, the Project contribution to the NO_2 hourly exceedance was negligible.

The 1-hour daily peak NO_2 ground-level concentrations and Project contribution for all special receptors in or near communities (Blairmore, Coleman and Frank) are presented in Table ECCC 10-3. The table indicates the Project contribution to the model-predicted NO_2 hourly exceedances in those communities was negligible.

Table ECCC 10-2 Summary of Predicted NO_2 Concentrations					
NO_2	**Project Only ($\mu g/m^3$)**	**Background ($\mu g/m^3$)**	**Baseline ($\mu g/m^3$)**	**Application ($\mu g/m^3$)**	**2025 CAAQS ($\mu g/m^3$)**
98th Percentile Daily Peak 1-hour Concentration[(a)]					
Overall Maximum (MPOI)	274	24	110	278	-
Mine Permit Boundary Maximum	104	24	59	107	-
Special Receptor Maximum	86	24	106	106	79
Annual Concentration[(b)]					
Overall Maximum (MPOI)	34	11	46	47	-
Mine Permit Boundary Maximum	12	11	20	28	-
Special Receptor Maximum	13	11	43	43	23

[(a)] The 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations.
[(b)] The average over a single calendar year of all 1-hour average SO_2 concentrations

Table ECCC10-3 Summary of Predicted 98th Percentile Daily Peak 1-hour NO_2 Concentrations at Special Receptors at Communities					
NO_2	**Baseline ($\mu g/m^3$)**	**Application ($\mu g/m^3$)**	**2025 CAAQS ($\mu g/m^3$)**	**Exceedance Frequency**	**Project Contribution**
98th Percentile Daily Peak 1-hour Concentration[(a)]					
R1-Campground	86	86	79	0.7%	0%
R3-Residential #1	88	88	79	0.6%	0%
R6-Coleman	95	95	79	2.8%	0%
R7-Frank	85	85	79	0.6%	0%
R8-Blairmore North	106	106	79	5.3%	0%
R14-Blairmore Center	92	92	79	1.7%	0%

[(a)] The 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations.

b) Provide a comparison of modelled ambient concentrations of NO2 in the local and regional study areas, assessing the locations and frequency of exceedance.

Response:

Please see response ECCC SIR 10(a).

c) If the annual or 1-hour CAAQS are exceeded, what additional mitigation measures would be employed in order to reduce ambient NO2 concentrations?

For predicted NO_2 exceedances of CAAQS at communities, no additional mitigation measures are planned beyond those presented in CR#1 Section 6.6, as the Project contribution at these locations was negligible.

More generally, predicted 1-hour concentrations of NO_2 are driven by methods used to estimate emissions from, and modelling concentrations due to, blasting. Benga will investigate alternative ANFO formulations that reduce NOx emissions during blasting.

The highest annual average NO_2 predictions, in both Baseline and Application scenarios, occur in Blairmore near Highway 3. At this location, the effect of the Project is negligible.

References

CCME. 2012. GUIDANCE DOCUMENT ON ACHIEVEMENT DETERMINATION CANADIAN AMBIENT AIR QUALITY STANDARDS FOR FINE PARTICULATE MATTER AND OZONE. https://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf. 43 pp.

11. Canadian Ambient Air Quality Standards for Sulphur Dioxide (SO2) and Fine Particulate Matter (PM2.5)

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1a, Section 2.4.1 - Ambient Air Quality Objectives and Guidelines, page 9

Revised EIS, Consultant Report #1b, Section 6.0 – Dispersion Model Prediction, Page 6

Benga Mining cited only the Alberta Ambient Air Quality Objectives (AAAQO) and not the CAAQS in their air quality criteria for SO2. CCME endorsed the CAAQS for SO2 in October 2016. The annual CAAQS for SO2 (4.0 ppb in 2025) is more stringent than the equivalent annual AAAQO (8.0 ppb) which was used in Benga Mining's assessment. Furthermore, the hourly CAAQS cannot be directly compared to the hourly AAAQO for SO2 as the standards are not equivalent statistically.

In addition, while Benga Mining considered the CAAQS for PM2.5 in their assessment, the 2015 standards were employed. As the mine life is 23 years, the more stringent 2020 standards should be considered. A comparison of 2015 and 2020 standards is shown below:

CAAQS "Red" Management Level	2015	2020
Annual	10 µg/m^3	8.8 µg/m^3
24-hour	28 µg/m^3	27 µg/m^3

Reference:

Department of Environment & Department of Health. (2017, October 28). *Canadian*

Ambient Air Quality Standards for sulphur dioxide. Accessed January 24, 2018, from http://www.gazette.gc.ca/rp-pr/p1/2017/2017-10-28/html/notice-avis-eng.html#na3

a) If the CAAQS are exceeded, what additional mitigation measures would be employed in order to reduce ambient SO_2 or $PM_{2.5}$ concentrations?

Response:

Table ECCC 11-1 outlines the new CAAQS for SO_2 that were endorsed by CCME on October 3, 2016. One-hour SO_2 concentrations should be based the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations and annual concentrations should be based on annual average of all 1-hour concentrations over one year. The conversion used from ppb to µg/m^3 assumes an ambient pressure of 1 atmosphere and a temperature of 25 degrees Celsius.

Table ECCC11-1 SO_2 CAAQS for 2020 and 2025

Averaging Period	2020 CAAQS	2025 CAAQS
1-hour SO_2	70 ppb (~ 183 µg/m^3)	65 ppb (~ 170 µg/m^3)
Annual SO_2	5.0 ppb (~ 13 µg/m^3)	4.0 ppb (~ 10.5 µg/m^3)

CCME (2012) indicates the CAAQS are not intended to be used for maximum point of impingement or fenceline reporting for industrial facilities. These standards will be used to characterize air quality and potential air quality impacts in areas where people live or where other sensitive receptors are likely to be found. Guidance from the Alberta Environment and Parks (AEP) also suggests the new CAAQS are to be used for management and/or monitoring, not for predictive modeling.

Model predictions for SO_2 from Benga Mining's assessment are listed in Table ECCC 11-2 and are compared to the CAAQS 2025 standards. Predictions are included at the MPOI and MPB where access is restricted, but these values are not compared to the CAAQS. The table indicates that no exceedances of the 2025 CAAQS were predicted for any averaging period or emission scenario at any locations.

Table ECCC 11-2 Summary of Predicted SO_2 Concentrations

SO_2	Project Only (µg/m^3)	Background (µg/m^3)	Baseline (µg/m^3)	Application (µg/m^3)	2025 CAAQS (µg/m^3)
99th Percentile Daily Peak 1-hour Concentration[(a)]					
Overall Maximum (MPOI)	41	2.6	8.2	44	-
Mine Permit Boundary Maximum	4.8	2.6	2.8	7.4	-
Special Receptor Maximum	2.7	2.6	7.6	7.6	170

Table ECCC 11-2 Summary of Predicted SO_2 Concentrations					
SO_2	**Project Only ($\mu g/m^3$)**	**Background ($\mu g/m^3$)**	**Baseline ($\mu g/m^3$)**	**Application ($\mu g/m^3$)**	**2025 CAAQS ($\mu g/m^3$)**
Annual Concentration[(b)]					
Overall Maximum (MPOI)	0.3	0.9	1.8	1.8	-
Mine Permit Boundary Maximum	0.05	0.9	0.9	0.9	-
Special Receptor Maximum	0.05	0.9	1.6	1.6	10.5

[(a)] The 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations.
[(b)] The average over a single calendar year of all 1-hour average SO_2 concentrations

The CALPUFF modelling predictions for $PM_{2.5}$ are listed in Table ECCC 11-3 and are compared to the CAAQS 2020 standards. The table indicates that no exceedances of the 2020 CAAQS were predicted for any averaging period or emission scenario at any special receptors. Also, the Project contributions at these locations were negligible.

Based on above, no additional mitigation measures would be employed for SO_2 and $PM_{2.5}$ beyond those identified in CR#1 Section 6.6.

Table ECCC 11-3 Summary of Predicted $PM_{2.5}$ Concentrations					
$PM_{2.5}$	**Project Only ($\mu g/m^3$)**	**Background ($\mu g/m^3$)**	**Baseline ($\mu g/m^3$)**	**Application ($\mu g/m^3$)**	**2020 CAAQS ($\mu g/m^3$)**
98th Percentile 24-hour Concentration[(a)]					
Overall Maximum (MPOI)	24	6.8	20	31	-
Mine Permit Boundary Maximum	5.8	6.8	7.7	13	-
Special Receptor Maximum	3.1	6.8	18	18	27
Annual Concentration[(b)]					
Overall Maximum (MPOI)	7.2	4.0	9.0	11	-
Mine Permit Boundary Maximum	0.9	4.0	4.3	5.0	-
Special Receptor Maximum	1.1	4.0	8.1	8.2	8.8

[(a)] The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
[(b)] The 3-year average of the annual average of all 1-hour concentrations

References

CCME. 2012. GUIDANCE DOCUMENT ON ACHIEVEMENT DETERMINATION CANADIAN AMBIENT AIR QUALITY STANDARDS FOR FINE PARTICULATE MATTER AND OZONE. https://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf. 43 pp.

12. Adequacy Modelling Inputs

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28; Section 6.4 – Mitigation, Page 32

Benga Mining, Conformity IR Responses, Attachment 2, Section 3 - Atmospheric Environment, Page 2-6

ECCC acknowledges the data provided by Benga Mining that shows an average of approximately 80% reduction in PM2.5 emissions (Table 3-1). These studies show that an average control efficiency of 80% is achievable with appropriate mitigation measures. However at this level of mitigation, actual control efficiency (CE) will vary both above and below this average throughout the year. Benga Mining's use of 80% CE was applied to modelled haul road emissions to determine predicted particulate matter concentrations for hourly concentrations. In each year, there will be numerous hours where mitigation below 80% is achieved, and these can coincide with environmental conditions which lead to more haul road dust emissions (warm, dry, and windy). As a result, Benga Mining's use of 80% CE may lead to an underestimation of PM concentrations on an hourly basis.

ECCC reiterates that use of an 80% CE in the model requires the assumption that this level of mitigation is achieved at a minimum, throughout the year. The Canadian Ambient Air Quality Standard (CAAQS) for PM2.5 (24 hour) is based on the 98th percentile of 24 hour averages of 1-hour concentrations. This metric is sensitive to short term high-concentration events, which may occur when dust mitigation effectiveness is low.

a) Provide information on whether use of an average 80% CE for haul road dust emissions is adequately conservative, or whether a lower CE is needed for this source in the model inputs.

Response

Benga believes that use of an average control efficiency of 80% is achievable based on a review of literature provided in CR#1 and the IR responses. Furthermore, this level of control efficiency is most needed during conditions most conducive to high predicted dust concentrations. These conditions usually occur in light wind, stable, low mixing-height conditions which occur most often in evenings and during winter. Watering is expected to be effective longer in light winds, but light winds would not influence other chemical suppressants.

In addition, Environment Canada guidance on estimating road dust emissions from industrial unpaved surfaces (Environment Canada, 2012) suggests that there should be no dust emissions on days with precipitation higher than 0.2 mm and on days with snow depth 1 cm or greater or days where ground was frozen. This guidance indicates that: "Frozen ground minimizes the breakdown of the travel surface leaving less material to be entrained in the air as vehicles pass". Using a 90% suppression efficiency throughout the winter, instead of 100% efficiency as suggested by Environment Canada during days with precipitation or snow on the ground, is a reasonable assumption by this standard.

Nevertheless, Benga has sought other literature sources with lower control efficiencies. Environment Canada provided guidance to reporting road dust emission from unpaved surface and Table ECCC 12-1 lists recommended dust control efficiency (Environment Canada 2008). These efficiencies were based on US EPA AP42 Unpaved Roads -Chapter 13.2.2, and the WRAP Fugitive Dust Handbook (WRAP 2006). Table ECCC 12-1 indicates that 55% control efficiency can be achieved if a haul road is watered twice a day. Benga has indicated its dust mitigation plan includes water trucks continuously operating on haul roads.

Table ECCC 12-1 EC Recommended Dust Control Efficiencies

Dust Control Techniques	Control Efficiency (CE)
Watering twice a day	55%
Watering more than twice a day	70%
Chemical Suppressants	80%

Source: www.ec.gc.ca/INRP-NPRI/6DE7F8BC.../RoadDustCalculator_e_18_Nov_2008.xls

b) Provide an analysis of the potential for the CAAQS to be exceeded if 80% dust mitigation is not achieved.

Response:

As an exercise, particulate concentrations were modelled with a summer control efficiency of 50%. Fugitive dust emissions from the haul road with 50% CE will be 2.5 times higher than with 80% CE (the emitted portion increases from 20% to 50%). Table ECCC 12-2 compares maximum daily $PM_{2.5}$ emissions for these two scenarios. The table indicates that total $PM_{2.5}$ emissions from all Grassy Mining's activities will be 706 kg/d, increased by 119%, assuming an average 50% mitigation is achieved.

CCME (2012) indicates the CAAQS are not intended to be used for maximum point of impingement or fenceline reporting for industrial facilities. Rather, these standards will be used to characterize air quality and potential air quality impacts in areas where people live or where other sensitive receptors are likely to be found. Guidance from the Alberta Environment and Parks (AEP) also suggests the new CAAQS are to be used for management and/or monitoring, not for predictive modeling of the impacts of specific industrial facilities.

However, for the purposes of this response, the $PM_{2.5}$ modelling predictions for both scenarios are listed in Table ECCC 12-3 and compared to the CAAQS 2020 standards. The table indicates that no exceedances of the 2020 CAAQS were predicted for any averaging period or emission scenario at any special receptors in or near communities. Also, the Project contribution at these locations was negligible.

At the Grassy mine permit boundary (MPB) where CAAQS are not meant to apply, the 98th percentile 24-hour $PM_{2.5}$ prediction increases by 98% for the Project-Only case and by 45% for

the Application case when the haul road dust control efficiency is reduced from 80% to 50%. The CAAQS are not exceeded at this location under reduced control efficiencies.

Table ECCC 12-2 Maximum Daily $PM_{2.5}$ Emissions from Grassy Project Activities

Project Activity	Maximum Daily $PM_{2.5}$ Emissions (kg/d)		
	80% CE on Haul Road	50% CE on Haul Road	Emission increase %
Fugitive Dust Emissions			
Coal Mining	5.0	5.0	0
Waste Removal	21	21	0
Haul Road	256	640	150
Disposal area	7.6	7.6	0
Reclamation	2.6	2.6	0
Plant	2.7	2.7	0
Train Loadout	0.3	0.3	0
Blasting	1.1	1.1	0
Diesel Fuel Combustion			
All Activities	27	27	0
Total	323	706	119

Table ECCC 12-3 Summary of Predicted $PM_{2.5}$ Concentrations

$PM_{2.5}$	80% CE on Haul Road		50% CE on Haul Road		
	Project Only ($\mu g/m^3$)	Application ($\mu g/m^3$)	Project Only ($\mu g/m^3$)	Application ($\mu g/m^3$)	2020 CAAQS ($\mu g/m^3$)
98th Percentile 24-hour Concentration[(a)]					
Overall Maximum (MPOI)	24	31	52	58	-
Mine Permit Boundary Maximum	5.8	12.6	11.5	18.3	-
Special Receptor Maximum	3.1	18.1	6.7	18.1	27
Annual Concentration[(b)]					
Overall Maximum (MPOI)	7.2	11.2	15.7	19.7	-
Mine Permit Boundary Maximum	0.9	5.0	1.8	5.9	-
Special Receptor Maximum	1.1	8.2	2.4	8.2	8.8

[(a)] The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
[(b)] The 3-year average of the annual average of all 1-hour concentrations

References

Environment Canada. 2008. Road dust emissions from unpaved surfaces: guide to reporting. https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/road-dust-unpaved-surfaces-guide.html (see spreadsheet at: www.ec.gc.ca/INRP-NPRI/6DE7F8BC.../RoadDustCalculator_e_18_Nov_2008.xls)

Environment Canada 2012. Guidance on estimating road dust emissions from industrial unpaved surfaces: http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=5DF2CF83-1.

CCME. 2012. GUIDANCE DOCUMENT ON ACHIEVEMENT DETERMINATION CANADIAN AMBIENT AIR QUALITY STANDARDS FOR FINE PARTICULATE MATTER AND OZONE. https://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf. 43 pp.

WRAP. WRAP Fugitive Dust Handbook. http://ulpeis.anl.gov/documents/dpeis/references/pdfs/countess_environmental_2006_wrap_fugitive.pdf.

13. Accounting for Fugitive Dust

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1a, Table A4-3 - Maximum Hourly and Daily Fugitive Dust Emissions from Project Activities. Page A-17

Preamble:

Dust emissions from the loadout are estimated to be 0.3, 7.6, and 16 kg/day for PM2.5, PM10 and total suspended particulate (TSP), respectively, which classifies the loadout as a relatively minor contributor to project PM emissions. Although the loadout is enclosed, the extent to which particulate matter will escape during loading operations is not clear. A specific source of the 0.1 kg/day emission rate was not provided. Furthermore, the loading of material into the rail cars may deposit dust onto the outside of the rail cars, which can act as a source of fugitive dust once the train leaves the loadout. This pathway of particulate matter to the local area was not taken into account the EIS.

a) Provide evidence, such as studies conducted under similar loadout operations, to justify the fugitive particulate emission rates used in the model.

Response:

The planned Coalspur met coal project (Millennium 2012) included a rail loadout without partial enclosure. Dust emissions from rail car loading were reduced because of the continuous loading method which was similar to the one proposed for Grassy Mountain. At Coalspur, a chute is lowered into each car and coal drops initially from 3 m within the first 15 seconds. The coal pile in the car builds back to chute level resulting in a choke load with much-reduced emissions for

the remaining 1.8 minutes of loading. Drop heights of 1.5 m were modelled. Using this approach, dust emissions were as follows: $PM_{2.5}$ (0.025 kg/d), PM10 (0.59 kg/d) and TSP (1.5 kg/d). These emission rates were in fact lower than the fugitive dust emission rates used for the Grassy loadout, for higher clean coal production rates.

Coal dust generated from continuous coal loading systems such as that planned for Grassy can be controlled more effectively than stationary loading systems (Katestone Environmental 2014). Continuous train loading systems can be located in the open air, within sheds or enclosed buildings. The Australian National Pollution Inventory (NPI 2012) emissions estimation manual identified a 70% control efficiency for loading of trains in an enclosure and 99% control efficiency for loading trains in an enclosure with air extraction to a fabric filter. Note that Benga assumed a control efficiency of 30% for the partially enclosed loadout.

An Australian Coal Mine Particulate Matter Benchmarking Study (NSW OEH 2011) ranked particulate matter emissions from 26 coal mining activities at open-cut and underground coal mines in New South Wales. Train loading ranked 20th for TSP emissions, 22nd for PM_{10} emissions and 23rd for $PM_{2.5}$ emissions. The top 15 mining activities contributed 99.8% of the total TSP emissions. This supports the calculations of Benga that loadout emissions are essentially negligible compared to other sources.

b) Provide an assessment of the potential for coal dust deposited on the outside of the train during loadout operations to act as a source of fugitive particulate matter to the region.

Response:

During coal loadout operations, coal dust deposited on the outside of the rail car, although uncommon, might occur as a result of winds in the partial shelter or continuous loading not synched to the motion of the rail car. The emission factor formula can be obtained from *Environment Canada Pits and Quarries Guidance* (EC 2009).

$$TSP(kg/day/ha) = (1.9)\left(\frac{s}{1.5}\right)\left(\frac{f}{15}\right)$$

$$PM_{10}\ (kg/day/ha) = 0.5 * TSP$$
$$PM_{2.5}\ (kg/day/ha) = 0.2 * TSP$$

Where:

s = silt content in percentage (%), which was 2.2% for the clean coal; and,

f = percentage of time that the unobstructed wind speed exceeds 5.36 m/s.

"*f*" was assumed to be 100 (%) to represent the windiest day with 24 hour speeds above 5.36 m/s. According to U.S. EPA AP 42, the corresponding threshold velocities for coal piles ranged from 11 to 27 m/s depending on material and location, measured on a 10-m tower (Table ECCC 13.2-5.2 in U.S. EPA 2006b). The current approach is conservative to ensure wind

driven model emissions are not under-estimated. Precipitation was not considered as a mitigating factor in this calculation.

Based on the above equations, the wind driven emission factor for coal fallen on flat surfaces will be 3.7, 9.3 and 18.6 kg/day/ha for $PM_{2.5}$, PM_{10} and TSP, respectively. Assuming the coal deposit area outside the rail car is about 100 m^2 (50 m length by 2 m width) on each side, and is freshly available for resuspension at all hours, the worst-case wind driven emissions (with 24 hours with winds above 5.36 m/s) from outside coal deposit were estimated and listed in Table ECCC 13-1.

Thus, if coal is spilled outside the rail car during loading, particulate emissions increase. However, compared to emissions from Highway 3 and communities, the worst-case wind drive emissions from coal spillage are negligible.

Table ECCC 13-1 Maximum Daily Fugitive Dust Emissions at Train Loadout

	Maximum Daily Emissions (kg/d)		
	$PM_{2.5}$	**PM_{10}**	**TSP**
Worst-case Wind Driven Emissions from Coal Spillage in the Loadout	0.07	0.19	0.37
Train Loadout Fugitive Dust	0.3	7.6	16
Train Locomotive Combustion	0.1	-	-
Total Baseline Emissions (Highway 3 and Communities)	97	320	1,557
Worst-case Wind Driven Emissions from Outside Coal Deposit vs Total Train Load-out Emissions	18%	2.4%	2.3%

Using the additional emissions from coal spillage in Table ECCC 13-1, the effect on air quality can be estimated. Particulate concentration predictions were scaled from loadout-only predictions in CR#1 and both sets are listed Table ECCC 13-2. The table indicates that maximum predictions for coal spillage in the loadout are all less than 1% of ambient guidelines for any averaging period.

Table ECCC 13-2 Summary of Maximum Predicted Ground-Level Concentrations

Contaminant	**Averaging Period**	**Loadout**		**Outside Coal Deposit**		**AAQO ($\mu g/m^3$)**
		Prediction ($\mu g/m^3$)	**% of AAQO**	**Scaled Prediction ($\mu g/m^3$)**	**% of AAQO**	
$PM_{2.5}$	Maximum 24-hour	0.7	2.3%	0.13	0.4%	30
	98^{th} Percentile 24-hour	0.3	1.2%	0.05	0.2%	28
	Maximum Annual	0.03	0.3%	0.01	0.05%	10

Table ECCC 13-2 Summary of Maximum Predicted Ground-Level Concentrations

Contaminant	Averaging Period	Loadout		Outside Coal Deposit		AAQO ($\mu g/m^3$)
		Prediction ($\mu g/m^3$)	% of AAQO	Scaled Prediction ($\mu g/m^3$)	% of AAQO	
PM_{10}	Maximum 24-hour	13	27%	0.31	0.6%	50
TSP	Maximum 24-hour	25	25%	0.58	0.6%	100
	Maximum Annual	0.9	1.5%	0.02	0.03%	60

c) Given the close proximity of the loadout to the community of Blairmore, assess whether the currently proposed mitigations are adequate to reduce the loadout's fugitive dust emissions.

Response:

Fugitive dust generation will be minimized at the rail load-out, with full cladding on the sides of the load-out structure to create a wind shelter, and with the movable discharge chute of the bin located as close as practical to the coal within the rail cars. Therefore, spills of coal outside of rail car are expected to be uncommon and also will be cleaned up at the time they occur.

Chute systems such as planned for Grassy Mountain provide more control over the material transfer process than clamshell systems (Katestone Environmental 2014). Load profiling of a rail car can be successfully achieved through appropriate chute design leading to fewer incidences of coal dust spillage or overloading, which will in turn reduce the potential for coal dust emissions in the loadout or the rail corridor.

In addition, the coal atop each rail car will be sprayed with a thin coating of dust suppressant to reduce the risk of coal dust blowing out of the cars.

Reference

Millennium EMS Solutions. 2012. Updated Air Quality Modeling of the CN Loadout – Carldale and East River Estates. 14 pp.

NSW Office of Environment and Heritage. 2011. International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, Report prepared by Katestone Environmental.

National Pollutant Inventory. 2012. Emission Estimation Technique Manual for Mining version 3.1, National Environment Protection Council.

Katestone Environmental. 2014. Literature Review of Coal Train Dust Management Practices Prepared for NSW Environment Protection Authority. *www.epa.nsw.gov.au/resources/epa/*coal*train-litreview.pdf.*100 pp

U.S. EPA. 2006b.

14. Inclusion of Existing Rail Line in Emissions Modelling

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1a, Section 4.7 - Estimates of Future Emissions, Page 49

Revised EIS, Consultant Report #2, Section 2.1 - Location, Page 1

The Canadian Pacific (CP) Rail line that runs parallel to highway 3 will be used for transportation of the coal product to the west coast, adding rail traffic to the existing 10 trains per day (based on information provided in the Environmental Noise Impact Assessment). Apart from the rail loadout itself, this source does not appear to be included in the modelling. Exclusion of emission sources could result in predicted ambient concentrations being underestimated.

Furthermore, in the estimates of future emissions, changes in future rail use was assumed to be "near neutral." This is based on Benga Mining's assertion that increases in rail traffic will be balanced by emission reductions of diesel locomotives, however a quantitative justification for this was not provided. It is also unclear what the Project's contribution to future rail use is (and resulting air quality impacts), as this was not assessed.

a) Clarify whether the CP rail line was excluded from the model as an emissions source or justify its exclusion within the regional study area.

Response:

Emissions from the CP line were not explicitly modelled in CR#1a. Instead, emissions were determined to have been addressed through:

- The use of conservative background concentrations taken from communities larger than Coleman (*e.g.*, Lethbridge).
- The inclusion in model inputs of community emissions from Coleman and other communities in the regional study area that include transportation emissions.

b) Provide an assessment of the increase in rail traffic and associated air emissions as a result of the Project.

Response:

In the initial assessment, it was assumed that a single switch locomotive would operate in the rail loadout. It is now understood that the number and type of locomotives attached to the train will be determined by CP operations. The train will be operated up the loadout rail spur grade by CP, and then the entire train, including all locomotives, will be handed over from CP to Benga operating crews. Benga crews will operate the train under slow-speed-control around the loading loop during loading, and then hand back the loaded train to CP crews to dispatch down the rail spur onto the CP network to Vancouver.

It is assumed that CP operations will utilize a collective pool of unit coal trains to service the site, as the trains are of similar length and origin to those serving nearby coal loadout facilities in southeast BC. These trains typically utilize 3 or 4 locomotives, of typical specification GE AC4400CW. Other locomotive specifications are also known to be utilized by CP on these services, including GE ES44AC, EMD SD60 and EMD SD90MAC CP fleet locomotives.

Modelling indicates a minimum of 2 operational locomotives of GE AC4400 specification are required to successfully power an empty train up the grade of the rail spur to the loadout. However, it is likely that CP train crews will utilize all available locomotives to increase acceleration and improve train handling, meaning that all 3-4 locomotives will be operational for CP delivery and dispatch along the rail spur.

Furthermore, a minimum of 2 operational locomotives of GE AC4400 specification are required to successfully power a unit train around the loading loop. To get the most precise slow speed control, it is likely that the Riversdale locomotive operator will shut down the remaining 1-2 locomotives during this time.

Therefore, the assumptions that were made in this re-assessment are as follows:

- All trains on the CP line, including the loadout meet Tier 1 standards in Table ECCC 14-1 and would emit at those levels. It is expected that, as a minimum, the loadout locomotives would be Tier 1, because the new locomotive is also designed to operate at low shunting speed.
- All trains consist of 4 locomotives and are similar to the 4400 h.p. GE AC4400 locomotive.
- The current traffic on the CP line is 8 trains per day (Transport Canada Grade Crossing Inventory). Approximately 263 to 274 trains per year will be required to service the Riversdale facility, depending on the number of cars on each. Based on return trips, this will result in an increase of 1.44 trains per day operating through the Crowsnest subdivision west of Blairmore, an increase of 18 to 20%.

Table ECCC 14-1 Line-Haul Locomotive Emission Standards, g/bhp·hr

Tier	MY	Date	HC	CO	NOx	PM
Tier 0[a]	1973-1992[c]	2010[d]	1.00	5.0	8.0	0.22
Tier 1[a]	1993[c]-2004	2010[d]	0.55	2.2	7.4	0.22
Tier 2[a]	2005-2011	2010[d]	0.30	1.5	5.5	0.10[e]
Tier 3[b]	2012-2014	2012	0.30	1.5	5.5	0.10
Tier 4	2015 or later	2015	0.14[f]	1.5	1.3[f]	0.03

a - Tier 0-2 line-haul locomotives must also meet switch standards of the same tier.
b - Tier 3 line-haul locomotives must also meet Tier 2 switch standards.
c - 1993-2001 locomotive that were not equipped with an intake air coolant system are subject to Tier 0 rather than Tier 1 standards.
d - As early as 2008 if approved engine upgrade kits become available.
e - 0.20 g/bhp-hr until January 1, 2013 (with some exceptions).
f - Manufacturers may elect to meet a combined NOx+HC standard of 1.4 g/bhp-hr.
Source: https://www.dieselnet.com/standards/us/loco.php

Table ECCC 14-2 summarizes the original and current emissions from loadout locomotives on the rail spur and in the loadout loop. It also includes estimated emissions of CP locomotives operating in the local study area in the Crowsnest subdivision. Because these trains pass through Blairmore 8 times per day with average speed 60 km/h, and because emissions beyond the communities are expected to have little influence on air quality in the communities, it is expected that their emissions are adequately accounted in the community emission estimate.

Compared to existing emissions, which include emissions from existing CP locomotives, Highway 3 and communities, current locomotive emissions on the Benga loadout are about 14%, 0.8% and 3% for NO_x, CO and $PM_{2.5}$, respectively.

Table ECCC14-2 Locomotive Emissions in the Local Study Area

	Locomotive Engine	Power Rating (hp)	Tier	Engine Units	Daily Emission (kg/d)		
					NO_x	CO	$PM_{2.5}$
Benga Mining Loadout Loop	Original locomotive emissions (CR#1)						
	P42DC Locomotive	4,250	4N	1	7.1	13	0.1
	Current locomotive emissions						
	GE AC4400 Locomotive	4,400	1	2	109	33	3.3
Existing Emission in the Local Study Area	Existing CP locomotive emissions (8 CP trains per day)						
	GE AC4400 Locomotive	4,400	1	4	77	22.8	2.3
	Highway 3 & Communities Emissions (CR#1a)				694	3,821	97
	Total Existing Emissions				770	3,844	99
Current Locomotive Emissions vs Total Existing Emissions					14%	0.8%	3%

Nonetheless, an updated assessment of the change in air quality due to the additional locomotives operating in the loadout, and due to the explicit inclusion of existing trains on the CP Crowsnest subdivision line, is presented.

A summary of air quality model predictions at the Mine Permit Boundary (MPB) and special receptors is presented in Table ECCC 14-3 for the updated assessment of the increase in rail traffic and associated current locomotive emissions as a result of the Project. These predictions are presented because they reflect the predictions presented in CR#1, even though the rail line is relatively distant from the largest Project sources. The predictions are compared to the Alberta Ambient Air Quality Objectives (AAAQO) and summarized below:

- The AAAQOs were met for all averaging periods for NO_2, CO and $PM_{2.5}$ at the MPB in all three assessment cases;
- Annual NO_2 exceeded AAAQO of 45 µg/m^3 at special receptor at Blairmore North location for both Baseline and Application cases. Blairmore North is nearest the loadout (and Highway 3). The Project contribution at the Blairmore North location was about 9.1%.

Comparing Table ECCC 14-3 predictions to the summaries presented in CR#1a Tables 6.4-2 and 6.4-3:

- no changes in Application and Project-Only case concentrations at the MPB were predicted as a result of the updated locomotive emissions;
- the increase in rail traffic resulted in an increase of 5 to 15% in NO_2 predictions at the MPB and special receptors in the Baseline case;
- hourly and annual NO_2 Application predictions at special receptors were increased about 14% and 18%, respectively, due to the combination of the increased rail traffic and Project loadout locomotive emissions.

Table ECCC 14-3 Key Predicted Air Quality Concentrations at Mine Permit Boundary and Special Receptors – Updated Rail and Project Locomotive Emissions

Contaminant	Averaging Period	Project-Only		Baseline	Application/ PDC	Application/PDC Case Increase Over Baseline [%]	AAAQO (µg/m³)
		Prediction (µg/m³)	Percentage of AAQO	Prediction (µg/m³)	Prediction (µg/m³)		
Maximum at Mine Permit Boundary							
NO_2	9th Highest 1-hour	110	37	70	113	63	300
	Maximum Annual	12	27	21	28	33	45
CO	9th Highest 1-hour	725	5	480	1,069	123	15,000
	Maximum 8-hour	1,055	18	393	1,358	246	6,000
$PM_{2.5}$	Maximum 24-hour	13	43	8.2	20	138	30
Maximum at Special Receptors							
NO_2	9th Highest 1-hour	91	30	124	124	0	300
	Maximum Annual	15	34	47	51	9.1	45
CO	9th Highest 1-hour	386	2.6	2,050	2,050	0	15,000
	Maximum 8-hour	314	5.2	1,584	1,584	0	6,000
$PM_{2.5}$	Maximum 24-hour	5.7	19	23	24	4.6	30

CCME (2012) indicates the CAAQS are not intended to be used for maximum point of impingement or fenceline reporting for industrial facilities. These standards will be used to characterize air quality and potential air quality impacts in areas where people live or where other sensitive receptors are likely to be found. Guidance from the Alberta Environment and Parks (AEP) also suggests the new CAAQS are to be used for management and/or monitoring, not for predictive modeling. Nonetheless, predicted concentrations resulting from changes to the loadout locomotive fleet and with the explicit addition of Baseline traffic are compared to CAAQS below.

A summary of NO_2 ground-level concentrations for all special receptors in or near communities (Blairmore, Coleman and Frank) for Baseline and Application cases and exceedance frequency

in Application case are presented in Table ECCC 14-4. Original predictions from CR#1a are also listed for comparison. The predictions are compared to the CAAQS 2025 standards for NO_2, which are converted from ppb to µg/m^3 assuming an ambient pressure of 1 atmosphere and a temperature of 25 degrees Celsius. The table indicates for 98th percentile 1-hour predictions:

- The updated rail emissions increase predicted Application-case concentrations by up to 14% at Blairmore North and by as little as 2% in the centre of town.
- Exceedances of the 2025 NO_2 CAAQSs were predicted at the special receptors for both Baseline and Application cases and for both original and updated rail and Project locomotive emissions;
- The Project contribution to the model-predicted NO_2 exceedance was negligible except at the Blairmore North location;
- The Project contribution at the Blairmore North location was about 9.1% as the result of the increased rail traffic and Project locomotive emissions.
- At Blairmore North in the Application case, the maximum frequency of NO_2 hourly exceedance was predicted to be 5.3% and 9% of the time for original and updated emissions. Only at the Blairmore North special receptor does the exceedence frequency increase from Baseline to Application case.

Annual average predicted NO_2 concentrations increase by up to 17% (Blairmore North, Application case) and by as little as 6% elsewhere. Maximum Baseline predictions exceed the annual NO_2 CAAQS at all community receptors.

The model predictions are based on estimated background concentrations which may be more conservative with the explicit addition of the rail source to modelling.

Table ECCC 14-4 Predicted NO_2 Concentrations at Special Receptors at Communities

	CR#1a Original Emissions-2016			Updated Rail and Project Locomotive Emissions-2018			2025 CAAQS (µg/m^3)
	Baseline (µg/m^3)	Application (µg/m^3)	Application Exceedance Frequency	Baseline (µg/m^3)	Application (µg/m^3)	Application Exceedance Frequency	
98th Percentile Daily Peak 1-hour Concentration[(a)]							
R1-Campground	86	86	0.7%	88	88	1.0%	79
R3-Residential #1	88	88	0.6%	91	91	1.2%	79
R6-Coleman	95	95	2.8%	103	103	4.6%	79
R7-Frank	85	85	0.6%	89	89	1.1%	79
R8-Blairmore North	106	106	5.3%	118	121	9.0%	79
R14-Blairmore Center	92	92	1.7%	94	94	2.4%	79
Annual Concentration[(b)]							
R1-Campground	25	25		26	27		23
R3-Residential #1	25	25		27	27		23

Table ECCC 14-4 Predicted NO_2 Concentrations at Special Receptors at Communities

	CR#1a Original Emissions-2016			Updated Rail and Project Locomotive Emissions-2018			2025 CAAQS ($\mu g/m^3$)
	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Application Exceedance Frequency	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Application Exceedance Frequency	
R6-Coleman	36	36		38	38		23
R7-Frank	29	29		31	31		23
R8-Blairmore North	43	43		47	51		23
R14-Blairmore Center	35	35		36	37		23

[a] The 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations.
[b] The average over a single calendar year of all 1-hour average concentrations

Predicted $PM_{2.5}$ ground-level concentrations for all special receptors in or near communities (Blairmore, Coleman and Frank) for Baseline and Application cases and the Project contributions are presented in Table ECCC 14-5. Predictions from CR#1a are also listed for comparison. The predictions are compared to the $PM_{2.5}$ CAAQS 2020 standards. The table indicates:

- No exceedances of the 2020 CAAQSs were predicted for $PM_{2.5}$ at the special receptors for both Baseline and Application cases and for both original and updated rail and Project Locomotive emissions.
- The Project contribution was very small at all locations with the original Project locomotive emissions.
- At Blairmore North, the Project contribution increased by 6 to 8% as the result of the updated Tier 1 loadout locomotive emissions.
- The addition of rail traffic on the CP line resulted in a 2% increase in 24-hour and annual predictions at special receptors in the Baseline case.

While predicted Baseline and Application/ PDC predictions increase with the explicit addition of the rail line in modelling and the change in emissions from the loadout locomotives, the overall conclusions of the EIA air quality assessment do not change. The predictions are expected to remain conservative given the use of background concentrations from non-rural monitoring stations.

Table ECCC 14-5 Predicted $PM_{2.5}$ Concentrations at Special Receptors at Communities

	CR#1a Original Emissions-2016			Updated Rail and Project Locomotive Emissions-2018			2020 CAAQS ($\mu g/m^3$)
	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Project Contribution	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Project Contribution	
98th Percentile 24-hour Concentration[a]							
R1-Campground	11.7	11.8	0.9%	11.8	12.3	4.2%	27

Table ECCC 14-5 Predicted $PM_{2.5}$ Concentrations at Special Receptors at Communities

	CR#1a Original Emissions-2016			Updated Rail and Project Locomotive Emissions-2018			2020 CAAQS ($\mu g/m^3$)
	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Project Contribution	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	Project Contribution	
R3-Residential #1	9.5	9.6	1.1%	9.7	9.9	2.1%	27
R6-Coleman	15.7	15.8	0.6%	15.9	16.2	1.9%	27
R7-Frank	11.0	11.0	0.0%	11.1	11.3	1.8%	27
R8-Blairmore North	17.7	17.8	0.6%	17.9	19.4	8.4%	27
R14-Blairmore Center	18.0	18.1	0.6%	18.1	18.4	1.7%	27
Annual Concentration[(b)]							
R1-Campground	5.2	5.2	0.0%	5.2	5.3	1.9%	8.8
R3-Residential #1	4.7	4.7	0.0%	4.7	4.8	2.1%	8.8
R6-Coleman	7.3	7.3	0.0%	7.4	7.4	0.0%	8.8
R7-Frank	5.4	5.4	0.0%	5.4	5.5	1.9%	8.8
R8-Blairmore North	8.1	8.2	1.2%	8.3	8.8	6.0%	8.8
R14-Blairmore Center	8.1	8.1	0.0%	8.1	8.2	1.2%	8.8

[(a)] The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
[(b)] The average over a single calendar year of all 1-hour average concentrations

c) Provide quantitative evidence for the assertion that increases in future rail use and decreases in emissions will balance to "near neutral."

Response:

Transport Canada proposed locomotive emission standards in 2016 and finalized them in 2017. The regulations limit emissions of NOx, PM, HC and CO from locomotives operated by railway companies under federal jurisdiction. The emission standards align with the US EPA in terms of both emission limits and effective dates. These standards are shown in Table ECCC 14-1 and indicate that all new locomotives purchased in Canada today should already meet Tier 4 standards.

According to Market Realist (2016) the average lifetime of CP's fleet in the U.S. is 25 years. Assuming a similar age in Canada, all CP locomotives would reach Tier 4 standards by 2040. CP's EMD SD90MAC locomotives manufactured in the mid-1990s (Tier 0 to Tier 1 emissions compliance) are currently in storage and for sale, demonstrating a trend to the operation of lower emission units.

Assuming the fleet today reflects Tier 1 engine standards, emission reductions from today for the line haul fleet to meet Tier 4 standards (from Table 14-1) would be as follows: HC (75%), CO (32%), NOx (82%), and PM (86%). If the current fleet is more accurately represented by Tier 0 engines, the predicted emission decreases by 2040 would be substantially larger. While

emissions from in-use locomotives may be higher than the standards in Table ECCC 14-1, it is expected that similar percentage reductions in emissions would be realized in future operations.

While predicting rail traffic is subject to many influences, it is conservatively expected that rail traffic will increase in future. Rail traffic on most of the route that the Riversdale coal trains will take to the Vancouver is long-distance traffic, either originating in or destined for west coast ports in Canada or the USA. There is relatively little rail local industry traffic directly accessing the CP Crowsnest subdivision.

CP provides weekly carload statistics which indicate an average rail carloads growth of 0.9% per year from January 2015 to March 2018 (CP-Weekly-RTM-and-Carload). The Crowsnest subdivision is near the center of CP's network, and it is assumed that traffic in the area would reflect this average growth rate. As the number of locomotives required to handle a train is approximately proportional to the number of railcars moved, it is anticipated that the number of locomotives in operation and total time of locomotive operations would also increase by 0.9% annually, if recent trends continue.

Thus, the rate of reduction in emissions considering the projected locomotive replacement rate and the Canadian standards is equivalent to an annual reduction of about 1.1%. If the anticipated traffic increase is 0.9% annually, the impact on emissions is "near neutral", or declining somewhat overall.

References:

CCME. 2012. Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone. https://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf. 43 pp.

CP Weekly RTM and Carload. http://investor.cpr.ca/key-metrics/default.aspx. Downloaded from the CP website March 29, 2018.

DieselNet. https://www.dieselnet.com/standards/us/loco.php.

Market Realist. 2016. US railroads' fleet age. https://marketrealist.com/2016/05/quick-glance-major-us-railroads-fleet-age

Transport Canada Grade Crossing Inventory. https://open.canada.ca/data/en/dataset/d0f54727-6c0b-4e5a-aa04-ea1463cf9f4c. Accessed March 29, 2018.

15. Selection of Air Quality Monitoring Stations

EIS Guideline, Section 6.1.1 – Project Setting and Baseline Conditions in the Atmospheric Environment, page 22

Revised EIS, Consultant Report #1b, Section C2.4 - Air Quality Meteorological and Climate Data Sources, Page C6

Four air quality monitoring stations were chosen to determine background concentrations of air contaminants, including a station in nearby Devon, Alberta. However, the Devon AB station only has sulfur dioxide data available, and other stations, including Lethbridge, Nelson, and Castlegar were used to determine background nitrogen oxides and particulate matter concentrations. Lethbridge is a much large community than Blairmore (ca. 90000 versus ca. 2000) with more sources of nitrogen oxides and particulate. A rationale for selecting air quality data as background in the model was not discussed in the EIS.

a) Discuss the representativeness of air quality monitoring data used to determine background air pollutant concentrations of NO_2, $PM_{2.5}$, and PM_{10}.

Response:

Data Sources

Benga's aim is to use background measurements that are sufficiently conservative such that the predicted effects of the Project are not under-estimated. The population in the RSA primarily consists of the Municipality of the Crowsnest Pass, which currently has a population under 6,000 (Statistics Canada, 2011). 'Industry' is limited to local, small-scale commercial operations. There is a paucity of regional sources within at least 50 km of the RSA.

As discussed in Section C2.4, two sets of monitoring stations were considered to find representative background concentrations:

- Stations in southern Alberta and B.C. that were relatively near the Project.
- Stations in central Alberta that were downwind to varying extents from open pit coal mines.

All measurement sites considered are long-term federal and provincial monitoring stations with well-established measurement and quality control practices. Tables C2-2 and C2-3 in Appendix C present the measurements made at the two sets of stations. NO_2 was measured at 5 of 7 stations considered, $PM_{2.5}$ at 4 of 7, and PM_{10} at the two B.C. stations of the 7 stations considered.

The CRAZ airshed also uses passives measurements to provide regional trends in air quality, monitoring SO_2, NO_2 and O_3 at stations south and west of Calgary. These passive stations provide 30-day integrated concentrations which do not provide the 90th percentile values suitable for use as background stations.

NO_2

NO_2 measurements from the Lethbridge air quality monitoring station between 2010 and 2014 were used to estimate background concentrations. As indicated in Table ECCC 15-1, differences in the 90th percentiles for hourly and annual averages between the Lethbridge and Castlegar stations are small and therefore use of either dataset would provide similar results.

Table ECCC 15-1 also compares NO_2 measurements at other locations in central Alberta, in smaller communities or between foothills coal mines and Edmonton. The highest concentrations

are found in Edson with a population of 9,000 but a station in a valley through which emissions are channeled. The lowest concentrations are found at the Steeper site, an upwind background location. The use of Lethbridge concentrations provided a conservative assessment for NO_2.

Table ECCC 15-1 Comparison Background to Other Air Monitoring Stations for NO_2

Averaging Period	Background - Lethbridge (ug/m^3)	Castlegar (ug/m^3)	Edson (ug/m^3)	Steeper (ug/m^3)	Wagner (ug/m^3)
1-h 90th percentile	24	25	39	7.5	23
Annual 90th percentile	11	12	12	2.2	8.6

$PM_{2.5}$ and PM_{10}

Appendix C summarizes $PM_{2.5}$ concentrations measured at the Lethbridge and Nelson Kutenai Place stations, as the Devon Coleman and Castlegar Zinio stations do not measure $PM_{2.5}$. Section C3.3 discusses the differences in seasonal and diurnal concentrations of $PM_{2.5}$ at Lethbridge and Nelson and Section C3.4 lists differences for PM_{10}. Differences between the two stations considered are shown in Table ECCC 15-2 for $PM_{2.5}$ and Table ECCC 15-3 for PM_{10}.

The 90th percentile concentrations of $PM_{2.5}$ are larger at Lethbridge than at Nelson (Table ECCC 15-2). As noted in Section C5.0, measurements from the Nelson station were used for $PM_{2.5}$; the Nelson station montane setting is expected to be more representative of the Project location than the prairie Lethbridge site. It is also expected to be similarly influenced by natural events such as forest fires. The population of Lethbridge, as noted by the reviewer, is also much larger than Blairmore and therefore combustion emissions from Lethbridge would be unrepresentative of the smaller community; even Nelson, with a population of about 10,000 is substantially larger than Blairmore. 90th percentile 24-hour and annual $PM_{2.5}$ concentrations are lower at Edson and lower at Steeper than at Nelson. The Castlegar station does not measure $PM_{2.5}$ and it was determined to be of value to have a common measurement location for the two particulate size ranges.

Differences between 90th percentiles at Castlegar and Nelson are small for PM_{10} (Table ECCC 15-3) and support the use of either dataset for background concentrations.

Table ECCC 15-2 Comparison of Background to Other Air Monitoring Stations for $PM_{2.5}$				
Averaging Period	**Background – Nelson Kutenai (ug/m^3)**	**Lethbridge (ug/m^3)**	**Edson (ug/m^3)**	**Steeper (ug/m^3)**
1-h 90th percentile	8	15	10	6
24-h 90th percentile	6.8	12	5.4	3.1
Annual 90th percentile	4	7.6	3.5	1.6

Table ECCC 15-3 Comparison of PM10 Background Concentrations, from Table C3-4		
Averaging Period	**Castlegar (ug/m^3)**	**Nelson (ug/m^3)**
24-h 90th percentile	21	21
Annual 90th percentile	14	13

16. Use of Correct Locomotive Emission Factors

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1b, Appendix A, Table A 5.1-1 - Exhaust Emissions of $PM_{2.5}$, PM_{10}, TSP, SO_2, CO, and NO_x, Page A-23

It is stated that the emission factors for train load-out in table A5-1 of Appendix A, reference U.S. EPA values for switch locomotives. However, it appears as though the factors selected are for Tier 4 locomotives. It is understood that the switch locomotive would only meet the Tier 0 emission standard, for which emissions are significantly higher than expected emissions for a Tier 4 locomotive.

The following table shows the emission factor used by Benga Mining and shown in table A5-1 for train load-out (Tier 4), as well as the emission factors for a Tier 0 switch locomotive.

Switch Emission Factors (g/bhp-hr) – U.S. EPA 2009				
Tier of Standards	**NO_x**	**PM_{10}**	**HC**	**CO**
Tier 4	1.00	0.015	0.08	1.83
Tier 0	12.60	0.44	1.01	1.83

a) Clarify why Tier 4 emission factors for train load-out were used for the P42DC locomotive.

Response

As noted in the response to ECCC IR#14, it is currently understood that shunting in the loadout will be handled with the same set of locomotives that would transport the coal train to Vancouver. It is expected that 3-4 locomotives of type GE AC4400 would be involved, although the number of locomotives operating during the shunting process is expected to be 2. The response to SIR#14 also noted the trend to decreasing emissions from locomotives, which is expected to include those operating in the Crowsnest subdivision. Tier 1 emission rates (in g/bhp-h) are listed in the response to SIR#14.

b) If these emissions factors have been applied in error, apply the correct Tier 0 emission factors and revisit the emission calculations.

Response:

In the original assessment, it was assumed that a single switch Tier 4 locomotive would operate in the rail loadout. nBased on updated information for loadout operation, current locomotive emissions for the Benga loadout are based on two Tier 1 GE AC4400 locomotives working 8-hour days. Table ECCC 16-1 summarizes the original and current emissions from loadout locomotives in the loadout loop. Implications for air quality on the locomotive update were included in the response to ECCC SIR#14.

Table ECCC16-1 Original and Current Emissions from Loadout Locomotives in the Loadout Loop

Locomotive Engine	Power Rating (hp)	Tier	Engine Units	Load Factor (LF)	Emission Factors (g/hp-hr)			Daily Emission (kg/d)		
					NO_x	CO	$PM_{2.5}$	NO_x	CO	$PM_{2.5}$
Original locomotive emissions (CR#1)										
P42DC Locomotive	4,250	4N	1	0.21	1.00	1.83	0.015	7.1	13.1	0.1
Current locomotive emissions										
GE AC4400 Locomotive	4,400	1	2	0.21	7.40	2.20	0.220	109	32.5	3.3

17. Inclusion of Marine and Rail Emissions (Beyond Project Boundary) in Emissions Estimates

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

The coal produced as a result of the Project is expected to be transported to the west coast of B.C. by rail and loaded onto ships for export. The scope of the environmental impact statement does not include incremental air pollutant and greenhouse gas emissions from these trains and ships.

a) Expand the geographic scope of EIS to include all incremental air pollutant and greenhouse gas emissions that are directly attributable to the project, including rail to the west coast of B.C. and marine emissions within Canadian territorial waters.

Response:

Rail Traffic Increase

The current traffic on the CP line Crowsnest subdivision is 8 trains per day (Transport Canada Grade Crossing Inventory). Approximately 263 to 274 trains per year will be required to service the Riversdale facility. Based on return trips, this will result in an increase of 1.44 trains per day operating through the Crowsnest subdivision west of Blairmore, an increase of 18 to 20% as assessed in the response to ECCC SIR 14.

The primary freight and shipping routes into/out of the Metro Vancouver area are listed below (Transport Canada Grade Crossing Inventory). Passenger train service operating on mainline rail tracks are also estimated from public timetables. Light rail/automated rail service operating on dedicated tracks within the area excluded from this list:

- CP Cascade subdivision – up to 42 trains/day
- CP Mission Subdivision – up to 6 trains/day
- CN Yale subdivision – up to 40 trains/day
- CN Squamish subdivision – up to 5 trains/day
- BNSF New Westminster subdivision – up to 8 trains/day
- SRY Link - up to 5 trains/day
- West Coast Express – Mission to Vancouver – 10 trains/day

The total number of trains operating in Metro Vancouver is 124 per day. The Project would increase rail traffic in the area by about 1.2%. Genesis (2005) estimated that 2.3% of all emissions in the Lower Fraser Valley (LFV) were due to locomotives. Thus, the CP fleet servicing the Project could increase LFV emissions by approximately 0.03%.

Impact at Port of Vancouver

In 2017, the Port of Vancouver handled approximately 142 Mt of cargo and saw about 3200 foreign vessel arrivals (Vancouver Fraser Port Authority 2018). The effect of the Project would be to add about 3.8 Mt of clean coal, which would represent an increase of about 2.7% of cargo handled. The increase in the number of vessels in the port and in territorial waters is expected to be significantly lower than this percentage as bulk carrying ocean vessels are large and potentially more efficient, and therefore the emission increase may be proportionately lower than the increase in cargo volume.

Metro Vancouver (2017) summarized 2015 emissions in the LFV for specific pollutants and emission rates in broad categories. Marine traffic was determined to contribute about 10% of "smog forming" emissions in the LFV. Assuming the fleet of vessels hauling Project coal is representative of marine emitters, the Project could increase smog-forming LFV emissions by 0.27% based on the increase in cargo handled.

Metro Vancouver (2017) also noted that marine traffic accounts for 3% of GHGs in the LFV and therefore the fleet hauling Project coal could increase LFV GHG emissions by 0.008%.

Overall Impact

Summing rail and marine emissions, agents handling Project coal could increase smog-forming emissions in the LFV by 0.30%. The effect on air quality is expected to be of similar magnitude. LFV GHG emissions might increase by 0.038%, which was deemed not significant.

References

Transport Canada Grade Crossing Inventory. https://open.canada.ca/data/en/dataset/d0f54727-6c0b-4e5a-aa04-ea1463cf9f4c. Accessed March 29, 2018.

VANCOUVER FRASER PORT AUTHORITY. 2018. 2017 STATISTICS Overview. https://www.portvancouver.com/wp-content/uploads/2018/03/2017-Stats-Overview-1.pdf

Metro Vancouver. 2017. 2015 Lower Fraser Valley Air Emissions Inventory - Final Report and Summarized Results. http://www.metrovancouver.org/services/air-quality/AirQualityPublications/2015LowerFraserValleyAirEmissionsInventory-Nov2017.pdf

Genesis Engineering. 2005. Reduction of Nonroad Diesel Emissions in the Lower Fraser Valley and the Rest of BC. http://www.metrovancouver.org/services/air-quality/AirQualityPublications/NonRoadHDD.pdf

18. Use of Train Load-out

EIS Guideline, Section 6.2.1 – Predicted Changes to the Atmospheric Environment, Page 28

Revised EIS, Consultant Report #1a, Table 4.4-1 - Project Emission Sources, Page 30; Table, 4.4-2 - Summary of Emissions from Highway 3, Page 42

Revised EIS, Consultant Reports #1b, Tables A3 - Summary of Maximum Daily Material Balance for the Project in Year 19, Page A-4; A3-3 - Parameters of Diesel Powered Equipment, Page A-5; Section A4.3 - Conveyor Drop Operations, Page A-12

Table A3-1 states that the Project will operate 354 days per year; however train load-out emissions are based on 274 trains per year with railcars being loaded for 8 hours per day. In Table 4.2.2 and Table A3-3, it is stated that the P42DC locomotive for train load-out will be operating 2832 hours per year, which equals 354 days per year at 8 hours per day. Therefore, it is unclear to us what is the actual expected number of days per year of operation of the train load-out.

a) Clarify the number of days per year of train load- out operation, and provide additional explanation for how the number of 274 trains per year was derived.

Response:

A total of 274 trains per year were used to assess the maximum daily dust emissions for train load-out operation. The calculation for 274 trains per year:

1. Clean Coal Production is 3.84 Mt for year 19;
2. assuming 14,000 tonnes of clean coal per load-out train;
3. total number of trains need for Year 19 = 3840000/14000 = 274

To be consistent, the operating hours for locomotive for the train load-out in Table 4.2.2 and Table A3-3 should be 2192 hours per year (274 days per year at 8 hours per day). The operating hours in these tables were typographical errors. Nonetheless, modelled locomotive exhaust emissions were based on the engine power rating operating 8 hours a day, 365 days a year to be conservative.

19. Inconsistency in Number of Haul Trucks

EIS Guidelines, Section 3.2 - Project Activities, Page 18

EIS Guidelines, Section 6.2.1 - Changes to the Atmospheric Environment, Page 28

Revised EIS, Volume 1, Section C, Table C 1.3-1 - Mine Plan Production Statistics, Page C-22; Table C 1.4-1 - Primary Equipment Fleet Summary, Page C-23

Revised EIS, Consultant Report #1b, Table A3-3 - Parameters of Diesel Powered Equipment , Page A-5

The Guidelines require Benga Mining to include a description of the equipment requirements (type and quantity) for site preparation, construction, and operation. ECCC notes that there are inconsistencies in the number of haul trucks between Table C1.4-1 (Primary Equipment Fleet Summary) and Table A3-3 (Parameters of Diesel Powered Equipment). Table A3-3, which was used for calculations, lists 33 haul trucks (220t) whereas Table C1.4-1 lists 39 trucks – rear dump (220t) at a maximum year (assumed to be year 19).

The Guidelines also specify that the EIA should include predicted changes in air quality as a result of all Project activities. Haul trucks are significant sources of NOx, fine particulates, and fugitive dust air emissions.

Explain or correct the inconsistencies in the number of 220 tonne trucks in Table C1.4-1 and Table A3-3 and if necessary:

a) Update Table C1.4-1 and Table A3-3 accordingly.

Response:

For design purposes, Benga planned to use a maximum of 39 220-tonne trucks (listed in Table C1.4-1) on mining operations. Not all trucks will be operating at the same time. To estimate Year 19 emissions, Benga determined that 85% of the fleet would be operational at any one time; the others would be undergoing maintenance. Therefore, for modelling purposes, the fleet consisted of 33 haul trucks (listed in Table A3-3).

b) Update the air quality modelling predictions.

Response:

The number of operating trucks is consistent and the model predictions do not change.

20. Mitigating Emissions from Mobile Equipment

EIS Guidelines, Section 6.4- Mitigation, Page 32

Revised EIS, Volume 1, Section E.1.4.1 - Mitigation, Page E-24

Benga Mining, Conformity SIR Response, Attachment 2, Section 4 - Greenhouse Gases, Diesel Combustion, Page 2-13

Mitigation measures to reduce the impact of the mobile equipment air emissions have not been clearly defined in the EIS. The Benga Mining's responses to CEAA's request for information mention the planned upgrades to the mine fleet, measures to minimize fuel consumption (a dispatch system to minimize delays and idling and minimizing the haul road length and gradient), and the potential to power some equipment electrically. Given that

diesel combustion makes up a large part of the lifetime GHG (47%) and NOx (49% daily NOx) emissions for the Project, ECCC recommends Benga Mining provide specific commitments and details within the EIS on their plans to retrofit or upgrade the mine fleet as well as to conduct regular maintenance and driver training.

With respect to the use of low-carbon diesel fuel, North West Redwater Partnership reports their fuel can reduce emissions and provide up to 30% greater fuel economy when compared to gasoline, not diesel. Diesel engines are already inherently more efficient than gas powered ones, the potential GHG savings would be substantially less than the 900kt reported by Benga Mining.

Reference:

Northwestern Redwater Partnership. (2018). Local Weather: Maximizing The Value. Accessed January 24, 2018, from Sturgeon Refinery: https://nwrsturgeonrefinery.com/project/maximizing-the-value/

Consider mitigation measures within the EIS and the Construction Management Plan to reduce impact from mobile equipment. This could include:

a) A maintenance program.

Response:

Section 6.6 in CR#1 lists the mitigation measures adopted by the Project to address air emissions. Most discuss methods to reduce fugitive dust and were not meant to be an exhaustive list of all measures Benga would undertake as part of its emissions management program - only those that directly affected modelled emissions. Benga will develop an emissions management plan that will address the issues below.

Capital measures that affect combustion emissions include:

- the mine fleet is regularly upgraded and by Year 19 which is representative of a year with worst-case emissions, some equipment may be newer and more efficient than assumed in emission estimation.
- Exhaust emissions from the U.S. EPA Tier 4 (2010) standards were used in Project emission estimates and off-road standards could be more stringent by Year 19. Thus, retrofit is not part of planned mitigation.

The reviewer has identified several additional operational practices that will help to reduce exhaust emissions, and others are under consideration as well.

- Rigorously reviewing and updating mine plans such that haul road lengths and haul road grades, and therefore fuel consumption and cost, are optimized;
- Alternative diesel formulations or fuel additives. The effectiveness of these fuels at reducing both PM and NOx emissions is generally much lower than the improvements offered by using Tier 4 technology. The use of a “specialty fuel” is

also unlikely to be practical due to the need for additional fuel storage and handling equipment, and special fueling operations to accommodate a second fuel (MJ Bradley and Associates 2008). Benga does not commit to using alternative fuel formulations but will monitor their availability and cost effectiveness.

Maintenance

Good maintenance practices lead to reductions in raw exhaust emissions and ultimately lower worker exposures. Maintenance plans, focusing on emissions, are integral to good practice.

Operators should be aware of their equipment's emissions and report any changes, such as visible black smoke, to maintenance.

Servicing should be undertaken by competent personnel who can interpret diesel emission monitoring results to minimize emissions following maintenance and repairs. If maintenance is inadequate, the performance of any diesel engine will degrade, with a resultant increase in particulate emissions. The effectiveness of the maintenance regime could be measured (DMP 2013), for example in the case of particulate emissions:

- conducting diesel particulate baseline tests prior to the diesel engine commencing operation
- regularly monitoring raw exhaust levels of diesel engines over their operational life cycle. For diagnostic purposes, this is best undertaken at the same time as a raw exhaust gas test.
- the cause of any deviation from the baseline should be determined and recorded, and appropriate action taken to return the engine emission levels to their baseline status.

Benga will develop a program to ensure the ongoing maintenance and optimization of diesel equipment. This includes ongoing diesel emissions testing. Some elements of a checklist for the program could include (DMP 2013):

- Air intake system. Is the air intake canister as tight as possible? Are seals and springs firm, with no leaks or blockages in hoses or connections? Are filters seated and fitted firmly?
- Is the charger cooler blocked or leaking? Has it been pressure-checked?
- Exhaust system. Do components move under load? Are there any blockages or restrictions?
- Do the fuel and lubricant additives meet specifications?
- Have the fuel and lubricants been checked for exposure to moisture or other contaminants?
- Are vehicles refuelled at the end of shift or when the engine is cold?
- Are sufficient spare parts available?
- If filters are cleaned and reused, is the cleaning technique verified as effective?
- Are tires maintained (*e.g.* air pressure, tread) to optimize vehicle performance?

- Are engines configured and optimized to reduce emissions?
- Are throttles configured to minimize aggressive use?

Training

A training program based on best management practice should ensure operators understand the objectives of an emission-reduction program, and the impact that certain driving techniques have on fuel consumption and diesel emissions.

Education and training focused on diesel emissions management should be developed, implemented and regularly provided to all employees involved in the operation and maintenance of diesel emission sources, such as light and heavy vehicles. The employee education and awareness program should address (DMP 2013) the composition, sources, and health effects of diesel emissions as a means of reinforcing the need to manage emissions.

Maintenance personnel should be trained to maintain engines and exhaust treatment devices at optimum performance. Operators should understand the benefits of pre-start and shut-down procedures.

Operator training should also address factors in the operation of diesel-powered vehicles that can have detrimental effects on engine performance and increase emissions. A diesel engine working at a steady state at peak horsepower is more efficient resulting in reduced emissions. The following should be emphasized:

- engine idling should be kept to an absolute minimum
- throttling or transient operation should be minimized — modulated shift automatic transmissions assist operators to change direction and speed without releasing the throttle
- the engine load directly influences particulate production — systems that apply mechanical load to the engine such as transmission, hydraulics, and brakes should be verified for proper settings at scheduled service intervals.

Workers directly responsible for managing controls of diesel emissions should undergo specific training relating to the use, care and maintenance of such controls to ensure their effectiveness. For example, service crews should be trained in the maintenance tasks required to reduce emissions.

References

Department of Mines and Petroleum (DMP). 2013. Management of diesel emissions in Western Australian mining operations — guideline. Department of Mines and Petroleum, Western Australia, 37 pp. http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_DieselEmissions.pdf.

M.J. Bradley & Associates. 2008. EVALUATION OF VEHICLE EMISSIONS REDUCTION

OPTIONS FOR THE OIL SANDS MINING FLEET. 40 pp. https://www.mjbradley.com/sites/default/files/Oil%20Sands%20Retrofit%20Feasibility%20Study%20Mar08_0.pdf.

b) Plans to upgrading vehicles or retrofitting (e.g. any plan to rebuild an engine to a high tier engines when it's available).

Response:

Please see response ECCC SIR 20(a).

c) Anti-idling practices (e.g. prohibiting idling between shifts, during loading).

Response:

Please see response ECCC SIR 20(a).

d) Operator training for minimizing emissions.

Response:

Please see response ECCC SIR 20(a).

21. Exposure of Aquatic and Terrestrial Biota to Contaminants of Concern

EIS Guidelines, Predicted Effects on Valued Components, Section 6.3.2 - Migratory Birds, Page 30; Section 6.3.3 Species at Risk, Page 31; Section 6.4- Mitigation, Page 32

Revised EIS, Section C – Project Description, Section C.5.6 - Water Management Construction Schedule, Page C-108

Addendum to EIS, Consultant Report #9, Section 5.5.3 - Change in Mortality Risk and Health, Page 303

Addendum to EIS, Consultant Report #9 - Section 7.2, Preliminary Wildlife Monitoring Program, Page 336

Levels of selenium are expected to increase in water accumulated in surge ponds in year 7. At which point, all water will be captured, pumped to the in-pit saturated zones and semi-passively treated for selenium attenuation (Section C, C.5.6 Water Management Construction Schedule, Page C-108).

Benga Mining acknowledges that migratory birds may experience an increased risk of mortality through dermal contact or ingestion of contaminated water stored in surge ponds and saturation zones (CR # 9, Section 5.5.3), but later states that the level of disturbance adjacent to surge ponds will deter birds from nesting along pond edges, thereby eliminating risk of exposure to selenium- laden water. In order to mitigate such exposures, Benga Mining will incorporate a wildlife monitoring program aimed at monitoring the effects of

the Project on wildlife species at risk or species of management concern during construction and operation of the Project and post-closure. In particular the effects of the Project on wildlife valued components (VCs), including disturbance, mortality, and movement will be monitored (CR # 9, Section 7.2).

a) Provide an assessment of maximum predicted concentrations of selenium and other project- related contaminants of concern (COCs) at surge ponds and saturation zones over the course of the Project.

Response:

Maximum predicted concentrations of cobalt, nitrate, selenium, sulphate and zinc within sedimentation ponds, surge ponds and saturation zones over the course of the project was provided in Appendix 10B, Section 7.3 – Effluent Water Quality.

b) Discuss how these values compare with published guidelines for the protection of aquatic health.

Response:

The relevant environmental quality guidelines for Alberta Surface Waters (AEP 2014) are presented in Table ECCC 21-1.

Table ECCC 21-1 Surface Water Quality Guidelines (AEP 2014)

Receptor	AEP (2014) Guideline (mg/L)[1]	Source
Cobalt	0.0025	EnvCan 2013
Nitrate	0.0030	CCME 2012
Selenium	0.001	CCME 1987
Sulphate	128 to >429	BC 2013
Zinc	0.030	CCM 1987

[1]chronic exposure guidelines (long-term) presented.

As indicated in Section C.5.5 – Water Management Structure Design Specifications, the Project's sedimentation ponds (Figure C.5.3-5) will be located downstream of the active mining areas and mining infrastructure areas during the operating life of the mine to receive and treat dewatering flows and surface water runoff for suspended solids prior to release into Blairmore Creek or Gold Creek. Design specifications for the sedimentation ponds are provided in detail in Section C.5.5.1. As indicated in Appendix 10B, Section 7.3 – Effluent Water Quality, the maximum predicted concentrations of cobalt, nitrate, selenium, sulphate and zinc within sedimentation ponds, are expected to meet applicable surface water quality guidelines, prior to release.

As described in Section C.5.5.1, the three surge ponds (NWSP, RWP, SESP) (Figure C.5.3-5) will be located downstream of the ex-pit waste dumps to collect toe seepage which is likely to contain elevated levels of selenium. As illustrated in Appendix 10B, Section 7.3, the surge ponds will receive runoff from external waste rock (NWSP, SESP, RWP) to collect ex-pit waste dump water that were modeled to have elevated concentrations of cobalt, nitrate, selenium, sulphate and zinc. The water collected within the surge ponds will be directed to the saturated zones for treatment during both the operation and closure phases. Section C.5.3 – Water Treatment provides details of the site water and selenium management plan.

As the intention of the surge ponds is for the engineered purpose of water management; to ensure capture and treatment prior to release to the associated downstream receiving environments, it is not entirely relevant to apply an aquatic health guideline to the surge ponds during operations. The application of an aquatic health guideline would be of potential relevance upon decommissioning, at which time theuses of these waters may change (*i.e.*, become a sustained aquatic habitat); note that presently, this is not the intended end of life use of these water bodies as these are to be filled in upon closure. A detailed assessment of the potential for water quality issues relating to Project activities has been provided in CR#5 – Surface Water Quality Assessment Report.

Surface water quality guidelines for the protection of aquatic health are not directly relevant to groundwater contained within the Saturated Zone. Instead, these waters are more adequately assessed through comparison to a groundwater quality guideline and through an understanding of potential for downgradient interaction with surface water bodies. Detailed assessment of the potential for water quality issues to negatively affect downstream surface waters is provided in CR#5 – Surface Water Quality Assessment Report and is further addressed in part c) of this response.

c) Discuss consequences of unintended exposure of aquatic (e.g. periphyton, benthic invertebrates, amphibians, and fish) and terrestrial biota (e.g. migratory birds) to water stored, or potentially seeping from surge ponds and saturation zones into downstream surface water (e.g. Gold Creek and Blairmore Creek).

Response:

The engineered ponds are unlikely to provide suitable substrate for lower trophic level aquatic organism (*e.g.*, periphyton or benthic invertebrates) as the base will be either be a mined bedrock or clay base) and these ponds will not be stocked with fish. There exists the potential for amphibians to migrate towards the engineered ponds; however, this exposure scenario is considered unlikely and negative effects at a population level are considered negligible. It is further anticipated that the potential for amphibian migration towards these ponds would be hindered by the level of ongoing disturbance surrounding these ponds and/or mitigations such as pit fall traps that could be monitored on a routine basis during open water or amphibian breeding seasons.

As described in the Wildlife Assessment (CR#9), the potential for terrestrial biota (*i.e.*, mammals and birds) to be exposed to the ponds is low. The design of the water management ponds is such

that minimal potential for entrapment of wildlife is expected. Due to the level of ongoing disturbance, wildlife exposure is not only of low likelihood, it is anticipated to be transient and would not provide a suitable long-term watering source for repeated exposure. As such, nominal exposure to impacted waters would be expected to have limited detrimental effect. Benga has committed to the development of a Wildlife Mitigation and Monitoring plan, which when implemented, will further reduce the potential for unintended exposure to terrestrial biota and reduce risk.

As part of the Project's water quality model conservative estimates, the Project's Water Management Plan will need to collect and capture 95% of the associated runoff and groundwater associated with the ex-pit dumps. The surface runoff requirements and design specifications for the sedimentation and surge ponds was provided in Section C.5.5, and for groundwater capture, a conceptual design of a seepage capture system was developed during the preparation of the Environment Impact Assessment, and was subsequently provided in a response to SIR#82 of the Alberta Energy Regulator (AER) Information Requests Response Package (Addendum 5, issued to the AER and CEA on February 28, 2018).

It has noted, that the water quality model output provided in Appendix 10B, Section 7 – Water Quality Results was intended to provide information for the purpose of helping inform the decision-making process for planning and mitigation rather than as an absolute prediction of receiving water data.

d) Describe mitigation measures to limit wildlife interaction with untreated water accumulating in surge ponds, other water management ponds and drainage ditches.

Response:

Final details of the mitigation measures required for limiting wildlife interaction with untreated water accumulating in surge ponds and other water management ponds and drainage ditches is subject to development of a detailed mitigation and monitoring plan. Benga has committed to completing such a detailed wildlife mitigation and monitoring plan subject to provincial and federal Approval Conditions and will be developed following Project approval.

Typical wildlife deterrents may include:

- wildlife fencing;
- amphibian pit fall traps; and
- mannequins (scare-crows).

Additional mitigation methods have also been described within Wildlife Assessment – CR#9, Section 7.1.5.

e) Discuss the extent to which COCs will be monitored in aquatic and terrestrial wildlife VCs throughout the course of the project.

Response:

The terms and frequency of monitoring for aquatic and terrestrial wildlife health have not been fully evaluated. This level of detail is subject to final development plans and is a component of a more detailed mitigation and monitoring plan. As previously indicated, Benga is committed to completing a detailed wildlife mitigation and monitoring plan based on provincial and federal Approval Conditions which will be developed following Project approval (CR#9, Section 7 – Wildlife Monitoring).

Additionally, water quality compliance monitoring will be in accordance with the terms defined under the EPEA approval for the Project. As stated in the Water Quality assessment (CR#5, Section 5.0 – Water Quality Monitoring), specific monitoring variables may vary depending on the type of pond and approval conditions. The frequency of sampling will vary depending on the whether the settling pond is classed as a major or minor pond in the approval. All sedimentation ponds will be equipped to use flocculants to assist with the removal of TSS, and will be classed as major ponds. Flocculants will be field tested for effectiveness and approved by the AER prior to use.

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

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

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

22. Inclusion of Amphibian Receptors in the Wildlife Risk Assessment

EIS Guidelines, Predicted Effects on Valued Components, Section 6.3.2 - Migratory Birds, Page 30; Section 6.3.3 Species at Risk, Page 31

Addendum to EIS, Consultant Report #12, Appendix H: Screening Wildlife Risk Assessment, Page H-1 to Page H-42.

Benga Mining, Conformity SIR Response, Attachment 2, Section 16 - Contaminants of Concern, Page 2-36

Benga Mining expanded the list of contaminants assessed to include those associated with coal mining activities, and compounds known to bioaccumulate and biomagnify that were not originally assessed. All toxicity reference values (TRVs) referenced for the Wildlife Risk Assessment (WRA) represent avian and mammalian receptors. Research shows that selenium can biomagnify in lentic systems through surface water to aquatic plants (BC MOE, 2014). In the Elk Valley, BC a study positively correlated deformities in Columbia Spotted Frog (CSF) tadpoles with water selenium concentrations (Selenium Status Report 2005/2006, Golder Associates Ltd., 2007). Several wildlife species, including amphibians, inhabit lentic aquatic habitats.

References:

British Columbia Ministry of Environment (2014). Ambient Water Quality Guidelines for Selenium Technical Report Update. Accessed: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/bc_moe_se_wqg.pdf

Golder Associates Ltd. (2007). Selenium Status Report 2005/2006 Elk Valley, BC. Accessed: http://www.teck.com/media/2005-Water-selenium_status_report_2005-2006-T3.2.3.2.1.pdf

a) Expand the WRA to include toxicological risk characterization of amphibian receptor species, in addition to avian and mammalian receptors already assessed.

Response:

Based on the results of the initial screening wildlife risk assessment (Consultants Report #12, Appendix H), responses to subsequent CEAA additional information requests (AIR) and Alberta Energy Regulator (AER) supplemental information requests (SIRs), assessment of multi-media exposure assessment (CEAA Technical AIR #38, CEAA AIR #14, AER SIR#162 and AER SIR#163), and the results of the surface water quality assessment and surface water mitigation factors (Consultants Report #5), it has been repeatedly demonstrated that there is no potential risk of adverse health effects to wildlife receptors due to Project emissions. Additional detailed evaluation of potential impact to wildlife receptors, including amphibian receptors species is not required based on the following rationale.

i. The results of the initial screening wildlife risk assessment (Consultants Report #12, Appendix H) indicated that based on predicted worst-case exposures, there was no potential risk of adverse health effects via exposure to soil and surface water impacted by Project air emissions. The screening wildlife risk assessment was conducted according to the principles and guidance presented in Ecological Risk Assessment Guidance (Environment Canada, 2012) and a Framework for Ecological Risk Assessment (CCME, 1996). The results of this assessment indicated no further assessment was required. The screening wildlife risk assessment included the following conservative assumptions: wildlife receptors were exposed to predicted soil and surface water concentrations at the RSA-MPOI; the worst-case predict soil and surface water concentrations were below established generic soil quality guideline or

surface water quality guidelines protective of sensitive species; and wildlife receptors were assumed to live for a life time at the RSA-MPOI.

ii. In the response to CEAA Technical AIR#38, the wildlife risk assessment was updated with additional toxicological reference values (TRV). All modelled surface water concentrations in the RSA are below the ESRD surface water quality guidelines for fresh water aquatic life (FAL) and wildlife watering. In cases where guidelines are not available, predicted contaminant of potential concern (COPC) concentrations are well below laboratory detection limits (antimony and PAH COPCs), or below guidelines for other exposure pathways, such as human drinking water ingestion (barium). No adverse health risks to human health or the environment (including aquatic life receptors and wildlife) are predicted due to waterbourne exposure pathways and requirement for further mitigation is not indicated.

iii. In response to CEAA additional Request #14 (AIR#14) detailed multimedia assessment of potential exposure to mammalian and avian receptors was conducted. The HQ results for this assessment were also substantially below 1.0, many by orders of magnitude. Therefore, additional, more detailed assessment of potential impact to wildlife receptors was not indicated.

b) Identify lentic habitat within the Project footprint and describe efforts to minimize contaminant exposure risks to amphibians and other wildlife receptors utilizing these types of habitat.

Response:

As stated in the response to Alberta Energy Regulator (AER) Supplemental Information Requests (AER SIRs) #152 and #163, wildlife receptors inhabiting lentic aquatic habitats will not be affected by the Project, and therefore do not require additional exposure risk assessment. As discussed in CR #5 - Surface Water Quality, Section 4 – Application Case and Planned Development Case for Surface Water Quality Assessment), no significant Project effects on surface water or groundwater quality are anticipated. Exposure to waterborne chemical of potential concern (COPC) is not an operative exposure pathway for human or wildlife receptors. Application of additional mitigation measures eliminates an exposure pathway for lentic aquatic habitats. Details describing the mitigation measures proposed for the protection of surface and groundwater quality is provided in the response to AER SIR 163 a) and b).

The exact details of the mitigation measures required for limiting wildlife interaction with untreated water accumulating in surge ponds and other water management ponds and drainage ditches is subject to development of a detailed mitigation and monitoring plan. Benga has committed to completing a detailed wildlife mitigation and monitoring plan subject to provincial and federal Approval Conditions and will be developed following Project approval (CR#9 Wildlife Assessment. Additional discussion of the mitigation measures required for limiting wildlife interactions including amphibians with untreated water is provided in ECCC SIR 21.

References:

CCME (Canadian Council of Ministers of the Environment). 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.

C. DEPARTMENT OF FISHERIES AND OCEANS

1. Consultant Report (CR)#6, Addendum, Section 4.2.3.1, Changes to Tributary and Mainstem Aquatic and/or Riparian Habitat, page 64, Table 4.4, Estimated loss of riparian habitat in the local study area due to Project activities

Table 4.4 contains estimates of the loss of riparian habitat in the local study area as a result of Project activities. There are large areas of varying qualities of riparian habitat that will be lost if the project is developed as proposed. Relating these estimated losses to the preliminary offsetting concept in Appendix A4, there doesn't seem to be any attention given to losses of riparian habitats along tributaries if they are deemed non-fish bearing. This does not take into account allochthonous inputs in Gold and Blairmore creeks and their tributaries. Removal of riparian vegetation may also lead to increases in flow, increased nutrient loading, increases in water temperature and fine particle sediment introduction that could impact fish and fish habitat.

1. Discuss how these potential effects will be mitigated or offset.

Response:

The Aquatic Effects Monitoring Program (AEMP) will address any scientific uncertainty associated with the assessment of Project effects on fish and fish habitat, as described in CR#6 Section 6.0 Proposed Monitoring and Follow-up. The proposed AEMP will integrate monitoring of all aquatic resources, including fish and fish habitat, stream flows, and water quality during operations, closure and early post-closure phases. Where applicable, the preferred study design for the AEMP is a before-after-control-impact (BACI) monitoring design. More detail on monitoring related to the specific issues identified in this SIR include:

Loss of allochthonous input: Potential changes in allochthonous input, with emphasis on Blairmore Creek watershed where the majority of riparian habitat changes are predicted, will be monitored through its potential effects on WSCT food supply (invertebrates). The approach will aim to evaluate changes in macroinvertebrate productivity and indirect effects to local WSCT. This could be performed through the application of a bioenergetic monitoring program. Bioenergetic habitat models are mechanistic (process-based) and offer an alternative to correlative habitat suitability models for drift-feeding fish and have the potential to predict habitat-specific growth rates based on swimming costs and energy intake. Bioenergetics can be a useful application for this system since WSCT are predominantly drift-feeders, thus bioenergetics could provide a direct measure of changes in fish habitat productivity through the calculation of net energy intake (NEI) rates:

- **Increase in flow**: Hydrometric stations deployed in Gold and Blairmore creeks since 2016 continue to collect annual/seasonal baseline streamflow data. This database will be used to refine baseline hydrological conditions and test the predictions of flow changes described in CR#6 Section 4.2.3.2 Changes to Hydrology in Gold and Blairmore Creeks Potentially Affecting Westslope Cutthroat Trout Habitat. These predicted flow changes incorporated assumptions on runoff yield between undisturbed and disturbed watershed

areas (CR#6 Appendix A3 Section 3.5.1 Average Hydrological Conditions), therefore potential increase in flow due to loss of riparian habitat was incorporated into the model.

- **Increase in nutrient loading**: The AEMP will include water quality monitoring, which will include nutrients such as phosphorous and nitrogen as described in CR#5 Section 5.0 Water Quality Monitoring. In addition, monitoring for stream periphyton and invertebrates will be considered, which can also inform the extent of any nutrient loading. These data can be used to test the predictions for changes in water quality as described in CR#6 Section 4.2.2.4 Changes to Water Quality Affecting the Health of Westslope Cutthroat Trout.
- **Increase in water temperature**: In addition to flow, the current network of hydrometric stations installed in Gold and Blairmore creeks are actively collecting continuous data on stream temperature at various stations. Additional temperature data loggers are also deployed collecting temperature data in other key areas of Gold and Blairmore watersheds (*e.g.*, Caudron Creek). This database will be used to monitor trends prior to mine development and validate predicted water temperature changes as identified in CR#6 Section 4.2.2.1 Changes in Water Temperature.
- **Increase in fine particle sediment**: The water quality monitoring will include parameters to detect any increase in fine particle sediment (*i.e.*, TSS, turbidity). Monitoring of stream habitat quality will also detect any deposition of fines on sensitive areas, such as spawning habitat.

If any additional adverse effects resulting from changes in allochthonous input, increase in streamflow, or water quality (*i.e.*, nutrient loading, changes in stream temperature, elevated sediment load) are detected, Benga will evaluate the opportunity for additional mitigation to reduce the spatial scale, duration or intensity of the effects. As described in CR#6 Section 6.1.1 Adaptive Management, Benga is committed to achieving continual improvement in environmental performance by applying an adaptive management approach to monitoring and follow-up programs. If residual serious harm to fish remains after mitigation, additional offsetting measures will be evaluated to counterbalance the effect, if required. The detailed Habitat Offsetting Plan will include contingency measures to address additional residual effects to fish and fish habitat.

2. CR#6, Addendum, Section 4.2, Pathways Analysis, Page 47, Table 4.2, Potential pathway for effects on westslope cutthroat trout

Benga states, "Water will be pumped to the upper reaches of Gold Creek (above Caudron Creek confluence) to mitigate potential incremental reductions in flows in Gold Creek during low flow periods (e.g. 1:10, 1:20) during operations, as deemed necessary".

1. What is the reason that upper-Gold Creek flows will need to be supplemented? Discuss.

Response:

The Instream Flow Assessment (IFA, CR#6 Appendix A3) predicted a potential decrease in flow in Gold Creek; subsequently, flows in upper Gold Creek (above the Caudron Creek confluence, reaches 8 and 9) may benefit from supplementation during infrequent dry and/or drought periods

(*e.g.*, 1:10, 1:20) to mitigate for changes in habitat quality and/or quantity. The IFA predicted decreased Area Weighted Suitability (AWS) for some months during spawning and rearing bioperiods under drought hydrological conditions (CR#6 Appendix A3 Section 4.1.3.2 Drought Hydrological Conditions). For example, during operations (2019-2042) in a 1:20 dry year, adult rearing habitat is predicted to decrease by 17 m^2 on average (over the duration of the bioperiod) with a 57 m^2 one-month maximum; juvenile rearing habitat is predicted to decrease by 15 m^2 on average (over the duration of the bioperiod) with a 61 m^2 one-month maximum; and spawning habitat is predicted to decrease by 9 m^2 (over the duration of the bioperiod) on average with a 27 m^2 one-month maximum (CR#6 Appendix A3 Table 4-3). Since the predicted habitat changes are relatively small and hydrological conditions are highly variable, it is proposed that ongoing hydrologic and habitat monitoring be performed as part of the Project Aquatic Effects Monitoring Program (AEMP, see CR#6 Section 6.0 Proposed Monitoring and Follow-up) to confirm modelling predictions and identify whether upper Gold Creek would actually need flow supplementation.

2. Provide information on how the pump(s) capacity adequately addresses the potential seasonal and annual variability in flows that could be encountered in Gold Creek.

Response:

As noted in response No. 1, the areas of predicted habitat change are relatively small and hydrological conditions are highly variable therefore it is proposed that the benefits and necessity of flow supplementation mitigation be continually evaluated as part of the Project's AEMP. If flow supplementation is determined to be beneficial and feasible, it will be executed as part of the Project's Water Quality Management Plan (WMP), which is designed to actively control water quality and quantity for the mine site.

3. What is the likelihood of having to supplement flows during the winter and how will water pumping be executed under frozen/freezing conditions?

Response:

The IFA did not predict any changes in hydrology that would require flow supplementation during the winter (see overwintering bioperiods in CR#6 Appendix A3 Tables 4-1, 4-2 and 4-3), thus flow supplementation during the winter months is not required.

4. Discuss the expected length of time that pumping may be required to supplement flows in Gold Creek; i.e., hours…days…years…?

Response:

As described in response No. 1 above, the spawning (May 1 – July 31) and rearing (April 1 – September 30) bioperiods during infrequent dry/drought conditions (*e.g.*, 1:10, 1:20) have been identified as potential time periods during which flow supplementation mitigation may be beneficial. The technical implementation of this flow supplementation will be integrated into the WMP, should it be required (see response No. 2, above).

5. If other watercourses in the Project area are subject to flow supplementation, discuss in the context of the previous four information requests stated above.

Response:

Based on the results of the IFA (CR#6 Appendix A3), no other watercourses in the Project area have been identified as potential candidates for flow supplementation. The need for flow supplementation mitigation would be further evaluated as part of ongoing baseline hydrology monitoring and the Project AEMP monitoring of hydrologic and habitat conditions. Discharge to Blairmore Creek as part of the Project is described in the water load balance model (Appendix 10B) and the IFA (CR#6 Appendix A3).

3. CR#6, Addendum, Section 4.3 Application Case, Page 70, Table 4.5, Project activities that will result in residual effects on aquatic ecological resources in the LSA.

CR#6, Addendum, Section 4.3.1.1, Page 71

Table 4.5: Project activities that will result in residual effects on aquatic ecological resources in the [local study area (LSA)] contain a description of "land clearing and construction of the rail loop and bridge crossing of Blairmore Creek".

In Section 4.3.1.1, Benga states: "Construction of the [coal handling and preparation plant] facility, camp, golf course, rail loop, bridge crossings, and haul road will follow BMPs and mitigation, including *Code of Practice for Watercourse Crossings* (AESRD 2013a) and *Stepping Back from the Water: A Beneficial Management Practices Guide for New Development Near Water Bodies in Alberta's Settled Region* (AESRD 2012). Detail design will aim to avoid any in-stream work for these features, particularly on mainstem watercourses".

1. Discuss the methodology that will be used to install a watercourse crossing over Blairmore Creek.

    a. Highlight whether or not isolations will be required and by what means, how fish passage will be maintained and the specific mitigations that will be employed to minimize serious harm to fish.

Response:

The proposed rail loop will require a permanent crossing over Blairmore Creek. Currently, Benga is proposing an open bottom concrete arch culvert to span Blairmore Creek. Detailed design for this crossing will include evaluation of technical and environmental feasibility including development of construction methodology following Best Management Practices (BMPs) and mitigation such as Measures to Avoid Causing Harm to Fish and Fish Habitat including Aquatic Species at Risk[4]. If isolation on Blairmore Creek is required, mitigation will include (but not be limited to):

- use of only clean materials free of suspendable matter for temporary coffer dams;

4 DFO. 2016. Measures to avoid causing harm to fish and fish habitat including aquatic species at risk. Accessed April 16, 2018: http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html

- situate or otherwise manage flow withdrawal and discharge so as to prevent erosion and sediment release to the waterbody;
- ensure the work zone is stabilized to the extent practical against the high impacts of high flow events during the work period; and
- remove fish from isolated in-water work zones if necessary.

Site-specific environmental management is subject to change as detailed design and construction sequences are refined. A detailed description of the proposed works including mitigation to avoid or minimize serious harm to fish will be captured in a Project Construction Environmental Management Plan (CEMP) with information provided as part of project permitting (*e.g.*, Application for a Fisheries Act Authorization/SARA Approval).

2. If other watercourse crossings are predicted for mine operations, discuss in the same context as the previous information request.

Response:

No other watercourse crossings are required for construction or mine operations. Associated tributaries to both Blairmore and Gold Creeks, that may be influenced by the Project Water Management Plan will be captured under the Project's CEMP.

4. CR#6, Addendum, Section 6.0, Proposed Monitoring and Follow up, page 98

Benga states: "It should be highlighted that Benga has partially funded a research project that specifically investigates the quality, exten[t] and use of overwintering habitat by [westslope cutthroat trout (WSCT)] in Gold and Blairmore creeks. This research is ongoing and is being run through the University of Lethbridge (Dr. Jospeh Rasmussen). This information will build upon the baseline overwintering habitat data collected as part of this effects assessment and provide valuable information moving forward to ensure the Gold and Blairmore populations of WSCT are well protected".

1. Are the results of these data available?

   a. If yes, provide the data.

Response:

Please see response DFO SIR 4(1b).

   b. If not, provide a timeline on when this data may be available?

Response:

The data from the University of Lethbridge is not publicly available at this time. A graduate student is intending to publish the data, in partial fulfillment of a Master of Science degree with the University of Lethbridge, as a thesis and in peer-reviewed journals. The target submission date is Fall 2018.

2. Discuss how this data will be taken into consideration in the context of the predicted alterations to the flow regime in Gold and Blairmore creeks.

Response:

This research is targeting the quality, extent, and use of overwintering habitat by WSCT in Gold, Blairmore, and Daisy creeks and is not expected to provide context to the predicated alterations to the flow regime in Gold and Blairmore creeks. Once the data are available, the research will be evaluated to confirm this assumption. The overwintering data are expected to provide additional value in the identification of limiting habitat and prioritization of habitat offsetting options. Preliminary dialogue with the University of Lethbridge regarding their evaluation of overwintering habitat quality, extent, and use suggest alignment with the data compiled as part of the EIS.

5. CR#6, Addendum, Appendix A3, Instream Flow Assessment, Appendix A4, Stream Temperature Memo, Section 1.0, Introduction, Page 1

Benga states: "Water temperature was modeled for Gold and Blairmore creeks over the lifespan of Grassy Mountain Coal mine from pre-construction to post-closure (i.e., 2017 to 2099) to determine how, during each phase of the mine, maximum monthly changes in forecasted flow (Appendix 1) could affect key bioperiods of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*; WSCT)".

As per the discussion throughout Appendix A4, it is unclear what potential influence water retention ponds, including any ponds that are proposed to discharge to Gold or Blairmore creeks or their tributaries, will have on the water temperature in receiving watercourses. Considering these retention ponds will receive thermal input over a large surface area, clarify whether or not this data has been included in the water temperature model, and/or model the influence that retention ponds may or may not have on receiving waters. Consider key fish life history criteria in the discussion.

Response:

The water temperature model provided in CR#6 Appendix A3 Instream Flow Assessment Appendix A4 Stream Temperature Memo uses predicted changes in Project flows on a sub-catchment level (CR#4) to predict changes to water temperature in Gold and Blairmore creeks. The water quantity contribution of sedimentation ponds (*i.e.*, retention ponds) was incorporated into the runoff calculations based on the results from the water load balance model (CR#4 Appendix 10b) developed for the Project. Thus, the influence of retention ponds to overall stream temperature has been accounted for in the stream temperature model (CR#6 Appendix A4 of Appendix A3).

6. CR#6, Addendum, Appendix A4, Preliminary Habitat Offsetting Plan, Section 5.0, Preliminary Offsetting Options, Page 15, Table 5.1, Potential habitat offsetting options for the Project

Benga has identified five examples of potential projects that could be executed to offset the residual serious harm to fish associated with the Grassy Mountain Coal Project proposal. Fisheries offsets are an important mitigation for unavoidable project effects; therefore, Fisheries and Oceans requires an understanding of what the fisheries offset will be for the purpose of the environmental assessment.

1. Select a fisheries offset or offsets, and prepare an offset plan in a detailed report identifying how the offset will: meet Fisheries and Oceans Fisheries Productivity Investment Policy; and, the objectives in the Recovery Strategy for Westslope Cutthroat Trout (Oncorhynchus clarkia lewisi), Alberta Populations in Canada. This plan must be detailed enough to be considered for project effects in the context of a joint federal-provincial environmental assessment.

Response:

A detailed Habitat Offsetting Plan is currently under development building upon the Preliminary Habitat Offsetting Plan (CR#6, Addendum, Appendix A4) and incorporating the necessary information as specifically noted in SIR#6 (1) and (2), above. Target submission of the draft detailed offsetting plan to DFO for review is Q2 2018. The intent of the draft is that it will be shared and discussed with DFO and that finalization of the Habitat Offsetting Plan will be subject to additional feedback from DFO.

2. Clearly identify why the offset(s) was selected and how it will maintain or improve fisheries productivity and meet the objectives in the Recovery Strategy for Westslope Cutthroat Trout in the context of uncertainty of project effects and the uncertainty of the success of the offset as proposed.

Response:

See response DFO SIR 6(1).

7. CR#6, Addendum, Appendix A4, Preliminary Habitat Offsetting Plan, Section 6.0, Effectiveness Monitoring for Offsetting, Page 35, Table 6.1, Framework for the effectiveness monitoring program (adapted from Smokorowski et al. 2015)

Benga proposes a framework for the development of a monitoring plan that has seven components designed to assess the effectiveness of offsetting and to determine if the offsetting activity is ecologically stable and self-sustaining. The following is a list of the seven criterion: establish the goals of monitoring; establish quantitative targets, based on equivalency metrics; determine likelihood of success of offsetting, monitoring frequency and intensity to be adjusted based on uncertainty; define monitoring metrics, based on equivalency metrics and metrics used to characterize baseline data; create monitoring design; determine duration of monitoring pre- and post-offsetting; and, report, following standardized format.

1. In the context of the selected fisheries offset(s) prepare a detailed monitoring plan, or include as an appendix in the offsetting plan a document that:

    a. clearly identifies the goals of monitoring;

Response:

As part of the detailed Habitat Offsetting Plan, an effectiveness monitoring design will be included that comprises the criteria identified in SIR#7 (1) (a-g), above, including metrics highlighted by Smokorowski et al. 2015 and in consideration of other applicable science including peer reviewed literature and existing watershed/population conditions (*i.e.*, barriers, population isolation). Target submission of the draft detailed offsetting plan to DFO is Q2 2018 and will be shared and discussed with DFO. Finalization of the detailed Habitat Offsetting Plan and the associated effectiveness monitoring program will be subject to additional feedback from DFO.

    b. describes the quantitative targets and why these targets have been selected as a measure of the success of the offsetting plan;

Response:

See response DFO SIR 7(1)(a).

    c. describes the frequency of monitoring, contingencies in the event that monitoring cannot be achieved as proposed based on site specific issues and identify why the frequency and duration of monitoring has been selected;

Response:

See response DFO SIR 7(1)(a).

    d. clearly identify the monitoring metrics as it relates to baseline data and how this will be used to measure the progress of the fisheries offset;

Response:

See response DFO SIR 7(1)(a).

    e. describes the monitoring design in detail;

Response:

See response DFO SIR 7(1)(a).

    f. describes the duration of monitoring, milestones and identify why the duration has been selected as a measure of the success of the fisheries offset; and,

Response:

See response DFO SIR 7(1)(a).

g. describes the reporting format and target dates for the submission of monitoring reports. If target dates are based on milestones, elaborate and discuss.

Response:

See response DFO SIR 7(1)(a).

8. Volume 2, Section H, Aboriginal Consultation, Sections H3 – H13

Benga has engaged several Indigenous communities that may have interest in the Grassy Mountain Coal Mine Proposal. These communities include: Kainai Nation, Pikani Nation, Siksika Nation, Stoney Nakoda Nation, Tsuu T'ina Nation, Ktunaxa Nation, Samson Cree Nation, Shuswap Indian Band, Foothills Ojibway First Nation, Metis Nation of Alberta Region 3 and Metis Nation of British Columbia Region 4. All of these groups have expressed interest and/or use of fish for subsistence, social or ceremonial purposes.

1. In the context of Fisheries and Oceans mandate, provide a summary of additional comments received by interested Indigenous groups after the environmental impact assessment was submitted.

   a. Identify feedback provided by the communities on monitoring, mitigation and the offsetting plan.

Response:

The following is a summary of feedback related to fish monitoring, mitigation, and/or offsetting since the submission of the August 2016 environmental impact assessment by the following Aboriginal Groups: Kainai First Nation, Piikani First Nation, and Tsuut'ina First Nation (Tables DFO 8-1, DFO 8-2, and DFO 8-3, respectively).

To date, neither the Siksika First Nation nor the Stoney Nakoda Nation have provided feedback regarding fishs monitoring, mitigation, and/or offsetting.

Table DFO 8-1 Fish Monitoring, Mitigation, or Offsetting Feedback from the Kainai First Nation (Blood Tribe)

Document or Meeting Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
Minutes from the June 6, 2017 Meeting with Blood Tribe.	Blood Tribe would like active involvement in the monitoring program.	Community Participation in Monitoring	Benga has provided information to Blood Tribe about potential ways they can participate in environmental monitoring.

Table DFO 8-1 Fish Monitoring, Mitigation, or Offsetting Feedback from the Kainai First Nation (Blood Tribe)

Document or Meeting Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
Minutes from the June 6, 2017 Meeting with Blood Tribe.	There are a great deal of problems with phosphorus in the water. Will the explosions create cracks in the earth and lead to added releases of nutrients in the water?	Water quality	Benga will implement a Water Management Plan (WMP) that will prevent any unwanted release of water that may not meet provincial or federal water quality guidelines. All water (surface and groundwater) will be collected, held, and only released once it meets the appropriate or applicable water quality guideline. For any acute releases (*i.e.*, in the event of an emergency), Benga will have the appropriate (and effective) Emergency Response Plans in place, and will ensure qualified staff are in place to implement these plans. All of the holding ponds that will be onsite were over engineered to meet Alberta's Dam Safety requirements. Benga will develop and implement an Emergency Response Plan in relation to potential accidents that would affect the environment, and are committed to discussing and receiving input from the Blood Tribe on these plans.
Minutes from the June 6, 2017 Meeting with Blood Tribe.	Treaty rights are impacted adversely if we cannot hunt or fish. Need to figure out how to address and mitigate this.	Treaty rights; Hunting; Fishing	This issue was considered in the updated Environmental Impact Assessment (EIA) (August 2016) which has been provided to Blood Tribe. Information from the Blood Tribe will help shape the structure and objectives of monitoring plan. Information provided in the Blood Tribe Traditional Use Study, including information about wildlife, was considered in the EIA under potential effects to wildlife and potential effects to hunting.

Table DFO 8-2 Fish Monitoring, Mitigation, or Offsetting Feedback from the Piikani First Nation

Document or Meeting Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
December 15, 2016 Letter re: Consultation Plan sent to Cal Clarke, Benga Mining Ltd., from Dustin Wolfe, Piikani Consultation Manager.	Piikani would like to work with Riversdale in the design, implementation and monitoring of the Project's Groundwater and Surface Water Management and Monitoring Plans.	Groundwater and Surface Water Management and Monitoring Plans	Benga would welcome the opportunity to work with the Piikani on developing details associated with the Groundwater and Surface Water Management and Monitoring Plans
December 15, 2016 Letter re: Consultation Plan sent to Cal Clarke, Benga Mining Ltd., from Dustin Wolfe, Piikani Consultation Manager.	Piikani requests that Riversdale develop a plan to replace any fish habitat they disturb. This will include a couple of different programs, which Piikani would like to be involved with, they are: Piikani Fisheries Offset Plan (create or protect more habitat than Riversdale removes) and a Westslope Cut-throat Trout Recovery Plan	Fisheries Offset and Trout Recovering Plans	An Addendum that comprised a comprehensive Aquatic Environment Assessment was provided to the Alberta Energy Regulator (AER) and Canadian Environmental Impact Assessment Agency (CEAA) on January 31, 2017. This Addendum provides a detailed baseline data site, including a benchmark for fish population in both creeks, a comprehensive habitat assessment, geomorphology assessment, benthic invertebrate assessment, and an instream flow needs (IFN) assessment. Offsetting options were identified in this Addendum, and Benga are in the process of providing details around the final Offset Plan. Benga welcome the opportunity to discuss the process and request any suggestions regarding this from the Piikani Nation.
March 22 - 23, 2017 Technical Review Conference Calls	We would like to see biomonitoring that includes measuring Se in attached algae (periphyton) and benthic invertebrates in Blairmore and Gold creeks to ensure that fish tissues remain below the chronic tissue residue guideline of 4 µg Se/g.	Surface Water Management	Detailed plans on monitoring selenium have not been developed to date. Benga welcomes the opportunity to discuss monitoring plans with Piikani Nation.
March 22 - 23, 2017 Technical Review Conference Calls	The First Nation would like to include options for more equitably dividing flows between the two rivers so that fish habitat in Gold Creek can be sustained under low flow conditions.	Surface Water Management	Benga have conducted a detailed instream flow needs (IFN) for the project area, and the flows needs for the aquatic environment are well understood. The potential impacts of the project on aquatic resources are well understood under normal seasonal conditions as well as a dry year scenario

Table DFO 8-2 Fish Monitoring, Mitigation, or Offsetting Feedback from the Piikani First Nation			
Document or Meeting Reference	**Specific Concern Expressed**	**Project Specific Aspect of the Concern Expressed**	**Proponent Response or Effort to Avoid or Mitigate Concern**
			were now understood. The mitigation of flow augmentation is available under operational conditions if needed. Offset Planning may account for this as well.

Appendix C-1 provides a summary of questions received by Benga from the Piikani Nation as part of their review of the environmental impact assessment document dated November 2015, in support from a 3rd party reviewer,

Table DFO 8-3 Fish Monitoring, Mitigation, or Offsetting Feedback from the Tsuut'ina First Nation			
Document or Meeting Reference	**Specific Concern Expressed**	**Project Specific Aspect of the Concern Expressed**	**Proponent Response on Effort to Avoid or Mitigate Concern**
Minutes from Meeting on June 8, 2017 between Tsuut'ina, CEAA and Benga	Tsuut'ina Nation would like water monitoring to be continuous. Water is seen as a medicine and has ceremonial use.	Monitoring	High level details of the water monitoring plan are presented in Section 7.0 of the August 2016 Environmental Impact Assessment (EIA) Update. Monitoring frequency will vary depending on the parameters being monitored and the plan will be approved by AER. Water held in storage ponds will always be tested prior to being released to ensure water quality parameters are being met.

b. Identify any preferences/protocol for continued engagement with the Proponent and government regulators.

Response:

Section H.1 – Aboriginal Consultation of the application provides an overview of the consultation process for the affected Aboriginal Groups. Benga tracks, addresses, and reports on issues and concerns identified by Aboriginal Groups using the Alberta Consultation Office's Specific Concern and Response Table form. The Treaty 7 Nations and Benga are working through developed tables to resolve identified issues and concerns that have been raised during

the regulatory process. No further preferences or protocols have been identified for engaging with the Proponent or with government regulators. Further information regarding engagement with Benga and government regulators is provided in part c of the response.

c. Identify any requests for discipline specific meetings; i.e., fisheries, and what the Proponents approach will be for continued engagement with interested Indigenous groups.

Response:

The following is a summary of records of communication regarding fish monitoring, mitigations, and offsetting with the following Aboriginal Groups: Kainai First Nation, Piikani First Nation, Siksika First Nation, Stoney Nakoda Nation, and Tsuut'ina First Nation (Tables DFO 8-4 to DFO 8-8, respectively).

Table DFO 8-4 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Kainai First Nation (Blood Tribe)

Date	Method of Communication	Topic of Communication
October 28, 2016	Meeting	Meeting took place to review project updates. Key discussion points included: Blood Tribe Community events and elections; transition to new Chief and Council; project regulatory updates, site specific mitigation and timing for a meeting to review 1) issues and concerns 2) mitigations. Discussed a follow up issues and mitigations meeting (tentative date set for November 14, 2016).
December 9, 2016	Meeting	Benga participated in a guided tour of the reserve communities. A project meeting followed the tour. Main items discussed at the project meeting: 1) consultation workplan 2) timing for a mitigation meeting.
February 15, 2017	Meeting	The meeting was arranged to further develop the Blood Tribe's Consultation Workplan for the Grassy Mountain Project and review upcoming planning for consultation related tasks. Follow up from this meeting included: Benga to work with the Blood Tribe to identify ways community members can contribute to and participate in monitoring.
May 19, 2017	Meeting	Meeting took place to review project updates, provide Addendums to the Environmental Impact Assessment (EIA) and discuss consultation activities moving forward. Hand delivery of USB containing 1) updated aquatic ecology assessment (Consultant Report #6) 2) updated wildlife assessment (Consultant Report #8).
June 6, 2017	Meeting	Meeting took place to provide a presentation and summary of the main objectives and results of the Grassy Mountain Environmental Impact Assessment (EIA, August 2016 version) and to answer

Table DFO 8-4 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Kainai First Nation (Blood Tribe)		
Date	**Method of Communication**	**Topic of Communication**
		questions related to consultation timelines, the technical aspects of the assessment and follow up programs. Hand outs included: 1) hard copy of EIA presentation 2) project infrastructure and Crown land map. Main discussion items included: 1) EIA project presentation which included a review of timelines, project components, overview of construction, operations, reclamation and closure phases and status of Project applications, including federal and provincial approvals 2) the development of the monitoring program and adaptive management plans. Benga will continue to work with the Blood Tribe to address the following items: organize meeting to further discuss the monitoring program options; and provide a summary of the environmental management plans to Blood Tribe.

Table DFO 8-5 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Piikani First Nation		
Date	**Method of Communication**	**Topic of Communication**
December 22, 2016	Email	Piikani Nation sent a letter (dated December 15, 2016) outlining plans for on-going consultation with Piikani Nation on the Grassy Mountain Project. The letter outlined a plan for Piikani First Nation to work collaboratively with Benga to address requests and recommendations itemized within the Piikani Technical Review of the EIA and CEAA's Supplementary Information Request (SIR). Areas of interest noted included: Groundwater and Surface Water Management and Monitoring Plans; and Fisheries Offset and Trout Recovery Plans. A series of conference calls were being arranged in March 2017 with Piikani Nation Consultation, Piikani Nation technical consultants and Benga to discuss Piikani Nation's questions related to each area of interest noted in the letter. The conference calls will be followed by a workshop in May 2017 to discuss further
February 2, 2017	Meeting	Meeting to review project updates. Hand delivery of 1 USB containing the EIA (August 2016) and Addendum (wildlife and aquatics). Key discussion points: consultation planning and upcoming tasks related to the EIA technical review workshop planned to discuss issues presented in the

Table DFO 8-5 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Piikani First Nation

Date	Method of Communication	Topic of Communication
		summary letter (December 15, 2016); timing and format of an issues and mitigations meeting discussed; reviewed the 9 issues and recommendations presented in the summary letter and the implementation of a monitoring program. Follow up items: 1) Schedule the technical review workshop 2) Schedule Issues/Mitigation meeting 3) Provide information on monitoring programs
March 20, 2017	Email	Email meeting request for Conference call from Benga to Piikani Nation. Agenda items to include ground water, surface water, fisheries and trout recovery.
March 22, 2017	Meeting	Conference call to discuss ground water, surface water, hydrology, fisheries offsets and trout recovery in preparation for the upcoming Piikani Technical Review workshop to take place in April, 2017. Call arranged to address concerns and recommendations outlined in Piikani Nation's technical review of the environmental impact assessment for the Project. Main areas of discussion included: management and monitoring plans including details on the integration of traditional knowledge into the design; First Nation involvement in the monitoring, management plan, stewardship program and mitigation measure development; assessment of natural springs and; communication of results to First Nation members.
April 4, 2017	Email	Piikani Nation outlined plans for the May 3 and May 4, 2017 workshops; May 3 to include Piikani Nation only; May 4 to include Piikani Consultation, Piikani technical consultants and Benga. A series of monitoring-based meetings/information sessions for community members to be arranged at a later date between May-July 2017.
May 2, 2017	Email	Erin Slater emailed several documents: 1) Conceptual Offset Plan Memo 2) EIA update Memo 3) Meeting Agenda 4) Q/A for March 22-23, 2017 conference calls.
May 4, 2017	Meeting	Meeting was arranged as a follow up to the community based Technical Review Workshop that took place on May 3, 2017 at Piikani Nation. Key discussion points included: discuss what Piikani Nation would like to see in the follow up and monitoring programs.
November 23, 2017	Meeting	Project meeting to review specific concerns and response tables. Key discussion points included: • EIA Monitoring Summary; Environmental Management Plans (EMPs) Summary; Specific Issues/Concerns Table (Draft Version – Nov 23, 2017) • Monitoring and Development of Environmental Management Plans • Mitigation Meeting • Next meeting date

Table DFO 8-6 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Siksika First Nation

Date	Method of Communication	Topic of Communication
March 3, 2017	Meeting	Meeting took place to discuss project updates, provide addendums to the Environmental Impact Assessment (EIA) and consultation activities moving forward. Hand delivery of USB containing 1) updated aquatic ecology assessment (Consultant Report #6) 2) updated wildlife assessment (Consultant Report #8)
October 17, 2017	Email	Benga requested a call with Siksika Nation to a future meeting to discuss Environmental Impact Assessment (EIA) results, and review mitigations and the consultation process.

Table DFO 8-7 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Stoney Nakoda First Nation

Date	Method of Communication	Topic of Communication
January 12, 2017	Meeting	Meeting to discuss project updates, status of the Environmental Impact Assessment (EIA) and consultation activities moving forward. Main discussion items included Project Regulatory updates and status of the AER review and joint panel review process, and technical review of the EIA.
March 8, 2017	Meeting	Meeting took place to discuss project updates, and consultation activities. Hand delivery of USB containing 1) updated aquatic ecology assessment (Consultant Report #6) 2) updated wildlife assessment (Consultant Report #8). Main items discussed included: Project regulatory updates; timing for a meeting to review the updated version of the EIA and CEAA process; and technical review of the EIA.
November 24, 2017	Meeting	Meeting to review issues, concerns and recommendations for mitigation identified by the Stoney Nation since the onset of consultation activities on the Grassy Mountain Project. Benga reviewed the contents of the meeting information package and provided documents for SNN review and input, including: EIA Monitoring Summary; GMP Environmental Management Plans Summary; and Concern and Response Table (Nov 24 version).

Table DFO 8-8 Record of Communication Regarding Fish Monitoring, Mitigation, or Offsetting Feedback with the Tsuut'ina First Nation		
Date	**Method of Communication**	**Topic of Communication**
March 10, 2017	Meeting	Meeting to discuss project updates. Hand delivery of USB containing 1) updated aquatic ecology assessment (Consultant Report #6) 2) updated wildlife assessment (Consultant Report #8). Main discussion items included project regulatory updates.
June 8, 2017	Meeting	Meeting took place to provide a presentation and summary of the main objectives and results of the Grassy Mountain Environmental Impact Assessment (EIA, August 2016 version) and to answer questions related to consultation timelines, the technical aspects of the assessment, and follow up programs. Hard copy hand outs included: 1) hard copy of EIA presentation 2) project infrastructure and Crown land map (June, 2017) 3) Project newsletter (Spring 2017 Issue).
October 6, 2017	Email	Erin Slater emailed Declan Starlight to ask timing for a mitigation meeting. Asked if they could start looking at dates in November, December or January for the mitigation meeting.

January 2017 Addendum 1, Aquatics Ecology Assessment, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, General

SNC-Lavalin Inc. (SNC-Lavalin) conducted a baseline geomorphic field assessment on both Blairmore Creek and Gold Creek. The baseline assessment contained a mapping level field reconnaissance where reaches were characterized into their dominant morphologies, and a mapping level survey was done characterizing geomorphic features of interest, sediment sources, sediment sinks, grain sizes (D50 and D90) and any instances of instabilities (bifurcations, bank erosion etc.). While the level of detail in the assessment and reach descriptions is high, limited quantitative metrics are carried forward to the impact analysis. Typically, detailed geomorphic surveys are conducted in concert with the reconnaissance/mapping level assessments which include; detailed cross-sections, longitudinal profiles and sediment samples. While metrics are included which imply these were done (bankfull widths/depths, D50 and D90 values and slopes), the exact nature of how these were measured in the field remains unclear and the data inputs and assumptions used in the impact analysis do not reflect the perceived level of data collected.

The impact analysis itself considers sediment mobility of both the median and largest particles (quantified by D50 and D90) for both the 2-year (assumed to equal the bankfull discharge) and the 100-year return period discharges throughout the lifespan of the project. The discussed Water Management Plan (WMP) will result in a reduction of peak discharges, and a redistribution of water to extend baseflow. Overall, it is concluded that due to the reduction in peak flow, the stability of the channel beds will not be impacted, and that the

redistribution of runoff to more baseflow will not impact bed stability as sediment moves at peak discharges.

Overall, this approach is limited since, in many cases, median (and greater) particle sizes were determined to be mobile well below the 2-year discharge. This is not an uncommon occurrence as sediment mobility is not particularly tied to a specific return period peak discharge. Instead, it is important to consider changes to the entire flow regime, and not just peak discharges. For example, if the captured peak discharges from Gold Creek are stored and released into Blairmore Creek, this process may lag that of runoff from the actual storm runoff; however, the attenuated release of the volume may still exceed the receiving rivers erosion thresholds. Assessing these impacts is commonly done by erosion threshold and threshold exceedance analyses. Field surveys and sampling inform the susceptibility to erosion (or erosion thresholds) of both the bed and bank material. These thresholds (shear stresses) are then combined with hydraulic modelling to determine the discharges that equal the established erosion thresholds. Then, the entire flow regime is assessed to determine both the magnitude (excess shear) and duration (time) that discharges exceed the erosion thresholds.

Assessing the fluvial geomorphic response of the Gold and Blairmore Creeks to changes in flow regime is important not only from a channel stability perspective, but it also needs to inform impacts on fish habitat.

For example, the fluvial assessment should consider critical westslope cutthroat trout habitat in its assessment, particularly spawning habitat, which is reliant on smaller sized gravels that can become mobilized under lower flow conditions and are likely sensitive to changes in the flow regime. For example, as flow is predicted to decrease in Gold Creek there is a higher likelihood of fine sediment deposition on the gravels beds. Correspondingly, Blairmore Creek is predicted to receive increased flows, with peak increases upward 33%. Again, how will these flows impact spawning gravels - will they be mobilized and redistributed? To this end, the location of detailed geomorphological survey stations should be correlated to critical fish habitats identified within the two watercourse systems.

The following are detailed SIR's which relate to these general concepts.

9. CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 2.3, Geomorphic Effects Assessment, Page 9

Cross-sections used for the sediment mobility analysis were not measured by SNC-Lavalin, but instead by another consultant (Hatfield). The report indicates that the slopes and roughness values for these sections were used from nearby sites. No information is given as to what types of morphological units these cross- sections represent. For example, riffles and pools both have different hydraulic characteristics and the resulting shear stress for a given discharge may be different. It is unclear what these cross sections represent, and they are not included in figures or appendices for reference. It is also unclear how channel slopes were measured in the field.

1. Provide more detail on how the cross-sections were selected, which morphologic features they represented and how they were ensured to be representative to the geomorphic assessment locations.

Response:

The cross-sections were measured using standard survey leveling equipment (optical level, tripod and stadia rod). The same cross-sections were used in the fluvial geomorphology assessment and the instream flow assessment for consistency across the impact assessment. Cross sections were selected to represent mesohabitat units for westslope cutthroat trout. Specifically, cross-sections were established in representative runs, riffles, and pools. The cross-sections and photographs of each site were provided in CR#6, Appendix A3 Instream Flow Assessment (Appendix A2 – Cross-Section Summary Data and Photographs).

SNC-Lavalin Inc. collected data at ~90 locations on both Blairmore and Gold creeks to characterize the channel morphology. The sites used in the sediment mobility threshold analysis were a subset of the data collected during the geomorphology baseline study. These sites were chosen due to their proximity and morphological similarity to the Hatfield cross-sections sites. The cross-sectional analysis is site-specific but the sites were chosen to represent the given reach.

2. Provide clarification on the methodology used to estimate the channel slopes and roughness values.

Response:

The channel slope at each geomorphology baseline assessment site was measured following the recommended methodology presented in the Forest Practices Code of British Columbia Channel Assessment Procedure Field Guidebook (BC MoF, 1996). Measurements were taken by a team of two field geomorphologists using a hand-held Suunto inclinometer. Slope was measured from similar features (for example from successive riffle or step-pool crests), with the greatest possible sight lines. The distance between upstream and downstream endpoints of the slope measurements were ensured to be a minimum of two channel widths. Each field geomorphologist was positioned at the water surface for the measurements, and the relative heights of the field staff were considered to ensure the measurement was taken at a consistent height above the ground. A minimum of five measurements were taken at each site and averaged

A Manning's n value was assigned to each reach by matching the characteristics of each site, documented in the site photos, morphology and grain size characteristics, to channel characteristics documented in Barnes (1967) and Hicks and Mason (1998). Barnes (1967) and Hicks and Mason (1998) provide Manning's n values for channels with a range of morphologies and grain sizes. Once the channel characteristics were matched the corresponding Manning's n value from Barnes (1967) or Hicks and Mason (1998) was assigned to the reach.

3. Provide a table listing all input variables for the sediment mobility analysis for each cross- section.

Response:

The input variables for the sediment mobility analysis are:

- longitudinal slope (measured in the field by SNC-Lavalin Inc.);
- Manning's roughness parameter (estimated using Barnes (1967) and Hicks and Mason (1998));
- 2-year and 100-year discharge (from Grassy Mountain Peak Discharge Changes Memo by SRK); and
- cross-sections (measured in the field by Hatfield Consultants).

Data collected by SNC-Lavalin are provided in the Table DFO 9-1.

Table DFO 9-1 Variables used in the sediment mobility threshold analysis.

Cross-section	Slope (m/m)	Manning's n	D_{50} (mm)	D_{90} (mm)
BC-01H	0.0425	0.035	50	340
BC-02H	0.0533	0.036	50	320
BC-05H	0.0138	0.035	15	110
BC-08H	0.100	0.038	40	500
BC-09H (BL-07)	0.1073	0.038	30	480
BC-11H	0.1385	0.042	35	360
BC-14H	0.0538	0.040	40	430
BC-15H (BL-03)	0.108	0.040	40	540
GC-00	0.009	0.035	30	640
GC-03	0.026	0.036	40	290
GC-07	0.052	0.038	35	540
GC-08H (GC-04)	0.052	0.038	85	560
GC-09	0.0349	0.039	30	430
GC-12	0.122	0.039	55	650
GC-15	0.0175	0.039	40	550
GC-19	0.0349	0.045	30	470
GC-20	0.0175	0.045	35	290
GC-22H (GC-10)	0.0175	0.036	20	260
GC-24	0.0175	0.035	40	400
GC-25	0.018	0.040	30	270
GC-26	0.018	0.043	120	330

The sediment mobility threshold analysis used a Shield's-based calculation to determine the size of bed material that could be mobilized for the predicted flows. Input parameters for the calculation include:

- average shear stress (calculated using the Hydraulic Toolbox).

- density of sediment (2650 kg/m^3);
- density of water (1000 kg/m^3);
- acceleration due to gravity (9.807 m/s^2); and
- Shield's parameter (0.03 and 0.07).

References:

British Columbia Ministry of Forests. (1996). Forest Practices Code of British Columbia Channel Assessment Procedure Guidebook.

Barnes, H.H., Jr., 1967, Roughness characteristics of natural channels: U.S. Geological Survey Water-Supply Paper 1849, 213 p.

Hicks, D.M., and Mason, P.D., 1998, Roughness characteristics of New Zealand rivers: National Institute of Water and Atmospheric Research Ltd., Water Resources Publications, LLC, 329 p.

10. CR#6, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 2.3, Geomorphic Effects Assessment, Pages 9-10

It is stated that a range of Shields numbers were used to reflect factors such as sediment packing, sorting, hiding etc. These factors are known to occur in gravel-bed rivers and can considerably influence mobility characteristics. There are sediment transport formulas available which account for this by introducing hiding functions (such as the Wilcock-Crowe (2003) model, which incorporates a non-linear hiding function) to account for size-selective mobility of different particles. Traditional Shields thresholds assume grainsize independence, which has been shown to misrepresent actual mobility characteristics in heterogeneous mixtures (such as gravel-bed rivers). Understanding sediment transport and mobility is important to understanding channel stability, fish habitat structure and the long-term sustainability of critical spawning habitat (gravel beds).

1. Provide the range of Shields parameters used and corresponding literature references.

Response:

The Shields values used were 0.03 and 0.07.

Reference

Buffington, J.M. and Montgomery, D.R. (1997) A Systematic Analysis of Eight Decades of Incipient Motion Studies, with Special Reference to Gravel-Bedded Rivers. Water Resources Research, 33, 1993-2029

2. Discuss limitations associated with these methods and how they may impact the results of the mobility assessment, particularly focusing on the mobility of spawning gravels pertinent to fish habitat.

Response:

The Shields equation is commonly used to analyze sediment mobility. Buffington and Montgomery (1997) concluded that less emphasis should be placed on choosing a universal shields value, while more emphasis should be placed on choosing defendable values for particular applications. Therefore, a range of shields values were chosen to provide a range of estimated sediment mobility values. The analysis shows the trend in the sediment mobility consistently decreasing through the project lifecycle, consistent with the decrease in peak discharges. The assessment concluded that the relatively small predicted decrease in sediment mobility will not cause a measurable change in spawning sediment.

3. The modelled mobility estimates only represent the D50 and D90 values that would be entrained for that flood. How would the mobility of other grain fractions change, and what are the associated impacts on channel morphology?

Response:

The estimated mobility estimates represent predicted changes in entrainment through time for two reference Annual Exceedance Probability (AEP) discharges (2-year discharge and 100-year discharge). Other grain size fractions would be expected to follow the same pattern of decreased mobility during transport events based on the changes in the shear stresses driven by the changes in AEP discharges (*i.e.* decrease in sediment mobility). A change in channel morphology based on the relatively small decrease in sediment mobility is not expected.

The fluvial geomorphology analysis was conducted to estimate sediment mobility at critical fish habitat sites (as identified in the Instream Flow Assessment), which indicates that the streambeds of Blairmore and Gold creeks are expected to become more stable through the life of the project. To test the predictions and the uncertainties associated with the assessment, monitoring is proposed as part of the project's Aquatic Monitoring Plan to confirm changes through time that may occur in the sediment grain size. For example, the monitoring program could include a spawning sediment survey to further characterize sample bed grain size in key locations that provide high spawning habitat value and track those areas over time. An adaptive management strategy would also be developed to mitigate identified changes.

11. CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek Section 2.3, Geomorphic Effects Assessment, Pages 9-10

It is stated that the two-year discharge was estimated to be the bankfull discharge.

1. Discuss if this implies that the bankfull discharge (estimated by the two-year discharge) represents the channel forming discharge?

    a. Discuss, clarify and provide additional detail regarding the assumption that the bankfull discharge equals the 2-year discharge, and is representative of the channel forming discharge.

Response:

The analysis of the fluvial geomorphology of Gold and Blairmore creeks predicted changes in sediment mobility through the lifecycle of the mine for two peak discharges: (1) a discharge with a high Annual Exceedance Probability (AEP) defined by the 2-year flow, and (2) a discharge with a low AEP defined by the 100-year flow. Bankfull discharge, defined by the flow filling the channel to the top of the banks, is often referred to as the channel forming flow (defined by Wolman and Miller 1960) by geomorphologists. The 2-year flow is within the range expected for the bankfull discharge (1-year to 2-year discharge from Leopold *et al.* 1964). The channel forming discharge depends on channel morphology, with step-pool channels generally having a greater return interval flow for the channel forming discharge than riffle-pool channels, for example. The 2-year flow was chosen to represent a discharge with a high AEP that is in the expected range of flow for bankfull discharge.

Flows with a statistical recurrence interval (2-year and 100-year flows) were chosen instead of the bankfull discharge as defined by the channel cross-section for each site because the AEP of the bankfull discharge may change from site to site based on channel morphology and antecedent conditions. The hydrological modelling predicted changes in the 2-year and 100-year flows. The 2-year discharge is independent of the channel morphology and therefore its use is appropriate to predict change over time. It would have been clearer in the text to use the term 2-year discharge instead of bankfull discharge through the discussion of sediment mobility.

2. Provide the hydraulic information verifying that the 2-year discharge corresponds to a stage which just overtops the banks into the floodplain.

Response:

Please see SIR DFO 11(1).

References

Leopold, L. B., Wolman, M. G., and Miller, J. P., 1964, Fluvial processes in geomorphology: San Francisco, W. H. Freeman and Co., 522 p.

Wolman, M. G., and Miller, J. P., 1960, Magnitude and frequency of forces in geomorphic processes: Jour. Geology, V. 68, No.1, pp. 54-74.

12. CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 2.3, Geomorphic Effects Assessment, Pages 9-10.

CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 4, Assessment of Incremental Effects to Fluvial Geomorphology Under Proposed Flow Changes and Section 5, Summary, Pages 25-42.

As stated above in the general comments, only peak flows for two return periods were used in the sediment mobility analysis. Although the Water Management Pond (WMP) will reduce peak flows in Gold Creek, it is unclear how the redistributed runoff volume will be released back into the receiving watercourses (target flow rates and durations). This is briefly discussed throughout the report and specifically noted on Page 41 stating “low flows may increase

during the Project lifecycle due to discharge of effluent from the mine site at discrete nodes". It is concluded that "stream channels are formed during peak discharges while sediment is mobile; therefore, the changes in low flows are not expected to alter the morphology of the stream channels". No detail is provided on what magnitude these low flow discharges are or the potential caliber of sediment that could be mobilized. There are many reaches identified in the mobility analysis that had median particles being mobilized well below the 2- year discharge. Yet, the exact discharge (erosion threshold) which mobilized these particles was never discussed or assessed against the change of the entire flow regime.

1. Provide additional discussion, analysis and rationale on how changes to the entire flow regime will impact river morphology.

Response:

The change in sediment transport due to predicted changes of mean monthly flows in both Gold and Blairmore creeks are not expected to alter channel morphology. An analysis of predicted monthly mean flows, comparing the baseline condition (2017) to the maximum affect from mine operations (2041 at decommissioning) (Instream Flow Assessment [CR#6 Appendix A3, Table 3-6]), illustrate decreases in flows for all nodes on Gold Creek (displayed in Figure 1), no change at one node on Blairmore Creek upstream of the impacts, and an increase in two nodes on Blairmore Creek (displayed in Figure 2). For the locations of nodes, see Instream Flow Assessment CR#6 Appendix A3, Figure 2.1.

The predicted maximum mean monthly flow reductions (difference between 2017 to 2041) in Gold Creek are greatest in May and June. The largest change in the five nodes analyzed was predicted for June at node GC 02, where the decrease in mean monthly flow was 0.12 m^3/s (from 1.19 m^3/s in 2017 to 1.07 m^3/s in 2041). GC 02 is the downstream most node. Figure 2-1 (Instream Flow Assessment CR#6 Appendix A3) illustrates predicted percent changes in flows for five nodes in Gold Creek from 2017 to 2099. As stated in Instream Flow Assessment CR#6 Appendix A3:

> "*Based on the model outputs (SRK 2016b, 2016c, 2016d, shown in Figure 2-2 below), net losses of total flow are anticipated in all reaches of Gold Creek, reaching a maximum of 4% at node GC-13, 6-9% at nodes GC-10, GC-04 and GC-01, and just over 10% at node GC-02 (located in Reach 6 of Figure 2-1)*".

For two of the three nodes analyzed on Blairmore Creek that predict increases in mean monthly flow, the largest increases are in the months of May and June. The analysis predicts mean monthly flows at node BC-02 increasing 0.05 m^3/s (from 0.69 in 2017 to 0.74 m^3/s in 2041) in May and 0.06 m^3/s (from 0.82 in 2017 to 0.88 m^3/s in 2041) in June. For comparison, peak 2-year flows at BL02 are predicted to decrease 1.39 m^3/s between 2010 (5.84 m^3/s) and (4.45 m^3/s) 2030.

Figure 2-1 (Instream Flow Assessment CR#6 Appendix A3) displays predicted percent changes in flows for five nodes in Blairmore Creek from 2017 to 2099. As stated in Instream Flow Assessment CR#6 Appendix A3:

> "*Flows in Blairmore Creek are expected to increase relative to baseline conditions as a result of the additional contribution of flow from some Gold Creek sub-catchments, but more importantly because of the estimated increase in runoff caused by changes to the hydrological characteristics of developed mine areas (i.e., increase in runoff coefficients for pit walls and waste rock areas) (SRK 2016b, 2016c, 2016d). For most of a calendar year, the maximum increase to flow is expected to be less than +15% for all stations (Figure 2-3). Large flow changes are possible during the low flow season (December to March); however, the water balance model (Appendix 10B, Appendix B- Catchment Delineation Maps) assumes that the discharge from the saturated zones or from any water treatment will be controlled based on the rate of accumulation of water in the saturated zone and the stream flow conditions in Blairmore Creek.*"

The majority of sediment transport occurs during peak freshet flows. The magnitude of the predicted increase in mean monthly flows are relatively small compared to the decrease in predicted peak 2-year flows and +15% or less from baseline (from Instream Flow Assessment CR#6 Appendix A3). The change in sediment transport due to changes in mean monthly flows are therefore not expected to alter channel morphology.

2. Are the expected increases in low flows below both bed and bank erosion thresholds? Quantify expected changes.

Response:

Bed erosion thresholds, represented by critical shear stress values, are presented in Table DFO 12-1. The erosion thresholds were calculated using:

$$\tau_c = \theta^*(s-1)\rho g d_{50} \quad ,$$

where

τ_c is the critical bed shear stress, in N/m^2,
θ^* is the Shields parameter for the given particle size, dimensionless,
s is the specific gravity of the particles and is calculated as the ratio of specific weight of sediment (γ_s) to the specific weight of water (γ), dimensionless,
ρ is the density of water, in kg/m^3,
g is the constant for acceleration of gravity, in m/s^2, and
d_{50} is the median particle size, in m.

from Berenbrock and Tranmer (2008). Shields parameter values ranged from 0.03 to 0.07, consistent with the sediment mobility threshold analysis presented in the geomorphology assessment. The analysis is consistent with equation 4 (page 3) in Fischenich, C. J. (2001), 'Stability Thresholds for Stream Restoration Materials'(EMRRP Technical Notes Collection (ERDC TNEMRRP-SR-29)), Technical report, U.S. Army Engineer Research and Development Center, Vicksburg, MS. Bank erosion thresholds are not calculated.

As discussed in the response to Question 1, mean monthly flows are generally predicted to decrease in Gold Creek and increase in Blairmore Creek. The predicted decrease in 2-year peak flows is much greater than the predicted increase in mean monthly flows. For examples, peak 2-year flows are predicted to decrease 1.39 m^3/s at BL02, while the maximum increase in mean monthly flows is 0.05 m^3/s. Changes in flow regime are not expected to alter sediment mobility because the predicted increases in low flows are much smaller than predicted decreases in peak flows.

Table DFO 12-1 Bed erosion thresholds defined by the critical shear stress values for the estimated D_{50} values. Upper critical shear stress estimate based on a Shields parameter of 0.07. Upper critical shear stress estimate based on a Shields parameter of 0.03.

Cross-section	Lower critical shear stress (Pa)	Upper critical shear stress (Pa)
BC-01H	57	24
BC-02H	57	24
BC-05H	17	7
BC-08H	45	19
BC-09H (BL-07)	34	15
BC-11H	40	17
BC-14H	45	19
BC-15H (BL-03)	45	19
GC-00	34	15
GC-03	45	19
GC-07	40	17
GC-08H (GC-04)	96	41
GC-09	34	15
GC-12	62	27
GC-15	45	19
GC-19	34	15
GC-20	40	17
GC-22H (GC-10)	23	10
GC-24	45	19
GC-25	34	15
GC-26	136	58

References

Fischenich, C. J., 2001, 'Stability Thresholds for Stream Restoration Materials'(EMRRP Technical Notes Collection (ERDC TNEMRRP-SR-29)), Technical report, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Berenbrock, C., and Tranmer, A.W., 2008, Simulation of Flow, Sediment Transport, and Sediment Mobility of the Lower Coeur d'Alene River, Idaho Scientific Investigations Report 2008–5093. U.S. Geological Survey, Scientific Investigations Report 2008–5093. Prepared in cooperation with the Idaho Department of Environmental Quality, Basin Environmental Improvement Commission, and the U.S. Environmental Protection Agency. (https://pubs.usgs.gov/sir/2008/5093/section6.html#eq4 accessed 2018.04.29)

3. Will the increased low flows result in additional mobility of sand particles? Discuss.

    a. If so, will it impact fish habitat or overall bed stability? Discuss and quantify potential impacts.

Response:

The mobility of sand particles was not assessed within the Geomorphology Assessment. The water quality assessment of Gold Creek and Blairmore Creek (CR#5) provides insight into the transport of fine sediment within the systems. Generally, the water within Gold Creek and Blairmore Creek has low Total Suspended Solids (TSS) throughout much of the year, with an increase in summer. TSS may include sand suspended within the water column. No data was collected to quantify the grain size of the sediment in suspension.

In Gold Creek, TSS levels were found to be mostly below detection limits in spring, fall, and winter but very high in summer (27 mg/L). (CR#5 page 63). Increases in the mobility of sand are not expected due to the decrease in mean monthly discharges predicted for Gold Creek.

The assessment of water quality found TSS levels in Blairmore Creek were below detection limits in all seasons except summer, where a high TSS concentration (97 mg/L) was recorded at an unnamed tributary to Blairmore Creek (CR#5 page 60). Increases in the mobility of sand may occur due to the increase in mean monthly discharges predicted for Blairmore Creek. However, as discussed in the responses to questions 1 and 2 above, the increase in discharge is small and therefore the increase in sand mobility would also be expected to be small.

The risk of increased mobilization of sand is thought to be unlikely due to the minor changes in base flows in Blairmore Creek. However, to test the predictions and the uncertainties associated with the assessment, a monitoring program is proposed as part of the project's Aquatic Effects Monitoring Plan (AEMP) to confirm whether changes in the sediment grain size materialize with predicted/confirmed alterations in flow noting specific focus on identified high quality spawning habitats. As described in CR#6 Section 6.1.1 Adaptive Management, Benga is committed to achieving continual improvement in environmental performance by applying an adaptive management approach to monitoring and follow-up programs, where required.

13. CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 4.1.2.4, Gold Creek: L Nodes GC-02 to GC-01,Figure 4-21, Sediment entrainment threshold ranges for cross-section GC-00, Page 40

Bed sediment sizes (D_{50} and D_{90}) were measured and were a primary input to the sediment mobility analysis. No clear methods are provided as to how bed material was characterized, calling to question some of the results. If percentile analyses were done, then presumably grainsize distributions were also generated. For example, Section 4.1.2.4 (page 40) reveals a riffle-pool dominated reach with a D_{50} of 30 mm and a "largest grain size" of 640 mm, which is plotted on Figure 4-21 as the D_{90}. It is unclear whether this 640 mm particle is a representative D90 particle or a large erratic that is not representative of reach characteristics, making the overall stability analysis for this reach unclear.

1. Clarify the field and analysis methods used to characterize bed sediments.

Response:

Field data collection was adapted from the Forest Practices Code of British Columbia's Channel Assessment Procedure Guidebook (BC MoF, 1996). The D_{90} is estimated to be the largest stone moved by flowing water. Latulippe et al (2001) show that visual estimates of grain size are efficient, rapid, and provide acceptable accuracy on both submerged and emergent sites. Individual clasts that represent the D_{50} and D_{90} were estimated visually in the field by experienced field geomorphologists. The B-axis of five clasts representative of the D_{50} and D_{90} were measured in the field and the average recorded. These values were then compared to the calculated sediment mobility thresholds. The trends in threshold values were not influenced by the grain size estimates.

2. Provide corresponding grainsize distributions for each of the reaches assessed in the stability analysis.

Response:

As discussed above, the D_{50} and D_{90} were visually estimated in the field. The full grainsize distribution was not collected during the channel assessment.

3. If the reaches were armoured, discuss what the approximate armour ratio (ratio of surface D_{50} to subsurface D_{50}) was.

Response:

The armour ratio was not measured for the fluvial assessment. From field observations, the channels are generally well armoured with patches of highly mobile gravels that may form spawning substrate.

References

British Columbia Ministry of Forests. (1996). Forest Practices Code of British Columbia Channel Assessment Procedure Guidebook.

Latulipe C, Lapointe MF, Talbot T. 2001. Visual characterization technique for gravel-cobble river bed surface sediments: validation and environmental applications contribution to the programme of CIRSA (Centre Interuniversitaire de Recherche sur le Saumon Atlantique). Earth Surface Processes and Landforms 26: 307–318.

14. CR#6, Addendum, Appendix A2, Fluvial Geomorphology Assessment of Blairmore Creek and Gold Creek, Section 3.3.2, Gold Creek, Pages 19 and 20

It is stated that for both Blairmore and Gold creeks, bank erosion and undercutting were present at almost every assessment site, with Blairmore Creek having loose, non-cohesive banks. Loose non-cohesive banks are typically less resilient to changes in hydrologic regimes as they have lower erosion thresholds (e.g. Julien, 2010; Fischenich, 2001). Thus, the noted potential increases in low flows through Blairmore Creek may result in accelerated bank erosion resulting in channel instability, additional bifurcations and negative impacts to fish habitat by releasing more fine material.

1. Provide further details, discussion and analysis on the projected impacts to bank stability due to the alterations in hydrologic regimes.

Response:

Increases in bank erosion due to mine operations is not expected. The vast majority of bank erosion occurs at high flows, when shear stresses are greatest. During seasonal periods of low flow within these systems, a low percentage of the bank height is impacted by flowing water due to the low water depths. This limits bank erosion at low flows.

2. What are the erosion thresholds for the bank material?

Response:

The erosion thresholds of the bank material were not assessed.

3. Are the increases in low flows above the erosion threshold for the bank material? Discuss the potential impacts to bank stability.

Response:

The determination of shear stresses during low flows were above erosion thresholds, thus were not analyzed for this assessment. An analysis of predicted monthly mean flows, comparing the baseline condition (2017) to the maximum effect from mine operations (2041 at decommissioning) (Instream Flow Assessment [CR#6 Appendix A3, Table 3-6]), illustrate decreases in flows for all nodes on Gold Creek for each month, no change at one node on Blairmore Creek, and an increase in two nodes on Blairmore Creek. For the two nodes on Blairmore Creek that predict increases, the largest increases are in the months of May and June. The analysis predicts the mean monthly flow for node BC-12 increasing 0.04 m_3/s (from in 2017 0.59 to 0.63 m^3/s in 2041) in May, and 0.05 m^3/s in June (from 0.69 in 2017 to 0.74 m^3/s in 2041). The analysis predicts mean monthly flows at node BC-02 increasing 0.05 m^3/s (from 0.69 in 2017 to 0.74 m^3/s in 2041) in May, and 0.06 m3/s (from 0.82 in 2017 to 088 m^3/s in 2041) in June. These predicted changes in mean monthly flow are not large enough to cause

consequential changes in the shear stresses at channel banks that drive bank erosion. Information with respect to how changes in flows were calculated can be found in Appendix A1 (local hydrology baseline data) of the Instream Flow Assessment (CR#6 Appendix 3).

4. What are the cumulative changes in magnitude (excess shear) and duration above the bank material erosion thresholds due to the changes in hydrology (reductions in peak flows and corresponding increases in lower flows)?

Response:

Cumulative changes in magnitude (excess shear) and duration above the bank material erosion thresholds due to the changes in hydrology were not calculated for this assessment. Based on the small increases in mean monthly flows predicted from the hydrological modelling at two nodes, consequential changes in the magnitude and duration of excess shear stress is not expected due to mine operations.

References

Fischenich, C. J. (2001), 'Stability Thresholds for Stream Restoration Materials'(EMRRP Technical Notes Collection (ERDC TNEMRRP-SR-29)), Technical report, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Julien, P. Y. (2010), *Erosion and Sedimentation*, Cambridge University Press.

Wilcock, P. R. & Crowe, J. C. (2003), 'Surface-based transport model for mixed-size sediment', *Journal of Hydraulic Engineering* 129(2), 120-128.

Hydrogeology

Volume 4, Consultant Report (CR)#3, Hydrogeology, Appendix C, General

We understand that interactions between groundwater and surface water were identified as a valued component within the natural setting of the Project, being critical for important fish and aquatic wildlife habitat. We note that the Proponent has relied upon stand-alone surface water and groundwater analyses with outputs from the respective models being used to assess interactions between the two systems.

We do feel that the assessments contained within the environmental impact statement report would have benefited from application of an integrated (coupled) groundwater surface water model given the number of groundwater supported headwater streams adjacent to the site. However, the approach selected is generally in keeping with the standard approaches used in these types of projects and that the Guidelines and Terms of Reference documentation do not explicitly require this enhanced level of analysis (i.e., a coupled groundwater-surface water model).

In general, we found the CR#3 report and supporting appendices generally well written and easy to follow. Specific comments related to the groundwater assessment are provided below.

15. Volume 4, CR#3, Hydrogeology, Section 4.4.2.3, Blairmore Group, Page 26

Volume 4, CR#3, Hydrogeology, Appendix C, Section 2.2.2.2, Blairmore Group, Page 21

Blairmore Group Hydraulic Conductivity. Section 4.4.2.3 indicates that three monitoring wells (MW15- 11-18.5, MW15-11-9, and MW15-12-14) were installed in the Blairmore Group, specifically in the upper portion of the Gladstone Formation mudstones. While in CR#3-Appendix C, Section 2.2.2.2, these same three wells are listed as being completed in the underlying Cadomine Formation – a conglomerate/sandstone lithology that is likely to have a higher permeability that the overlying Gladstone Formation mudstones. This should be consistent across both reports, particularly since this is the sub- cropping bedrock unit across the majority of the LSA and is potentially significant for conveying groundwater between the upland areas (pit footprint) and the downslope creek valleys.

1. In which geologic formation (Gladstone or Cadomine) were these wells completed?

Response:

MW15-11-18.5, MW15-11-9 and MW15-12-14 are completed within mudstones of the Gladstone Formation.

Monitoring well MW15-12-14 and nested well MW15-12-07 were drilled and completed near Blairmore Creek as their primary purpose was to measure groundwater levels and vertical hydraulic gradients for comparison with the river stage to help with understanding the groundwater-surface water interaction. MW15-12-14 was completed within the upper portion of the Gladstone Formation while MW15-12-07 was completed within the surficial deposits.

Monitoring wells MW15-11-18.5 and MW15-11-9 were completed to assess the groundwater conditions beneath the future Coal Handling and Processing Plant (CHPP) infrastructure so preliminary information on shallow and deep groundwater within the upper geological unit would be available for the development of a future groundwater monitoring program.

The intent of these wells was not to characterize the deeper units, but to gain knowledge about groundwater-surface water interaction and the shallow water table, if any, beneath the CHPP, thus the Cadomin Formation was not targeted by these wells.

2. Provided Section 4.4.2.3 is correct, why were the presumably more permeable sandstones of the lower Gladstone Formation not targeted by any wells? Or the conglomerates/sandstones of the Cadomine Formation? Using the hydraulic conductivity of 2.6x10-6m/s measured in these wells as a basis for the hydraulic conductivity of the bulk Blairmore Group unit is likely to under predict the water bearing capacity of this hydrostratigraphic unit.

Response:

Key geological and hydrogeological formations for the Project are the coal layers of the Kootenay Group. These units were studied in greater detail, via the completion of monitoring wells. The upper Blairmore Group (Gladstone) and surficial deposits were also of importance to

gain an understanding of the groundwater-surface water interactions, and thus were the target of monitoring wells.

The conglomerates / sandstones of the lower Gladstone Formation were not studied in detail because the unit is only marginally present within much of the study area. As presented on cross-sections AA, BB, CC and DD on Figures 4.2-5 to 4.2-8, the subcrop of the formation is located at the mine pits. The lower Gladstone Formation was not suitable for monitoring within the proposed pit boundaries because 1) it is mostly unsaturated (dry), and 2) the unit is relatively thin.

16. Volume 4, CR#3, Hydrogeology, Appendix B, Page B-7, Table B3a, Monitoring Well Completion and Hydraulic Conductivity Values (MEMS)

Volume 4, CR#3, Hydrogeology, Appendix B, Page B-8, Table B3b, Packer Tests and Hydraulic Conductivity Values (Golder)

Limited Hydrogeologic Data at Depth. It is anticipated that the pit floor will be approximately 430 m below topography. We noted that of the 19 monitoring wells listed in Table B-3a and 8 listed in Table B- 3b, none were extended to depths beyond 127.4 mbgs and 176.7 mbgs, respectively.

1. Discuss why deeper monitoring wells were not completed to provide hydrogeologic information for the deeper lithologies that will ultimately host the base of the pit?

Response:

The completion of monitoring wells becomes increasingly challenging as the target depths increase. Among these challenges are:

- The casing may break during installation due to the need to suspend great lengths in a deep borehole.
- Boreholes may not be drilled completely straight and therefore impede the placement of casing, filter pack and sealing materials.
- Accurate installation of filter pack and bentonite seal at great depth is not straightforward as it may take several hours for the materials to settle.
- The cost to drill the borehole and maintain clear access for well placement increases dramatically with depth.
- The completion zone may get plugged during drilling as elevated hydrostatic mud pressure may be required during drilling (leading to inability to properly develop the monitoring well.
- The presence of abundant fractures along a deep borehole provides significant opportunity for loss of cement sealing materials thus increasing costs and, in extreme cases jeopardizing the validity of information from nearby shallower wells.,

In summary, the probability of completing a monitoring well providing representative information at great depth was very low and therefore the decision was made to allocate the

available resources to obtaining more-abundant and reliable information from wells completed at shallower depths than those suggested above.

The monitoring wells and vibrating wire piezometers were thus completed to the maximum practical depth that will allow for proper well development, reliable assessment of hydraulic conductivity values and collection of representative water levels and water samples.

17. Volume 4, CR#3, Hydrogeology, Appendix C, Page 24, Figure 2-12, K vs. Depth
Volume 4, CR#3, Hydrogeology, Appendix C, Page 28

Limited Hydrogeologic Data at Depth. Benga notes that "While the hydraulic testing data presented in Figure 2-12 does not suggest a strong reduction in K with depth, and has a bias towards testing conducted in coal seems, testing depth has been relatively modest to date, and it is expected that deeper testing would show reduced permeability associated with a given formation".

1. Given that the conceptual framework for the hydraulic conductivities applied in the numerical groundwater model is based on a decreasing K with depth trend, how has the proponent resolved the fact that on-site measurements do not necessarily support this?

Response:

The on-site measurements are limited. There were only three tests in the Blairmore group, and no test in the Fernie Group, and the K values biased toward higher K lithologies (*i.e.* coal seams) and/or potential fractures/faults. The on-site measurement results were therefore not considered representative of individual lithologies at the scale of the numerical model and could therefore not be used as a basis for verifying or invalidating the conceptual model.

2. Does Benga intend to supplement the existing hydraulic conductivity testing results with new, deeper tests to confirm this relationship?

    a. If so, provide materials (discussion, mapping) indicating where they intend to construct future monitoring locations.

Response:

Benga does not intend to supplement the existing hydraulic conductivity testing results with new, deeper tests to confirm that K is decreasing with depth. As per the answer to #16, the completion of deep monitoring wells becomes increasingly complicated at depth greater than 130 m, especially when the completion material is highly fractured. Before performing hydraulic conductivity testing, the wells need to be properly developed. Successfully developing very deep wells with low hydraulic conductivity can be very difficult, time consuming and typically only has limited success. If a well is not properly developed, then the results from the hydraulic conductivity testing may not be fully representative of the formation K value.

Sufficient site specific information was collected for the site and that the bias of targeting and testing predominantly the coal seams has resulted in a weak correlation of K decreasing with depth which would otherwise be visible. The interpretation of K decreasing with depth is

however consistent with observation made at other mine targeting the same geological interval and documented for Canadian Foothills and Mountains as discussed in CR#3, Appendix 3, Section 2.2.3.1.

b. If not, discuss why it is not felt that additional (deeper) characterization is necessary.

Response:

Please see response DFO SIR 17(2)(a).

3. If the bias of testing predominantly the coal seams is sufficient to obfuscate the assumed K vs. depth trend, does this not suggest a conceptual model based on lithology is more suitable for the numerical groundwater flow model?

   a. Discuss why a lithology based approach was not appropriate or not selected for the groundwater model, tying it back to the evidence that supports your selected conceptual framework.

Response:

A lithology-based approach (*i.e.*, explicit modelling of the geometries and hydraulic properties of individual lithologies) was not selected for the groundwater model because the data did not provide enough details for each lithology and for the scale required to evaluate the project effects to groundwater.

It was considered a reasonable approach to:

- Simplify the groundwater system into one unit (*i.e.*, fractured rock);
- Account for the reduction of K and aperture with depth caused by the increase of stress, using the relationship developed by Wei (1995) which is based on a very large number of tests in fractured rock;
- Account for the preferential flow paths along beddings using a 3D geological model informed by regional and local geological maps, geology models and borehole logs;
- Calibrate K and recharge values to match the observed water levels and estimated baseflows, while keeping the parameters within a plausible range.

This approach resulted in simulated Ks ranging between 1x10-9 and 1x10-6 m/s which is reasonable for the lithologies of this site. Figure 17-1 shows how the simulated K range compares to the on-site measurements. The calibrated recharge is also reasonable, with an equivalent of 28% of MAP recharging the groundwater system over the entire model domain.

18. Volume 4, CR#3, Hydrogeology, Appendix C, Page 38

Surficial Geology in Model. It appears from the groundwater modelling report that the top layer of the model was simulated with a uniform thickness of 40 m and ignores the role of overburden deposits, which were not explicitly modeled (CR#3-Appendix C, Section 3.4.3, Page 38). It is understandable that the hydrogeologic role of the surficial deposits is minimal

in the upland areas where field observations confirm their absence. However, these deposits were noted to exist regionally with an average thickness of 7 m (Waterline 2013), and within the northern part of the LSA (CR#3-Section 4.2.2).

1. To what extent has ignoring the surficial deposits limited the model's ability to capture surface water-groundwater interactions, and the impacts on these interactions due to mining?

Response:

Ignoring the surficial deposits was considered to have minimal influence on the evaluation of groundwater impacts due to mining. It was also deemed to lead to conservative predictions of potential reductions to creek baseflows.

Since mining is located where the water table is found at depth within the fractured rock, it is the hydraulic conductivity (K) of the fractured rock that will constrain how excavations influence the groundwater discharge rates in the valleys. Therefore, the discharges rates along the creeks are directly linked to the capacity of the fractured rock to transmit water. If overburden had been simulated explicitly, the till and the stream alluviums would have increased the storage capacity of the groundwater system along the creek beds and buffered the potential reductions of baseflows due to mining.

2. Was any consideration given to varying the hydraulic conductivities in where overburden thickness was significant based on field observations or mapping?

Response:

There was no consideration given to varying the hydraulic conductivities in overburden.

19. Volume 4, CR#3, Hydrogeology, Appendix C, Page 38

Simplified Local-Scale Hydrogeology. Our review of the geometry and parameterization of the groundwater flow model represents an extreme simplification of site. Most critically, Benga described that the model involves assuming "that overburden deposits... are not explicitly modelled", and "there is little large-scale variability in the bedrock, and that it may be effectively modeled as a single unit". To this end, the geometry of the groundwater flow model consists of 9 layers with increasing thicknesses "starting at about 40 m for the top layer and increasing gradually to about 140 m for the bottom layer". Within each layer, K values are constant. Our concerns regarding the omission of any overburden are expressed in Comment 17.

1. Based on geologic sections presented in CR3 (Figures 4.2-5 to 4.2-8) and elsewhere in the document (e.g., Volume 1, Section B, Figures B.2.0-1 to B.2.0-7), it seems that substantial geologic data were available to locally delineate the different lithologies. This combined with hydraulic testing results that provided representative K values for the different units (detailed in CR#3, Appendix C, Section 2.2.2). Why were these local-scale insights (lithology and hydrostratigraphy) largely absent from the construction of the groundwater flow model?

Response:

The local-scale geological insight is part of the groundwater flow model construction. SRK used the software Leapfrog Geo, a three dimensional (3D) geological modelling tool that builds models directly from various sources including drill holes, points and surfaces. The Leapfrog Geo model integrated all the available data (*i.e.*, satellite imageries, geological maps, geological models, bed orientations, and borehole details). It was used to create a 3D geological model that served as basis to estimate bedding orientations anywhere within the model domain. The bedding orientations were then converted for the numerical flow model into a 3D field of anisotropy tensors (*i.e.*, highest conductivity parallel to bedding, and flows assumed impeded by thrust fault systems).

As stated in DFO-SIR17, the hydraulic testing results were not considered representative of the individual lithologies at the scale of the numerical model.

2. Confirm that the thickness is uniform across any given layer (i.e., layer 1 is 40 m across the entire layer)? This is in reference to the use of the word "about" in discussing the thickness of the layers.

    a. If layers are variable, why and where?

Response:

The thickness is uniform across any given layer.

20. Volume 4, CR#3, Hydrogeology, Appendix C, Page 42

Top of Model Boundary. The top of the FEFLOW model (boundary) can be configured to represent different processes (assumptions) when water table heads are higher than the top of the model. These areas would fall within the yellow and lightest green areas on CR#3-Appendix C, Figures 3-17, 3-24, 3-

One would expect these areas to roughly correspond to springs where the groundwater system might be contributing to wetlands or runoff/interflow/throughflow to streams.

1. How has the top layer in the FEFLOW model been configured when it comes to water table heads above land surface?

Response:

The heads are unconstrained at the top of the model domain (*i.e.* heads can be predicted above land surface).

2. What steps have been taken to quantify the changes in groundwater discharge in these areas due to the Project build-out? These regions of groundwater discharge to land surface would be considered areas of groundwater-surface water interaction, which should be evaluated under the TOR (4.2.2 [B]).

Response:

No steps were taken to quantify the changes in groundwater discharges in the yellow and lightest green areas on CR#3-Appendix C, Figures 3-17, 3-24, 3-27. It is possible that these may represent groundwater discharge to land surface due to the Project build-out but one should be careful with the over interpretation of the model results. The head predictions in these areas are still within the standard deviation of the simulated head (*i.e.*, Root mean square error = 26.4 m).

21. Volume 4, CR#3, Hydrogeology, Appendix C, Page 43, Figure 3-4, Boundary Conditions

Constant Head and Seepage Nodes. The above figure presents the location of constant head and seepage node boundary conditions for the pre-mining (baseline) and mining (EOM/LTS) simulations. Combined, the choice of symbols and scale make it very difficult for the reader to identify to which reaches the different boundary types have been assigned.

1. Provide a revised figure that more clearly shows where and which boundary conditions have been assigned along the different reaches.

Response:

An updated version of Figure 3-4 is shown on Figure 21-1.

22. Volume 4, Section (CR) 3, Hydrogeology, Appendix C, Page 43, Figure 3-4, Boundary Conditions

Volume 4, Section (CR) 3, Hydrogeology, Appendix C, Page 50, Figure 3-9, Steady-State Calibration Base Flows ("Linear" Calibration)

Constant Head and Seepage Nodes. From what we can see in Figure 3-4, all the base flow inspection nodes used in the impact analysis are associated with constant head nodes. The model results suggest that baseflows are slightly overpredicted.

1. Provide a figure showing the distribution of simulated groundwater seepage (gain or loss) to the constant head and seepage nodes. The idea being to identify if there are any constant head nodes that are providing unrealistic amounts of water to the groundwater system, which could cause heads to be artificially "pegged" to land surface.

Response:

The distribution of simulated groundwater gains and losses at all boundary conditions is shown on Figure 22-1 attached.

23. Volume 4, CR# 3, Hydrogeology, Appendix C, Page 55, Figure 3-12, Transient Calibration: Monthly Hydraulic Heads ("Linear" Calibration)

Downward Trend in Simulated Heads. A few of the monitoring wells (MW14-05-114, RGSC-006a, and MW14-06-105) have modelled hydraulic heads that experience a downward trend across the three "years" of the transient baseline simulation.

1. Confirm that the same recharge pattern was applied for all three years of the transient simulation?

Response:

Yes. The same recharge pattern was applied for all three years of the transient simulation.

a. If so, discuss the cause of this trend.

Response:

The transient model used the results of the steady state simulation as initial conditions. The trend corresponds to an adjustment of the steady state heads to transient state.

24. Volume 4, CR#3, Hydrogeology, Appendix C, Page 71, Figure 3-22, Predicted Drawdown, EOM Volume 4, CR#3, Hydrogeology, Appendix C, Page 75, Figure 3-25, Predicted Drawdown, LTC

Drawdown Intercepting Stream Boundary Conditions. In both drawdown figures (EOM and LTC), the simulated drawdown cones from the Project appear to intersect the constant head boundary conditions associated with Blairmore Creek to the northwest, west, and south of the Project.

1. This relates to previous Comments 22 and 23, regarding the use of constant head boundary conditions. Provide, a map showing the flux into (or out of) each constant head stream node.

a. Are there cases in the stream reaches (constant head nodes or seepage nodes) where groundwater discharge to the streams have been reduced to zero or less than zero? What are the expected impacts to fish habitat in areas where groundwater discharge is significantly reduced?

Response:

The simulated drawdown cones in both EOM and LTC scenarios do not intersect constant head stream nodes. They do intersect deactivated seepage nodes where groundwater discharge is reduced to zero.

A map showing the flux into and out of each constant head node is shown on Figure 24-1.

The three-dimensional numerical groundwater model from which the drawdown simulations were derived from provides one input to the Project site-wide water and load balance model (Consultant Report #3 Appendix C). This site-wide water and load balance model provided the estimated Project changes in stream flow both spatially and temporally through the various Project phases and integrates all of the changes to runoff processes estimated by the groundwater and other models.

The information of predicted flow changes from the water and load balance model (Appendix 10B/10C, Consultant Report #3 Appendix C) was then used within the Instream Flow

Assessment (CR#6 Appendix A3), to predict changes in flow and associated fish habitat across a number of potentially affected reaches along Gold and Blairmore creeks. The methodologies and results of predicted alterations to habitat are captured in this report. Specifically, the water and load balance model for Blairmore Creek predicted increases in flow over the mine life, relative to the baseline period, with a predicted net gain in fish habitat quantity and suitability.

25. Volume 4, CR#3, Hydrogeology, Appendix C, Page 64, Figure 3-17, Simulated Depth to Water Table, Baseline

Volume 4, CR#3, Hydrogeology, Appendix C, Page 73, Figure 3-24, Simulated Depth to Water Table, End of Mine

Volume 4, CR#3, Hydrogeology, Appendix C, Page 77, Figure 3-27, Simulated Depth to Water Table, Long Term Closure

Simulated Depth to Water Table. In the simulated depth to water table figures (listed above), the legend indicates that yellow areas are locations where heads are more than 25 m above ground surface (-25 m depth). Based on this interpretation, it is evident that the groundwater model is predicting dramatic shifts in the water table-to-ground surface relationship both inside and outside the Project area (red dotted line). The dramatic increase in yellow areas between baseline (Figure 3-17) and the end of mine (3-24) and long term closure (3-27) could only be brought on by either (1) reductions in ground surface, (2) increases in water table elevations, (3) combination of both.

1. If it is a case of the simulated water table increasing between baseline and end of mine/long term closure, what is causing this (both inside/outside the project boundary)?

Response:

It is not a case of the simulated water table increasing between baseline and end of mine/long term closure.

SRK reviewed the three figures and found an error with the setup of Figure 3-17 "Simulated Depth to Water Table, Baseline". This figure portrayed depth to groundwater based on simulated transient heads at low flow conditions[5] and baseline ground surface, whereas in Figure 3-22 and 3-25 they were based on simulated steady state heads[6] and the End-of-Mine excavated ground surface (*i.e.*, the waste rock dumps were excluded).

Figure 25-1 shows the appropriate setup for Figure 3-17 to allow the comparisons of depth to groundwater with the Figures 3-22 and 3-25. This confirms that model does not predict water

5 Source: model "03_PrMng_Baseline_Grassy_Transient3y_Calibration_Linear.dac" at time = 781 days.
6 Sources: model "70-[34]_EOM_2041_Grassy_Mmtn_FM_Steady_LNR.dac" at time = ∞, and model "72-[39]_LTC_2046_2056_Grassy_Mmtn_FM_Steady_LNR.dac" at time = ∞

table increasing between baseline and end of mine/long term closure, except for the mine footprint.

2. If ground surface changes are responsible, what changes to ground surface are being proposed outside of the Project boundary?

Response:

There are no ground surface changes proposed outside the Project boundary.

3. Groundwater interactions with surface water features are highly dependent upon the water table-to-ground surface relationship; if these are model artifacts, what is the impact on predictions regarding impacts to creek baseflow?

Response:

The noted issue arose from an error in Figure 3-17 as stated in the first bullet.

4. Provide an alternate version of Figure 3-22 and Figure 3-25 with scales adjusted to show areas of negative drawdown (increased hydraulic heads) to assist with diagnosing where these increases in simulated head are occurring.

Response:

There is no simulated water table increasing between baseline and end of mine/long term closure.

Hydrology

Volume 3, Appendix 10B, Water and Load Balance Model Report, General

The water quantity forecasts generated by the GoldSim Water Balance and Load Model discussed in this Appendix form an important component of several analyses. Most critically from a fisheries perspective, simulated changes in runoff are applied in the Instream Flow Need assessment (CR6 – Appendix A) to evaluate the potential for flow-related effects on Westslope Cutthroat Trout and their habitat.

The GoldSim modelling framework applied in this report represents a powerful tool for modelling complex system processes. However, GoldSim inherently is not a hydrologic model, and only incorporates the processes that are explicitly added by the modeler. For example, the Grassy Mountain model does not explicitly include a representation of evapotranspiration (either potential or actual). The various model inputs derived from estimates of precipitation and unit runoff seem appropriate to the general setting; however, the description of the model structure is insufficient to determine how the hydrologic processes have been simulated within the GoldSim model. The discussion of how groundwater exchange was handled is also insufficient.

The following are detailed SIR's which relate to the GoldSim Water and Load Balance.

26. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 3.1, Model Platform and Timescale, Page 12

The introductory paragraph states "The water balance and quality model for the Grassy Mountain Project was developed using the GoldSim software package (version 11.1 GoldSim Technology Group 2014)."

1. Describe the suitability of GoldSim to represent the water balance components of a complex, mountainous hydrologic setting with changing topography and land cover?

Response:

GoldSim software is a graphical, object-oriented interface for carrying out spreadsheet calculations. The software includes many standard functions that allow for easy implementation of Monte Carlo simulations, vector and matrix operations, for tracking interdependencies of calculations, and unit consistency checks. GoldSim is fundamentally a spreadsheet program; subsequently, it is up to the user to define the level of complexity and physical processes represented in the water balance. Any process that can be described in terms of mathematical functions can be implemented in GoldSim; as such, there are no inherent limitations on the level of complexity that can be incorporated.

2. What was the rationale for selecting the hydrologic processes included within the model?

Response:

The water balance model for the Grassy Project was developed to evaluate potential effects of the Project on the water balances of the project area and downstream creeks on a monthly timescale. The use of a monthly timestep means that the water and load balance assessment are evaluated over longer averaging periods rather than complex interactions at higher temporal or spatial resolution.

The resolution of the water and load balance assessment was defined to specifically evaluate potential changes to a system as opposed to characterizing the full range of flow and water quality conditions that could be encountered in the receiving environment. Potential changes were evaluated by keeping all hydrological variables constant except for the attributes of the system that are known to change, such as catchment boundaries and land use.

As an example, development of the mine will necessitate diversion of a portion of surface runoff away from Blairmore Creek and into the sedimentation or surge ponds. The effect of this is modelled by removing a portion of the surface flow contribution to the creek. According to the conceptual model, a 20% reduction in catchment area would cause a 20% reduction in flow on a monthly basis. Because of the monthly temporal resolution, any complexities associated with orographic effects, aspect, land cover/evapotranspiration, local infiltration and groundwater discharge, time of concentration, *etc*. are assumed to be constant across each subcatchment.

Evaluation of individual hydrological variables require a watershed model, which operate on timescales of hours or days and relies on meteorological data (historical or synthetic), land cover data, topography and other inputs to parameterize various hydrological processes. Watershed

models evaluate watershed characteristics at a greater level of temporal and spatial resolution but also introduce uncertainties with every term included in the model. In watershed models, each hydrological process is characterized by mathematical relationships and adjusted by selecting input parameters to match specific catchment characteristics. In most instances, the different input parameters must be assumed. Therefore, although watershed models are more complex, the added complexity does not necessarily translate to improved accuracy of model predictions. Typically, complex watershed models require a substantial body of monitoring data collected over several years to allow for meaningful model calibration.

In the absence of monitoring data sufficient for calibration, the results of a watershed model could be expressed as ranges of flow (and flow changes) commensurate with the model uncertainty. However, expressing results as potential ranges of outcomes still does not provide any information on the probability distribution of the outcome within those ranges. Results of watershed models are often presented at face value with little information concerning uncertainty inferring a level of precision that is not warranted or supported by the model inputs or conceptual model.

The hydrological model used for the Grassy Mountain Coal Project brings the water balance evaluation back to a more conceptual level where general water balance changes can be evaluated. Again, the conceptual model result that a 20% reduction in catchment area causes a 20% reduction in flow on a monthly basis is a reflection of the order-of-magnitude of the potential change as a central tendency.

27. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 3.2.1, Stochastic Water Balance, Page 13

Section 3.2.1 states "The water balance model was run stochastically for 1000 iterations to determine a probability distribution function of predictions of potential flow conditions at the prediction nodes. This range of results spans a range of wet and dry years." This approach is useful to generate the water quality results; this is a confusing approach to apply when generating synthetic streamflow datasets. For example, the model results presented in Appendix D suggest there is no variability in inter-annual runoff. By averaging 1000 Monte Carlo simulations the author has effectively generated a streamflow series from a single uniform value of mean annual precipitation (MAP).

1. Is there a difference in physical meaning between a single synthetic streamflow time series and the streamflow time series generated from the average of 1000 iterations? Discuss.

Response:

The purpose of the Monte Carlo simulation was to examine the range of variability in flow at various nodes based on the expected year-to-year variability in total annual precipitation, which was the only stochastic variable defined in the simulation. The hydrograph (monthly proportion of flows in the creeks) was assumed to be constant. The results of the 1,000 iterations were not simply averaged but were used to generate a probability distribution of the outcomes. For clarity, the results included in Appendix D (of Appendix 10B) are reproduced in Figure 27-1 for

a time series of two years (named "GC01 Flow (m^3/day)" in Appendix D). The shorter time scale in the graphs below makes it easier to discern the probability distribution of the outcome.

The average flow result of a stochastic simulation with 1,000 iterations are indeed expected to be identical to a single deterministic model run that uses average precipitation conditions.

a. How does applying a single average MAP affect the results of the analysis?

Response:

As indicated above, the Monte Carlo simulation did not rely on a single MAP but incorporated the return periods for total annual precipitation listed in Table 4.3 in Appendix 10B.

2. Present sample streamflow results from a single model iteration of the stochastic Water Balance Scenario. Include the simulated runoff hydrographs in Gold and Blairmore creeks that are sensitive to changes in precipitation.

Response:

Figure 27-2 shows an example of three stochastic iterations for flow at BL03 for a period of four years. The simulated hydrograph is not sensitive to changes in total annual precipitation.

28. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 4.1.1, Precipitation, Page 17, Table 4.1, Mean Annual Hydrology Inputs

Table 4.1 presents a value of 738 mm/year for "Evaporation". From consultant report #4 this value appears to conform to an estimate of lake evaporation for the study area.

1. How is this evaporation value incorporated into the model?

Response:

The evaporation value of 738 mm/year was applied only to open water bodies on site including sedimentation and surge ponds and the end pit lake. Evapotranspiration from land areas are accounted for the in the yield coefficients for the different land areas.

29. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 4.1.2, Yield, Page 19, Table 4.4, Yield Coefficients

Volume 4, CR#4, Hydrology, Section 3.5, Mean Annual Runoff, Page 20

The yield coefficient approach represents a rudimentary method of estimating runoff at the site. Importantly, within the water balance model, yield coefficients represent the only incorporated hydrologic parameter. These coefficients also control the runoff under future conditions; accordingly the selection of the coefficients is critical. Section 4.1.2 states "The remaining yield coefficients were estimated through best engineering judgement according to land use and surface cover characteristics."

1. Is the yield coefficient method suitable to represent runoff (combined as surface and groundwater flow) in a complex, mountainous hydrologic setting with changing topography and land cover? Discuss.

Response:

The yield coefficient method is suitable considering the monthly temporal resolution of the water and load balance and the fact that the primary objective of the model is to evaluate potential changes in the water balance caused by the Project.

Longer averaging-period water balances generally require less complex hydrological inputs. For example, total annual flow at a hydrometric station can adequately be represented by total annual precipitation and a runoff or yield coefficient. Yield coefficient typically change from year to year, in part because of imprecisions associated with precipitation and flow measurements (which can be considerable) but also due to difference in the catchments' response to wetter or dryer conditions. Nonetheless, annual yield coefficients are likely to fall within a predictable range assuming that the catchment characteristics remain the same.

The water and load balance for the Project extended this annual yield concept to monthly averaging periods by imposing a constant hydrograph on the total annual flow calculated from the total annual precipitation and yield coefficients. The model approach was to compare a hydrological 'snap-shot', represented by mean annual precipitation and a fixed hydrograph, to a 'snap-shot' with the same annual precipitation and hydrograph but with altered landscape due to the mine development.

2. How does temporal resolution affect the results generated by the yield coefficient method?

Response:

The temporal resolution is a paramount consideration when using the yield coefficient method. For example, on a monthly basis evapotranspiration (or simply evaporation) from unvegetated land is generally lower than from vegetated land. Therefore, if all other attributes are equal, the total flow from an unvegetated catchment is expected to be higher than from a vegetated catchment. However, this is only true when longer averaging times are considered. Runoff from unvegetated land is expected to be flashier with higher runoff during and following storm events, but lower runoff during dryer periods. On the other hand, runoff (or discharge) from managed catchments such as areas within the mine footprint that report to a sedimentation or surge pond are expected to be less variable than the natural hydrograph. On the scale of months or years the simpler yield approach is a reasonable approach.

a. What is the correlation between observed monthly precipitation and runoff yield in the datasets used to generate the Undisturbed and Reclaimed Areas yield coefficient?

Response:

The yield coefficient methods used did not rely on a correlation between monthly precipitation and runoff. The method used distributed the total annual runoff according to a hydrograph derived from regional flow data.

3. The assumed future yield coefficients represent the only mechanism which captures the future hydrology of the site. Can the author provide references or book values to support the assumed values in Table 4.4 (Yield Coefficients)?

Response:

The yield coefficient for undisturbed land was based on the regional hydrological analysis presented in the 2016 Grassy Mountain Surface Hydrology Baseline and Effects Assessment. Note that the yield coefficient definition is identical to the definition of a runoff coefficient with the exception that it explicitly includes interflow and groundwater discharge upstream of the flow measurement location. Runoff coefficients implicitly include such flows but the term runoff coefficient is commonly thought of as a parameter that quantifies overland flow only.

The literature on waste rock hydrology suggests that net infiltration (and therefore potential yield) from waste rock and developed areas are highly variable and site specific. O'Kane[7] reported net percolation rates of approximately 80% for uncovered waste rock dumps in southeastern British Columbia for conditions with 940 mm total annual precipitation. On the other hand, waste rock infiltration rates and therefore yield from dumps in dryer, more northern climates such as Red Dog (Northwest Alaska) and Diavik (Northwest Territories) are reported to range between 30% and 50% of total annual precipitation[8]. However, there is a general agreement that infiltration is greater for waste rock areas than for undisturbed or waste rock covered by soil. Hillside rock dumps situated on relatively steep topography are likely to report as toe seepage. Therefore, the increased infiltration will cause an increase in catchment yield. O'Kane estimated that infiltration is 15% greater for bare waste rock compared to covered areas. The selected yield coefficient of 0.60 was selected to recognize the greater expected yield from waste rock and developed mine areas.

Pit walls were modelled as impervious surfaces. Text book runoff coefficients for impervious surfaces generally range between 0.7 and 0.9. Therefore, 0.8 was selected.

4. Can the sensitivity of these values be included in the model evaluation discussion? Discuss.

Response:

Qualitatively, the assumed yield coefficient values in the water balance model affect the relative increase in overall yield from the Project area. Over longer averaging periods, yield is expected

7 O'Kane, M. et al. 2015. Near-Surface Water Balances of Waste Rock Dumps. 10th International Conference on Acid Rock Drainage (ICARD), International Mine Water Association (IMWA) 2015.
8 AREVA Resources, 2011. Hydrology of Waste Rock Piles in Cold Climates - Volume 5I. Kiggavik Project Final Environmental Impact Statement, Tier 3, Technical Appendix 5I. Issued by Golder Associates, October 2011.

to increase because of the reduction in evapotranspiration. The assumed yield coefficient values would affect the magnitude of the expected increase.

5. It is assumed that runoff calculated with the yield coefficient incorporates groundwater flow. Is this assumption consistent with the conclusions reported in the numerical groundwater modelling study (SRK 2016d – Groundwater Report)? How are cross-boundary or deep groundwater flows accounted for within this approach?

Response:

The yield coefficient includes only that part of the groundwater flow that report to the creeks. Accordingly, the reduction in groundwater discharge to the creeks predicted by the groundwater modelling study was incorporated in the water and load balance as a percent reduction in baseflow.

30. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 4.2, Seepage Minimization and Capture, Page 19

In reference to the second paragraph of this section, which reads "Groundwater model results (SRK 2016d – Groundwater Report) were used to estimate the amount of leakage out of the Pit Lake and from SZs. Leakage rates were calculated as a percentage of base flow provided by SRK (2016c – Hydrology Report), and were applied in the model to estimate the flow rate along this flow path between the water management facilities and the downstream prediction nodes. Leakage is conservatively assumed to reach the downstream environment immediately in the model, where in actuality the travel time via groundwater flow paths would be on the order of years."

1. Summarize the leakage volumes in a tabular form?

    a. How large are these volumes compared to the overall water balance?

Response:

Leakage values from saturated zones and the End Pit Lake to nodes along Blairmore Creek and Gold Creek are listed in Table DFO 30-1. Leakage represents less then 1% of estimated flows at each node.

Table DFO 30-1 SZ and End Pit Lake Leakage Rates to Model Nodes (m^3/day)

	Leakage to BC07	Leakage to BL02	Leakage to BC03	Leakage to BC01	Leakage to GC10	Leakage to GC04	Leakage to GC02
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0
2021	38	44	112	3	0	0	0
2022	61	72	182	4	0	0	0

Table DFO 30-1 SZ and End Pit Lake Leakage Rates to Model Nodes (m^3/day)							
	Leakage to BC07	**Leakage to BL02**	**Leakage to BC03**	**Leakage to BC01**	**Leakage to GC10**	**Leakage to GC04**	**Leakage to GC02**
2023	61	72	182	4	0	0	0
2024	61	72	181	4	0	0	0
2025	61	72	182	4	0	0	0
2026	61	72	182	4	0	0	0
2027	61	72	182	4	0	0	0
2028	61	72	181	4	0	0	0
2029	61	72	182	4	0	0	0
2030	61	72	182	4	0	0	0
2031	61	72	182	4	0	0	0
2032	61	72	181	4	0	0	0
2033	61	72	182	4	0	0	0
2034	61	72	182	4	0	0	0
2035	61	72	182	4	0	0	0
2036	61	72	181	4	0	0	0
2037	61	72	182	4	0	0	3
2038	61	72	182	4	0	0	30
2039	61	72	182	4	0	0	30
2040	61	72	181	4	0	0	30
2041	61	72	182	4	0	0	30
2042	61	72	182	4	0	0	30
2043	92	61	278	12	298	0	30
2044	92	61	278	12	695	0	30
2045	92	61	278	12	695	0	30
2046	92	61	278	12	695	0	30
2047	92	61	278	12	695	0	30
2048	92	61	278	12	695	0	30
2049	92	61	278	12	695	0	30
2050	92	61	278	12	695	0	30
Same rates in the years following							

2. Include additional discussion as to how these leakage rates were used in the analysis. For example, were these rates used to quantify loading of parameters to the creeks? Were they used to evaluate changes in groundwater flow to the creeks?

Response:

Leakage was routed to each node and was assigned the water quality predicted for the respective saturated zone or End Pit Lake and were therefore used directly to calculate loadings to the creeks from those sources. Changes to baseflow resulting from changes to the groundwater regime on site were calculated as percent reduction of baseflow, which matched the percent reduction predicted by the groundwater model.

3. The groundwater model developed for the site was constructed with a different set of assumptions. Discuss the conceptual differences between the water balance model and the groundwater model?

Response:

The groundwater model is a multi-physics finite-element model that solves the groundwater flow equation, which is a diffusion-type equation. The model applies a driving force (head differential) across an element and solves for flux across the element boundaries based on inputs of hydraulic conductivity and other estimated attributes of the subsurface matrix. The water balance model, on the other hand, is a mass balance model that solves the equation:

$$\text{Input} - \text{Output} = \text{Storage}$$

The mass balance model accounts for transfer of water and loadings but does not model the physical processes that drive the transfer.

a. Why is it appropriate to combine flow rates and estimates from the different models?

Response:

Different models are required to evaluate potential changes to different components of a natural system. A water balance model must include groundwater flow estimates to account for all inflows and outflows. Since groundwater flows cannot be measured directly, it is necessary to rely on groundwater model results for the required estimates.

b. Does the application of the yield coefficient methodology produce differing conclusions from the numerical groundwater model?

Response:

Yield estimates contain no information about groundwater flow and therefore offer no conclusion about changes to groundwater in the flow regime. Rather, the estimated yields in the Project water balance model were adjusted for the reduction in baseflow predicted by the groundwater model.

c. How do the calibrated estimates of recharge in the groundwater model compare to the overall water budget derived from the GoldSim model?

Response:

The recharge estimated by the groundwater model does not conflict with the water budget but is also not directly comparable. In simple terms, precipitation that falls within a catchment can either infiltrate, become overland flow, report to storage (snow, ice, lakes or aquifers) or evaporate. If the infiltration estimate is less than total precipitation minus evaporation the water budget has not been violated. The water balance estimates annual or monthly yields from various sub-catchments. The estimated yield is a combination of overland flow and groundwater discharge. However, only groundwater that reports to surface at the catchment outflow is accounted for in the yield estimate. It is not possible to accurately estimate the total proportion of groundwater recharge within a catchment that would report to any particular catchment node. For this reason, the recharge estimates cannot be directly compared to the water budget.

31. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 4.3, Pond and Saturated Zone, Page 20

The water management system described in Section 2.4 is relatively complicated with many interconnected ponds and ditches. However, there is very little discussion of how this system and the interconnections are represented within the model.

1. Provide the process schematic for the model linking the various runoff areas, ponds, ditches, and streamflow nodes.

Response:

Figure 31-1 shows a schematic of linkages between ponds, saturated zones and various mine area. Ditches play a relatively minor role in the overall water management scheme and are shown in Figure 2-2 in Appendix 10B.

32. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 4.7, Saturated Zone, Page 25

Benga states that "The volumes available for water storage within the Saturated Zones assumed a void ratio of 25%."

1. Provide justification for the selection of this value?

Response:

The void ratio of 25% reported should have been listed as a void fraction meaning that 25% of the volume of bulk waste rock would be void space. The void fraction was estimated based on typical waste rock bulking factors. Bulking factor is the ratio of loose volume of blasted material to its in-situ volume before blasting and excavation. *Guidelines for Mine Waste Dump and Stockpile Design* by Mark Hawley (2017) lists typical bulking factor for waste rock as between ~1.25 and 1.5. SRK's geotechnical engineers recommended void fraction of 25%, which corresponds to a bulking factor of 1.33, a value typical of the type of waste rock storage facility planned for the Grassy Mountain Project.

33. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 6, Water Balance Results, Page 32

The results from this model are being used to evaluate land cover changes and predict future streamflow and runoff volumes. Demonstration of the model's fitness to describe the hydrology of the study area by matching observations onsite is required. Since management decisions, especially as they pertain to fisheries, will be made with the results of this modelling exercise, any validation or verification that will demonstrate the good function of the model will increase the confidence placed on the results.

1. Discuss if the performance of the model can be evaluated against any of the existing data collected on site?

    a. Demonstrate that the simulated streamflows are reasonable (qualitatively in terms of peak flows and total annual volumes).

Response:

There are limited opportunities for validating the water balance model against data collected in site. Figure 33-1 shows a comparison of measured flows at the mouth of Gold Creek (GC01) to the results of the stochastic simulation. The results of the stochastic simulation are shown as "the probability of flow being less than" the indicated percentage value (*i.e.* the there is a 25% probability that flows will be lower than the 25% line. The agreement is reasonable. Anecdotally, the summer of 2016 was reported to be an unusually dry year, as reflected by the monitoring results, which skirt the minimum flow predicted by the stochastic scenario run.

2. Provide a site-wide water budget determined for the overall site?

Response:

Table DFO 33-1(Appendix C-2) shows a summary table for the annual site-wide water balance.

    a. Provide a breakdown of the water budgets for each stream node.

Response:

Tables DFO 33-2, and DFO 33-3 (Appendix C-2) show annual water budgets for each node in terms of flow from undisturbed local catchments, flow from site, which includes treated discharge and seepage (combined) and inflow to the node from upstream nodes.

34. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 6.2, Pit Lake Water Balance, Page 32

Benga states that "The pit lake water balance indicates that the pit will flood to a spill elevation of 1700 m in 2055, approximately 13 years after it is allowed to begin filling (Figure 6-1). This conservatively assumes that no significant source of groundwater will contribute to the pit lake inflows." We did note that the results of the groundwater model suggest that "mine pit inflows are predicted to rise gradually to a peak of about 55 L/s (4,781 m^3/d [1.74Mm^3/year] in 2037." CR#3, Appendix C, Section 3.7.3, Page 68.

1. What are the non-groundwater inflows to the Pit Lake that were used to base this 13 year filling horizon?

Response:

Non-groundwater inputs include pit wall runoff and direct precipitation on the end pit lake.

a. Are the simulated groundwater inflows (1.7Mm³/year) still insignificant?

Response:

The estimated End Pit Lake volume is approximately 6.3 Mm^3. Therefore, an annual inflow of 1.7 Mm^3 of groundwater would make the total inflow about 2.2 Mm^3/year, which would reduce the time to fill the pit to approximately 3 years.

2. What are the implications of these increased inflows to the pit lake on concentrations and residence times prior to release to Gold Creek?

Response:

An increase in contribution of groundwater to the End Pit Lake would dilute loadings from the pit walls and cause a reduction in constituent concentrations. The reduction in the mean hydraulic residence time to roughly 3 years would be offset by the reduction in concentrations and would not affect the predictions.

35. Volume 3, Appendix 10B, Water and Load Balance Model Report, Section 8.2, Sensitivity Analysis, Page 48

A sensitivity analysis was conducted on several model parameters. The bullet list in this section states "Yield coefficient for reclaimed areas which, in the base case, assumes the objective of reclamation is stability only and not reduction in infiltration."

1. Where is this analysis presented?

Response:

The bullet item referenced should have been omitted from the list of sensitivity analyses. The intention of the sentence was to say that the assessment specifically did not look at infiltration as part of the sensitivity analysis.

Aquatic Ecology

Consultant Report (CR)#6, Addendum, Aquatics Ecology Assessment, Appendix A3 – Grassy Mountain Coal Project Instream Flow Assessment, General

The use of System for Environmental Flow Analysis (SEFA) model to assess potential impacts to fish habitat based on predicted flow changes due to the mining operations is an appropriate approach. The overall program of establishing cross sections appears to have been appropriately completed; however, more information on how sediment classes were determined is requested. While it is understood why monthly flow averages were used, and there is a good discussion as to the limitations of this approach within the instream flow

needs document, we feel the habitat analysis should be completed on a monthly basis and reported as such. The analysis has been reported as an average of a bioperiod stanza, which has the potential to 'hide' impacts (i.e. impacts during low flow periods may be under reported).

The results of the Area Weighted Suitability (AWS) should be integrated with the fluvial geomorphic analysis to understand if the habitat will remain stable under the new flow regimes. The AWS analysis assumes that habitat structure within the channel cross section is static and does not change as flows change, which may not be the case in reality. Discussion on the potential changes to habitat structure with increasing flow should be included and tied back to the erosion analysis.

The Area Weighted Suitability Table shows losses within reaches within Gold Creek for various Bioperiods. A threshold of greater than 10% change has been identified as a significant impact. It is noted that the 10% threshold is only being applied to the individual bioperiod components; however each of the bioperiod components would presumably have differing habitat needs (i.e. adult rearing has different habitat suitability criteria than spawning or fry). As a result, it appears that the cumulative change in overall habitat is greater than 10% when considering the aggregate of the life stage bioperiods in a number of cross sections. Provide further discussion related to the cumulative habitat impacts for the individual life stages of the WSCT.

The use of monthly means on the 41-year time series should complete a trend analysis for the timing of the spring melt. There is evidence that the spring melt is occurring earlier now than 41 years ago. If this is the case, and the snow melt was occurring in July 41 years ago but is now occurring in June, this shift will have an impact on mean monthly flow in both June and July, effectively lowering the flows for these two months. Further analysis on this potential flow shift should be investigated.

1. Discussion on the potential changes to habitat structure with increasing flow should be included and tied back to the erosion analysis.

2. provide further discussion related to the cumulative habitat impacts for the individual life stages of the West Slope Cutthroat Trout.

3. Provide trend analysis on timing of snow melt over 41-time series data to demonstrate if the full 41-year record is applicable for establishing 2016 baseline conditions.

36. CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 3.5, Hydrology Input Data, Page 45

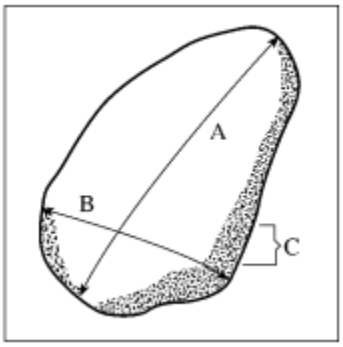
The methods for collecting cross sectional hydraulic data are provided in this section; however details on a number of specific data collection methods are missing.

1. Provide methods, data and analysis showing how sediment sizing (D_{50} and D_{90}) was calculated?

Response:

The D_{95} represents an important indicator of fish habitat quality and is the diameter of the bed material particle that is larger than 95% of the total substrate (RISC 2001). As per the method outlined in RISC 2001, a particle larger in size than 95% of the bed material was selected, from which the intermediate diameter (B diameter, Figure 36-A) was measured using a calibrated ruler or a stadia rod (Figure 36-B).

Figure 36-A Bed material showing D95 measurement (source: RISC 2001)



Source: RISC 2001

Figure 36-B Ruler and stadia-rod based sampling of D95 and substrate distributions.

Particle sizes along the length of each cross-section (including wetted width and banks) were also estimated to characterize the substrate distribution, which was combined with the Westslope Cutthroat Trout Habitat Suitability Curve for substrate as part of Area Weighted Suitability

(AWS) habitat calculations (CR#6 Appendix A3 Section 3.6.2 Development of Hydraulic Habitat Models). The bed material composition was classified as per the categories in Table 36-1, to the nearest 5% of area within every depth and velocity cell (typically 0.1-0.2 m in Gold and Blairmore creeks). These size classes were recommended within the software tool used for the IFA calculations (System for Environmental Flow Analysis, SEFA; Jowett *et al.* 2016) and are very similar to corresponding size classes in the BCIFM (Lewis et al. 2004) guidelines.

Table DFO 36-1 Substrate distributions and size classes used within the IFA.

Substrate Categories	Size Range (mm)	Default Average Size (mm)
Vegetation (bank or instream debris)	n/a	25
Mud/Silt	< 0.06 mm	0.01
Sand	0.06 - 2 mm	1
Fine Gravel	2 - 8 mm	5
Gravel	8 - 64 mm	36
Cobble	64 - 264 mm	160
Boulder	> 264 mm	256
Bedrock	n/a	1000

The median amour size (D_{50}), used to calculate flushing flow effectiveness at each point, was not explicitly required within AWS calculations, but can retrospectively be calculated at each IFA cross-section within the SEFA model from the measured distribution of substrate category and the average size of each category (Table DFO 36-1) where 50% of the substrate is smaller than that type.

2. Provide methods describing how channel slope data was collected or calculated?

Response:

As per BCIFM requirements (Lewis *et al*., 2004), a suite of parameters was surveyed at each cross-section using standard survey leveling equipment (optical level, tripod and stadia rod), to characterize the channel environment and change in water levels between sampling visits. These surveyed parameters included:

- Benchmarks (referenced to an arbitrary datum);
- Water surface elevations;
- Cross-section bed profile including wetted width and banks; and
- Local stream slope (water surface elevations up/downstream of cross-section).

An additional key measurement of bed elevation was obtained downstream of the cross-section, at the best-estimate of the lowest point within a hydraulic control feature, termed the Stage of Zero Flow (SZF; critical for cross-section specific rating-curve development, CR6# Appendix A3 Section 3.4.1 Initial Site Visit). Additional bed elevations were collected upstream and downstream of each cross-section to characterize more highly-variable channel sections (*e.g.*, step-pool sequences) in which the bed and stream slopes may differ significantly. Benchmarks, water levels and bed profiles at each cross-section were presented in Appendix A2 Cross Section Summary Data and Photographs of the CR#6 Appendix A3, in addition to other information (*e.g.*, cross-section photographs and rating curves).

Best-practice survey techniques were applied during the surveying process, including reading of stadia rod heights to the nearest millimeter, use of independent level positions and survey setups, and level calibration checks prior to each field program using a two-peg test as outlined in BC Hydrometric Standards (BC MOE 2009).

37. CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment Section 3.7, Assumptions and Limitations, Page 62

A simulated 1-year time series was "converted to corresponding simulated monthly habitat time series for westslope cutthroat trout spawning and incubation, fry/juvenile/adult rearing, overwintering, and flood supply in watercourse." Simulated project conditions were compared against baseline conditions, and if a greater than 10% change was observed, an impact was assumed. To complete this analysis, the monthly results within a given bioperiod were averaged to establish a monthly average result, which was used in the comparative analysis. By using a monthly average approach over the duration of a bioperiod, impacts can be 'hidden', particularly during low flow conditions.

1. In addition to providing monthly average bioperiod results, provide area weighted suitability analysis results on a monthly basis for each bioperiod.

Response:

The percentage change in average monthly Area Weighted Suitability (AWS, in m^2/m) during five biologically relevant stanzas (adult rearing, juvenile rearing, spawning, fry, overwintering) was the metric used to assess potential effects of predicted flow changes to fish habitat and food supply in Gold and Blairmore creeks, during each of the four mine phases following baseline (construction, operations, decommissioning and closure). Average monthly AWS was calculated as the total stanza habitat during each calendar month, divided by the total number of months included in the total stanza estimate. As the preamble outlines, the threshold for "no significant" effect to fish due to predicted flow changes in each Project watercourse was that at least 90% of total habitat availability remained (*i.e.*, no more than 10% of total habitat was altered) over each stanza, study reach, and project phase.

The simulated changes in AWS (both in absolute and relative terms, compared to baseline) were presented for all combinations of stanza, reach, and project phase, in CR#6 Appendix A3 Table 4-1 to Table 4-3 (Gold Creek during average hydrological conditions, 1-in-10 year and 1-in-20 year droughts conditions, respectively) and CR#6 Appendix A3 Table 4-4 to Table 4-6

(Blairmore Creek during average hydrological conditions, 1-in-10 year and 1-in-20 year droughts conditions, respectively). In all tables, corresponding 1-month maximum monthly habitat changes were also presented to identify the worst-case predicted habitat change estimated for a given combination of stanza, reach, and project phase. The combination of the stanza-averaged results, and highest individual monthly changes, provides full transparency regarding the long-term and worst-case changes in habitat suitability that were estimated both spatially (for each study reach) and temporally (for each year and mine phase).

Changes in habitat quantity and suitability were estimated to be relatively higher in lower flow conditions, as was inferred in the preamble. Higher relative AWS declines (either averaged per stanza, or for individual months) occurred in the lower-flow reaches of Gold Creek (Reaches 8-9 above Caudron Creek inflow, and Reach 6 near Lille), during the 6-year period of 2038-2044 (end of operations into start of decommissioning) when project flow reductions were highest, and during the most conservative (1-in-20 year) drought conditions.

The most pronounced predicted change (alteration) in habitat estimated in the entire IFA study (stanza-averaged AWS reduction of 11%, individual month AWS reduction of 20%) was identified in Gold Creek Reach 9 (location shown in CR#6 Appendix A3 Figure 2.1), during both late-operations and decommissioning (CR#6 Appendix A3 Table 4-3) when coincident with extreme (1-in-20 year) and infrequent drought conditions.

This result occurred for the spawning stanza, which covers the two highest monthly mean flows (May-June), as well as July (when mean monthly flow is under half of June and when the highest 20% habitat loss was estimated). Table DFO 37-1 summarizes the spawning habitat changes estimated in Gold Creek Reach 9, during all project phases (as is presented in CR#6 Appendix A3 Table 4-3), and Figure 37-1 displays all monthly time-series data from which these summary results were calculated. Individual spawning habitat losses (calculated annually from May-July) are shown as crosses ('x'), from which the mean and maximum habitat losses for each project phase are shown as the yellow line and red circles, respectively. Note that the 11% (average) and 20% (worst-case) losses correspond to small losses of habitat area in absolute terms (16 m^2 and 22m2 of corresponding baseline area, respectively) compared to existing (baseline) conditions.

Table DFO 37-1 WSCT mean and maximum monthly losses of spawning habitat, Reach 9 of Gold Creek during 1-in-20 year drought conditions.

Project Phase	Years	AWS			
		Mean (m^2)	Mean (%ΔAWS from baseline)	Max Reduction (m^2)	Max (%ΔAWS)
Baseline	2018	146	-	-	-
Construction	2019	146	0	0	0
Operations	2020-2043	137	-6	-10 [1]	-20

Decommissioning	2044-2045	130	-11	-10 [2]	-20
Closure	2046-2100	133	-9	-22 [3]	-10

Source: all values except max reduction presented in Table 4-3, p86 of CR#6 Appendix A3 of the Instream Flow Assessment.
[1] Calculated as the change from 53 (July 2018) to 43 (July 2040)
[2] Calculated as the change from 53 (July 2018) to 43 (July 2044)
[3] Calculated as the change from 222 (June 2018) to 200 (June 2052)

The information presented in CR#6 Appendix A3 Tables 4-1 to 4-6 (including both stanza-averaged habitat loss results and the maximum monthly habitat losses representative of worst-case conditions), in addition to Figure 37-1, (monthly time-series of the maximum habitat losses estimated across the IFA) illustrates the full spectrum of predicted habitat alterations resulting from changes in flow (hydrology) over the life of the mine. A small number of individual months for which habitat losses exceed 10% are not shown within the graphs or summary tables, but these will always be less than the predicted maximum habitat changes that have been provided explicitly and are only anticipated to occur infrequently during drought events.

38. CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment Section 3.7.1, Time Series Approach, Pages 63 to 65

A 41-year flow time series based on the Water Survey of Canada stream gage data was used to establish a 1-year time series of mean monthly flows within study reaches on Gold and Blairmore Creeks. This 1- year time series is then used as the baseline flow condition within the area weighted suitability analysis and the basis for the future condition analysis. This approach is appropriate, however as mentioned in the text on page 63, “it assumes that the flow time-series used is broadly representative of conditions that fish would experience over the duration of the project phases.” There is no discussion in the text describing if a trend analysis on the 41-year time series was completed to demonstrate if the full time series is appropriate to use as an average condition for the 2016 baseline condition.

1. Provide additional justification that averaging the 41-year time series into a 1-year 2016 baseline condition is appropriate when considering trends in land use change, climatic change, snow pack depth and spring melt timing.

Response:

Please refer to the response provided for DFO SIR 39.

2. Provide justification that the baseline flows are appropriate to use for the life span of the project, considering the implication of climate change.

Response:

Please refer to the response provided for DFO SIR 39.

39. CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 4.1.3.2, Drought Hydrological Conditions, Page 82

It is demonstrated that there may be a significant impact to fish habitat during drought conditions during the decommissioning of the mine in early 2040. It is possible that climate change could affect the frequency of extreme drought conditions in 2040.

1. Provide the predictions for weather conditions due to climate change during this period (2040), and is there a greater likelihood that drought conditions could occur under climate change scenarios?

Response:

Provided, below is a combined response to DFO IR 38, DFO IR 39, and portion of the Aquatic Ecology General preamble of which was not identified specifically as an IR.

Recap of IFA baseline flow generation

A long-term flow time-series across the Project area was estimated for Gold Creek using the 41-year flow record (1976-2016) from Gold Creek near Frank (Water Survey of Canada gauge 05AA030), transformed using the empirical relationships developed between these data and at short-period local hydrometric gauges (Section 2.2, Appendix A1, Instream Flow Assessment). For the same record period, the long-term flow time-series from Crowsnest River at Frank (Water Survey of Canada gauge 05AA080) were transformed to estimate flows across the Project area for Blairmore Creek. The derived Mean Monthly Discharge (MMD) time-series for each creek incorporate the subtle differences in seasonal flow regime between Gold and Blairmore creeks, that strengthen the validity of predicted habitat changes across the entire Project (*i.e.*, lower annual range within MMD on Gold Creek, due to higher groundwater contributions during low flow months).

Changes in hydrological inputs

At longer timescales, changes in flow usually reflect changes within one or more of the potential forcing conditions, such as climate (*e.g.*, precipitation and temperature trends, timing of snowpack melt) and land-use (*e.g.*, mining or forestry). A hydrologic model represents the best method to quantify the relative impacts of each changing input on flows.

Land-use maps (CR#6, Fluvial Geomorphology Assessment, Appendix C) indicate that former mining and logging developments characterize large sections of the Gold Creek watershed, with most mining-related development occurring prior to 1982 and most logging or forest management occurring between 1982-1996. There has been essentially no further land development in the Gold Creek watershed from 1996-2015. In the Blairmore Creek watershed, the headwater area around Grassy Mountain was mined prior to 1982, and a smaller amount of logging or forest resource management activities occurred from 1996-2015. It is assumed that mining and forestry-related activities extended across the wider Crowsnest River watershed during the last four decades.

Because Project-area monitoring of climate is limited, a regional analysis is the only practical means to infer changes in variables such as temperature and precipitation. Thus, the ClimateWNA software program (Wang *et al.* 2012) was used to extract Project area precipitation and temperature conditions, estimated using historical weather station data from across Western North America, a digital elevation model, and a combination of bilinear interpolation and elevation adjustment to downscale the resulting data to an individual location. The elevation

adjustments integrate expert knowledge of climate patterns such as rain shadows, coastal effects, orographic lift, and temperature inversions over topographically delineated facets (Daly *et al.* 2002).

Figures 39-1 and 39-2 display Mean Annual Precipitation (MAP) and Mean Annual Temperature (MAT) respectively, estimated using ClimateWNA for the Project Area (confluence of Gold Creek and Caudron Creek) between 1976-2016 Water Years (WY; November 1-October 31). The long-term MAP across the 1976-2016 WY period was 602 mm (standard deviation 90 mm), with a trendline indicating that MAP reduced very slightly across this period (from 614 to 591 mm, average reduction 0.6 mm/WY; Figure 39-1). Seasonally, modest decreases occurred from November-February (*i.e.*, winter), May, and from July-September (*i.e.*, late summer), offset by modest increases in the remaining four months. The long-term MAT across the 1976-2016 WY period was +1.8ºC (standard deviation 0.8ºC), with a trendline indicating that MAT increased across this period (from +1.6ºC to +2.0ºC, average increase of +0.1ºC; Figure 39-2). Seasonally, modest temperature increases were predicted in most months from July to March (*i.e.*, summer, fall and winter), offset by modest temperature decreases from April to June (*i.e.*, spring).

Changes in runoff

Figure 39-3 displays the Mean Annual Runoff (MAR) from 1976-2016 WY, gauged at the long-term WSC regional stations (Crowsnest River at Frank, 05AA008, and Gold Creek near Frank, 05AA030). Annual runoff is well correlated between the two drainages (R = 0.92) and is slightly higher at Crowsnest River (mean long-term value 356 mm, standard deviation 98 mm) than at Gold Creek (334 mm, standard deviation 110 mm). These values are just over half of the MAP value as reported above for Gold Creek at Caudron Creek (602 mm), though watershed-averaged MAP values are likely higher (annual runoff ratios lower) when accounting for the higher terrain and MAP towards the headwaters of both Gold Creek and Crowsnest River watersheds.

Long-term MAR has been increasing at both WSC gauges (Crowsnest River and Gold Creek) across the 1976-2016 WY period (Figure 39-3). The trendlines indicate that MAR increased from 313 to 401 mm at Crowsnest River and from 280 to 388 mm at Gold Creek, equivalent to an annual increase of 2 mm and 3 mm per year, respectively. As with any trend analysis, the direction and magnitude of change can be very different when analyzing alternative record periods. For example, excluding the first decade of MAR data (1976-1985 WY, a relatively dry period) from the trend analysis substantially reduced the magnitude of increasing trend, to 1 mm/year at Crowsnest River and 0.6 mm/year at Gold Creek between 1986-2016 WY. The importance of analysis period is discussed further in the subsequent section.

Mean Monthly Discharge data at each regional gauge, and corresponding linear trends, are shown from March-October in Figure 39-4. Note that flow data from November-February are largely estimated for the seasonal WSC Gold Creek near Frank gauge and unsuitable for trend analysis. At both gauges, flows increased (or remained relatively constant) during all 8 months, except for August when a slight decreasing trend occurred at Crowsnest River. The increasing flow trends at both gauges were statistically significant at the 0.05 alpha value in June, but otherwise were not significant in the remaining months. When excluding the drier 1976-1985 WY period, the majority of linear flow trends were still positive (increasing), though modest

decreases occurred at both gauges in July-August and additionally at Gold Creek from March-April. None of these linear trends were statistically significant at the 0.05 alpha value.

Figure 39-5 displays the annual (julian) date when the maximum daily flow occurred at the regional gauges. At Crowsnest River, the long-term average julian date of maximum daily flow was 156 (June 5), with virtually no trend over the 1976-2016 WY period. At Gold Creek, the long-term average date was similar (June 13), although the trend in this date decreased (shifted earlier) by one month during the analysis period (predicted from the linear trend as starting on June 27, ending on May 28). As a potential indicator of freshet timing, the Gold Creek trend was likely biased by the data from at least 3 years (all prior to 1986) where maximum daily flow occurred in or after August (Julian date 213 onwards, when peaks were almost certainly driven by summer rainfall storms and unrelated to snowpack melt). Removing these data points, by restricting the analysis to the period 1986-2016 WY, shifted the average date one week earlier (June 7) and reduced the difference in timing predicted by the trend line, from June 14 to June 1 across the period. No change occurred for the Crowsnest River data.

Future climate-changes

There are projected, future seasonal and annual precipitation changes available for Alberta from the Canadian Climate Data and Scenarios website (CCDS). These projections are based on area-averaged climate model simulations from the Coupled Model Inter-comparison Project, Phase 5 (CMIP5; Taylor *et al.* 2012). The changes in temperature and precipitation, expressed relative to the 1986-2005 reference period, are simulated by 29 different climate models, for three different Representative Concentration Pathways (RCPs) representing low, medium, and high plausible future global anthropogenic forcing (RCPs 2.6, 4.5 and 8.5, respectively). The projected changes from three of these models (CanESM2, CNRM-CM5, HadGEM2-ES) are available within the ClimateWNA software, enabling future climate conditions to be downscaled and assessed for the Project area.

Figure 39-6 displays projected annual precipitation changes for the Project (Gold Creek at Caudron Creek confluence) in 2025, 2055 and 2085, relative to a standard climate baseline period of 1981-2010 (MAP 596 mm, basically identical to the 602 mm described above for the 1976-2016 period). Results are shown for the two more-conservative medium (RCP 4.5) and high (RCP 8.5) anthropogenic forcing scenarios. For all years, models, and forcing scenarios, an increase in precipitation is predicted for the project, although there is wide uncertainty within the magnitude of these increases (from <10% to >20%) by 2055, consistent with the projected 2-14% increases averaged across Alberta by 2045-2065.

These projections of annual precipitation mask a strong divergence within the magnitude and direction of projected seasonal precipitation differences, which are most critical for assessing potential impacts on streamflows and WSCT Area Weighted Suitability (AWS). Figure 39-7 illustrates the relative seasonal precipitation differences projected for the Project in 2040 (towards the end of operations and into decommissioning, calculated as the average of model data for 2025 and 2055), around when the highest project-related flow and changes in habitat (AWS) were predicted in the IFA. Consistent with other projections in the foothills region (*e.g.*, Rood *et al.* 2014), the annual increases are strongly driven by increases projected during winter

and spring (approximately 30-50% and 10-30%, respectively, depending on the model and forcing scenario used). During summer months (June-August), precipitation decreases are projected by all three models, however, the range is broad (from 4-24% reductions). During fall months (September-November), precipitation changes were modest (up to ±10% change). Corresponding Alberta-average values projected for 2045-2065 reached as high as +18% during winter, +22% during spring, +15% during fall, and as low as -4.2% during summer based on the majority (75th percentile) of CMIP5 results[9].

Corresponding annual and seasonal temperature changes for the Project are displayed in Figure 39-8 and Figure 39-9, respectively. Projected annual temperatures (Figure 8) generally rise throughout the 21st century, reaching the +2-4ºC range by 2045-2065 that is approximately equal to the majority of provincially-averaged projections1. Projected seasonal temperature changes (Figure 9) for 2040 remain relatively modest during fall and winter (from -1 to +3ºC) but increase for spring (range +1-5ºC) and are generally highest during summer (range +2-6ºC). Provincially, the projected temperature increases by 2045-2065 appear to be less seasonally variable, with the majority (75th percentile) of CMIP5 results1 reaching +3-4ºC difference in all seasons under a high anthropogenic forcing scenario.

Discussion

The 1976-2016 WY (41-year) period was used to establish the hydrology baseline period, from which MMD values were generated using regional gauge data and then translated to the Project area for running the IFA simulations. The above information indicates that regional runoff, and likely across the Project, has increased during this period, both annually and for almost every individual month from March-October. This does not appear to be driven by a corresponding increase in precipitation, although this assumption is uncertain given the use of model-estimated precipitation data and the absence of any reliable, long-term monitoring within the wider Crowsnest Pass area. It is plausible that the runoff increases are more associated with the changing land-use, given the historical mining and logging activity (which both involve land clearing and typically coincide with increase runoff) especially during the early part of this 1976-2016 period. Hydrologic modelling of these historic land changes would be required to assess the influence of land use changes on the observed runoff increases.

Differences between these runoff trends and other reported trends from the wider Rocky Mountain foothills area of Alberta, are invariably related to differences in either the hydrologic forcing (*e.g.*, through climate and land-use) and/or the period of analysis. Kienzle 2012 determined that runoff trends across the foothills region from 1971-2000 were generally flat, ranging from -0.5% to +0.5 % annual change in MAR. A number of trend analyses from the Upper Athabasca and North Saskatchewan basins (north of the project) used entire gauge records (some beginning around 1910) and detected mostly negative runoff trends, in part due to the additional hydroclimatic variability driven by the inter-decadal climate patterns of Pacific Decadal Oscillation and North Atlantic Oscillation (*e.g.*, Peters *et al* 2013, Rood et *al* 2014). The impact of using even slightly different analysis periods was shown by Burn *et al*. 2008 in which seasonal prairie runoff volumes trended upwards during the period 1975 to 2005 but

9 Available online from CCDS: http://climate-scenarios.canada.ca/index.php?page=download-cmip5

downwards during the period 1965 to 2005 due to the rapid runoff declines occurring from 1965 to 1975. A similar pattern occurred in the results outlined above, in which runoff volumes clearer trended upwards during the period 1976-2016 but were largely consistent during the shorter 1986-2016 period, both in the annual and monthly data.

The climate change projections for the Project area indicate that annual temperatures and precipitation will both increase during the life of the mine. The seasonal projections of increasing temperature and precipitation during winter and spring highlight that the future snowpack may be smaller, and melt earlier, but increased rainfall amounts may increase winter runoff. An earlier and potentially smaller freshet has been hypothesized in other studies from the foothills region (*e.g.*, Kienzle 2012, Rood *et al* 2014). The largest implications for reduced streamflows, and ultimately AWS, is potentially during summer when the combination of earlier freshet, higher projected temperatures (which may augment evapotranspiration losses) and lower projected precipitation sums (by up to 24% in the worst-case model, Figure 7) may increase the frequency of drought during these months. Any potential repercussions to WSCT are likely during July and August (when flows are naturally much lower), relative to the annual peak flows that typically occur in June.

Summary

It is our position that the results described above support the credibility of the streamflow time-series (1976-2016 WY MMD values) used for estimating baseline-period Area Weighted Suitability (AWS) calculations within the IFA. Since higher flow values usually translate into greater AWS (higher-quality habitat), the reported AWS values may be considered conservative, given that more recent flows (closer to 2016) were higher than the 1976-2016 averaged flows. When removing the initial (1976-1985) period of drier conditions largely responsible for the increasing trends, annual or monthly flows remain largely consistent (or slightly increase). For either period, there is no suggestion that streamflows (ultimately AWS) have recently been decreasing to the point where an updated, more conservative baseline MMD time-series should be established. Likewise, there is no strong evidence to suggest any changes in habitat (AWS) based on timing of peak flows (and by association, subsequent lower flows), given that the average peak flow date (from 1986-2016, the more reliable indicator of changes in freshet) remained within the first two weeks of June both on Crowsnest River and Gold Creek.

Various conservative climate change projections for the Project indicate the potential for drought conditions to increase by 2040 (when Project-related effects are predicted to be highest). The occurrence of more severe droughts is projected during the months of July and August, when decreased precipitation inputs and higher (temperature-driven) evapotranspiration losses may further reduce the existing low flows. These low flows may also become more frequent if the freshet shifts earlier during a warmer climate. The IFA results outlined predicted AWS losses during a severe drought condition (1-in-20 dry year), and while the probability of these predicted changes increase during summer due to climate change, the probability of this event coinciding with the period of greatest predicted Project-related effects (approximately 2040-2045) remains low.

Continued hydrometric monitoring both regionally and across the Project will extend the available records and enhance the ability to detect changes in flow due to future changes related to climate, the Project, or other potential forcings.

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Wang T, Hamann A, Spittlehouse D, Murdock TN. 2012. ClimateWNA – High-resolution spatial climate data for western North America. Journal of Applied Meteorology and Climatology 61: 16-29.

40. CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 4.3, Invertebrate Drift, Page 98, Table 4-7, Gold Creek Habitat Area Predictions for Benthic Invertebrates, 2017-2099, during average hydrological conditions

CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 4.3, Invertebrate Drift, Page 98, Table 4-8, Gold Creek Habitat Area Predictions for Benthic Invertebrates, 2017-2099, during dry hydrological conditions (1-in-10 year recurrence) CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 4.3, Invertebrate Drift, Page 99, Table 4-9, Blairmore Creek Habitat Area Predictions for Benthic Invertebrates, 2017-2099, during average hydrological conditions

CR#6, Addendum, Aquatics Ecology Assessment, Appendix A3, Instream Flow Assessment, Section 4.3, Invertebrate Drift, Page 99, Table 4-10, Blairmore Creek Habitat Area Predictions for Benthic Invertebrates, 2017-2099, during dry hydrological conditions (1-in-10 year recurrence)

The bioperiod for benthic drift is June 1st to September 30th. The tables present the assessment as an average of these 4 months.

1. Present as individual months to better represent and understand potential impacts.

Response:

The predicted habitat area changes to invertebrate drift habitat suitability (CR#6 Appendix A3 Tables 4-7 to Table 4-10) included both averaged results (across each month within a particular bioperiod, reach and project phase) and worst-case results (highest monthly loss, or least positive monthly gain, within a particular bioperiod, reach and project phase). This analysis aligns with the approach for presenting modelled WSCT habitat changes as was outlined in the response to SIR #37, although no drought (1-in-20 dry year) hydrologic condition was simulated for predicting invertebrate drift changes.

Modelling results indicate that no habitat losses for invertebrates are predicted on Blairmore Creek, where flows are anticipated to increase during all months. All results were either zero change or net gains of habitat area, ranging from 0-7% (average) and 0-3% (worst-case or least positive). In Gold Creek, where flows are predicted to decrease, averaged losses of invertebrate habitat ranged from 0-6% across all reaches, project phases and hydrologic conditions, implying that no significant habitat alterations due to changes in flow are predicted. Worst-case (individual month) scenario of invertebrate habitat change exceeded the 10% threshold (-13%) during infrequent dry hydrological conditions in Reach 9, occurring during mine operations. Figure 40-1 presents the monthly time-series of predicted invertebrate habitat changes through each Project phase. In absolute terms, the highest average habitat loss (6%) and maximum monthly habitat loss (13%) corresponded to areas of 18 m^2 and 23 m^2, respectively (Table DFO 40-1).

Table DFO 40-1 WSCT mean and maximum monthly losses of benthic invertebrate habitat, Reach 9 of Gold Creek during 1-in-10 year drought conditions.

Project Phase	Years	AWS			
		Mean (m^2)	Mean (%ΔAWS from baseline)	Max reduction (m^2)	Max (%ΔAWS)
Baseline	2018	318	-	-	-
Construction	2019	318	0	0	0
Operations	2020-2043	308	-3	-23 [1]	-13
Decommissioning	2044-2045	300	-6	-13 [2]	-10
Closure	2046-2100	302	-5	-13 [3]	-10

Source: all values except max reduction presented in Table 4-10, p99 of CR#6 Appendix A3 of the Instream Flow Assessment.
1 Calculated as the change from 185 m^2 (August 2017) to 162 m^2 (August 2040)
2 Calculated as the change from 126 m^2 (Sept. 2017) to 113 m^2 (Sept. 2044)
3 Calculated as the change from 126 m^2 (Sept. 2017) to 113 m^2 (Sept. 2052)

As described in CR#6 Section 4.2.2.2 Changes in Westslope Cutthroat Trout Food Supply, studies evaluating invertebrate drift distances in stream environments have generally found that invertebrate drift is short, indicating that drift typically originates from the area immediately

upstream, rather than from a cumulative contribution from the upper stream (headwater) reaches. Under average flow conditions, most field-based studies have estimated that daily drift distances in stream habitats range from less than 1 meter to typically no more than 100 meters, depending on local conditions and taxa present. In terms of prey budget, various studies have suggested that even at low flows, headwater streams can move limited quantities of invertebrates. Thus, given the predicted infrequent and localized change in invertebrate habitat within Reach 9, significant adverse effects to Gold Creek food supply as a result of changes in hydrology are not anticipated.

41. CR#6, Addendum, Grassy Mountain Coal Project: Aquatic Ecology Effects Assessment Addendum, General

The impact assessment does not appear to take an integrated approach between the disciplines of aquatic biology, hydrology, hydrogeology and fluvial geomorphology. Results from the hydrology, hydrogeology and fluvial geomorphology should be considered together. For instance, mapping of critical habitat for westslope cutthroat trout (spawning, over wintering etc.) should be overlaid on groundwater and surface water mapping to understand how changes in both ground and surface water may impact critical habitats. This should be followed by a channel stability analysis based on predicted flow changes within the identified critical habitat (i.e. impacts to spawning gravel beds – gravel mobility), which is informed by the results of the surface and groundwater models. These results combined with the area weighted suitability analysis would provide a very good picture of the potential impacts associated with the proposed mine operations.

1. Provide further integration between disciplines within the impact analysis for critical westslope cutthroat trout habitats.

Response:

The Aquatic Ecology Effects Assessment Addendum (Consultant Report [CR] #6) applied an integrated approach between the disciplines of aquatic biology, hydrology, hydrogeology, and fluvial geomorphology and meets the conformity information requirements laid out in Section 6.3.1 (Fish and Fish Habitat) of the Grassy Mountain Coal Project Guidelines for the Preparation of an Environmental Impact Statement pursuant to the *Canadian Environmental Assessment Act*, 2012.

The following key technical reports were completed and used to inform other associated technical assessments including the Aquatic Ecology Effects Assessment Addendum (CR #6), dated January 31, 2017:

- [Hatfield] Hatfield Consultants. 2016a. Grassy Mountain Coal Project: Fisheries and Aquatic Technical Baseline Report. Prepared for Benga Mining Ltd. 224 pp.
- [Hatfield] Hatfield Consultants. 2016b. Candidate List and Selection of Westslope Cutthroat Trout Habitat Suitability Criteria (HSC) Curves. Memo dated December 6th, 2016. Prepared for Millennium EMS Solutions Ltd. 10 pp.
- [Hatfield] Hatfield Consultants. 2017a. Instream Flow Assessment: Grassy Mountain Coal Project. Prepared for Benga Mining Ltd.

- [Hatfield] Hatfield Consultants. 2017. Water Temperature Modelling Using Forecasted Flow Changes for the Grassy Mountain Coal Mine. Prepared for Benga Mining Ltd. 29 pp. (Appendix A4 of Hatfield 2017a).
- SNC-Lavalin. 2016. Grassy Mountain Coal Project Fluvial Geomorphology Effects Assessment. Prepared for Hatfield Consultants. December 2016. 98 pp.
- [SRK] SRK Consulting. 2016a. Grassy Mountain: Water Quality Management. Prepared for Millennium EMS Solutions Ltd. Appendix 10C.
- [SRK] SRK Consulting. 2016b. Grassy Mountain: Water and Load Balance Model. Prepared for Millennium EMS Solutions Ltd. Appendix 10B.
- [SRK] SRK Consulting. 2016c. Grassy Mountain: Surface Hydrology Baseline and Effects Assessment. Prepared for Benga Mining Ltd. Consultant Report #4.
- [SRK] SRK Consulting. 2016d. Grassy Mountain Coal Project Groundwater Numerical Model. Prepared for Millennium EMS Solutions Ltd. Consultant Report #3, Appendix C.

Integration of data/information between the disciplines is evident in the Instream Flow Assessment (Hatfield 2017a), which merges multiple and applicable data sets from aquatic ecology (Hatfield 2016a, 2016b), hydrology (SRK 2016c), and hydrogeology (SRK 2016b, 2016d). The assessment incorporates ecological (critical) habitat and species-specific (valued component) information compiled from historical data sets and project-specific field studies. Appendix A1 of the Instream Flow Assessment provides a further detailed empirical hydrology baseline assessment that was integrated with aquatic ecological (Westslope Cutthroat Trout) information and species-specific habitat suitability criteria (curves) to characterize existing habitat conditions (*i.e.*, quality and quantity) in both Gold and Blairmore creeks. The Instream Flow Assessment then integrated modelled changes in total flow at multiple sub-catchment points that were generated from the Water and Load Balance Model (SRK 2016b), the Surface Hydrology Baseline and Effects Assessment (SRK 2016c) and the Groundwater Numerical Model (SRK 2016d), to predict changes in westslope cutthroat trout habitat suitability and quantity.

The Fluvial Geomorphology Effects Assessment (SNC Lavalin 2016) takes a similar approach by integrating pertinent information from the Instream Flow Assessment (Hatfield 2017a) as well as the Water and Load Balance Model (SRK 2016b), the Surface Hydrology Baseline and Effects Assessment (SRK 2016c) and the Groundwater Numerical Model (SRK 2016d). The geomorphic assessment explored potential changes in channel characteristics and geomorphic processes (sediment mobility) resulting from proposed flow changes throughout the lifetime of the mine and following closure, with an emphasis on changes that may affect aquatic and riparian habitat.

The Aquatic Ecology Effects Assessment Addendum (CR #6) incorporates information from all the listed documents (above) and meets the conformity requirements specific to discipline data integration as noted in the information request.

D. HEALTH CANADA

1. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.1, Page 13, Table 5.1.1-1

Health Canada recommends that the EIS include an inventory of all emissions and potential COPCs resulting from the proposed project in an air quality assessment. Vehicles for hauling and other activities may be a significant source of diesel particulate. Diesel particulate matter (PM) was not included as a potential COPC and may result in an underestimation of potential health risk.

1. Include diesel PM as a potential COPC within the HHRA or provide a strong rationale for its exclusion.

Response:

The diesel particulate matter (DPM) emissions resulting from diesel fuel combustion was estimated for all receptor locations and are provided for acute (two hour maximum) and chronic (annual average) in Table HC 1-1. A 2-hour duration was predicted for the acute assessment to allow for comparison to Health Canada's 2- hour exposure guideline (Health Canada 2016).

Table HC 1-1 Diesel Particulate Matter (DPM) Predicted 2-hour Max and Annual Average Air Concentrations.

Receptor	Project		Baseline		Application	
	2-hr Max ($\mu g/m^3$)	Annual ($\mu g/m^3$)	2-hr Max ($\mu g/m^3$)	Annual ($\mu g/m^3$)	2-hr Max ($\mu g/m^3$)	Annual ($\mu g/m^3$)
RSA-MPOI	31.27	1.01	19.34	2.50	31.35	2.51
FL-MPOI	13.57	0.24	2.11	0.15	13.61	0.26
R1	1.75	0.01	9.98	0.64	10.00	0.65
R2	1.94	0.02	0.23	0.004	2.00	0.03
R3	1.38	0.01	7.61	0.41	7.63	0.42
R4	1.37	0.01	0.18	0.002	1.54	0.01
R5	1.12	0.01	0.18	0.003	1.21	0.01
R6	1.37	0.01	9.84	1.45	9.88	1.45
R7	0.76	0.01	6.64	0.71	6.68	0.72
R8	1.61	0.03	13.10	2.07	13.20	2.10
R9	7.61	0.11	0.99	0.05	7.77	0.17
R10	4.60	0.20	0.40	0.02	4.88	0.22
R11	5.75	0.07	0.27	0.01	5.85	0.08
R12	2.08	0.07	0.65	0.03	2.17	0.10
R13	2.37	0.06	0.51	0.02	2.42	0.08
R14	1.40	0.01	16.57	2.07	16.61	2.08

Acute Inhalation Risk Assessment

Health Canada (2016) published a 2- hour non-cancer short-term exposure risk/guidance value of 10 µg/m^3 for increased airway resistance and inflammation. This value was based on a review of studies indicating that respiratory endpoints are the most sensitive. Acute HQs were calculated for all receptor locations and are provided in Table HC 1-2.

Table HC 1-2 Diesel Particulate Matter (DPM) Acute HQ Results

Receptor	Project	Baseline	Application
RSA-MPOI*	**3.1E+00**	**1.9E+00**	**3.1E+00**
FL-MPOI	**1.4E+00**	2.1E-01	**1.4E+00**
R1	1.8E-01	1.0E+00	1.0E+00
R2	1.9E-01	2.3E-02	2.0E-01
R3	1.4E-01	7.6E-01	7.6E-01
R4	1.4E-01	1.8E-02	1.5E-01
R5	1.1E-01	1.8E-02	1.2E-01
R6	1.4E-01	9.8E-01	9.9E-01
R7	7.6E-02	6.6E-01	6.7E-01
R8	1.6E-01	**1.3E+00**	**1.3E+00**
R9	7.6E-01	9.9E-02	7.8E-01
R10	4.6E-01	4.0E-02	4.9E-01
R11	5.8E-01	2.7E-02	5.9E-01
R12	2.1E-01	6.5E-02	2.2E-01
R13	2.4E-01	5.1E-02	2.4E-01
R14	1.4E-01	**1.7E+00**	**1.7E+00**

***Note:** The locations for RSA-MPOI differ based on assessment case and COPC. The RSA-MPOI for Baseline $PM_{2.5}$ is predicted to occur in the townsite of Blairmore, whereas the RSA-MPOI for the Project occurs within the Project boundary (See CR#5, Figures 5.4-1 and 5.4-2 respectively).

For acute inhalation exposure to DPM (Table HC 1-2), HQs were predicted to be greater than 1.0 at the RSA-MPOI, FL-MPOI, R8 and R14 (Blairmore) receptor locations. There were no HQs in excess of 1.0 at any of the other locations. For those locations within the project boundaries (Project and Application RSA-MPOI) and at the Project boundary, (FL-MPOI) the Project emissions were predicted to contribute the majority of the HQ results. Access to areas within the plant boundaries is restricted from the public.

At both R8 and R10 the HQ results are marginally elevated above 1.0 and almost entirely a result of Baseline emissions (predicted maximum DPM concentration from project emissions were 11% (at R8) and 8% (at R10) of the Baseline emission).

Provided that the mine site area is restricted from the public during construction and operation activities, that outside of the mine area contribution of DPM is primarily a result of Baseline

emissions and the conservative nature inherent in both the TRV and the air modelling methodology, acute exposure to project related DPM is not considered to pose a risk of adverse human health effects.

Chronic Inhalation TRV

Health Canada (2016) published a non-cancer chronic exposure risk/guidance value of 5 µg/m^3 for respiratory inflammation, histopathological and/or function changes. Chronic HQ results for all receptor locations are provided in Table HC 1-3.

Table HC 1-3 Diesel Particulate Matter (DPM) Chronic HQ Results

Receptor	Project	Baseline	Application
RSA-MPOI	2.0E-01	5.0E-01	5.0E-01
FL-MPOI	4.8E-02	3.0E-02	5.2E-02
R1	2.0E-03	1.3E-01	1.3E-01
R2	4.0E-03	8.0E-04	6.0E-03
R3	2.0E-03	8.2E-02	8.4E-02
R4	2.0E-03	4.0E-04	2.0E-03
R5	2.0E-03	6.0E-04	2.0E-03
R6	2.0E-03	2.9E-01	2.9E-01
R7	2.0E-03	1.4E-01	1.4E-01
R8	6.0E-03	4.1E-01	4.2E-01
R9	2.2E-02	1.0E-02	3.4E-02
R10	4.0E-02	4.0E-03	4.4E-02
R11	1.4E-02	2.0E-03	1.6E-02
R12	1.4E-02	6.0E-03	2.0E-02
R13	1.2E-02	4.0E-03	1.6E-02
R14	2.0E-03	4.1E-01	4.2E-01

For chronic inhalation exposure to DPM (Table HC 1-3), HQs were predicted to be less than 1.0 at all receptor locations. The results indicate that chronic exposure to project related DPM is not considered to pose a risk of adverse human health effects.

Health Canada (2016) does not provide a carcinogenic TRV for DPM exposure due to an apparent species specificity of the observed effect, very high levels of exposure required to solicit those effects and the role that particle overload have in tumor development. Hence, chronic inhalation exposure was not assessed for carcinogenic potential.

References

Health Canada. 2016. *Human Health Risk Assessment for Diesel Exhaust*. Fuels Assessment Section, Water and Air Quality Bureau, Healthy Environments and Consumer Safety

Branch, Health Canada.

2. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.2, Page 16

The EIS uses a 1-hour average of 450 µg/m³ exposure limit for SO_2. However, the Government of Canada recently established Canadian Ambient Air Quality Standards (CAAQS), which replace the outdated National Air Quality Objective (NAAQO). The new 1-hour average of 170 µg/m^3 (65 ppb) is substantially smaller than the NAAQO and comes into effect in 2025.

Revise the SO_2 exposure limit to reflect the 1-hour SO_2 CAAQS within the HHRA, as the project is expected to operate beyond 2025.

Response:

The 1-hour SO_2 predictions were updated based on the Canadian Ambient Air Quality Standards (CAAQS) method[10]:

- 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations.

The revised SO_2 predictions are provided in Table HC 2-1.

Table HC 2-1 Sulphur Dioxide (SO_2) Predicted 1-hour Air Concentrations.

Receptor	Project	Baseline	Application
	3-year average of the annual 99th percentile of the daily maximum 1-hour average (µg/m^3)		
RSA-MPOI	41.19	5.60	41.19
FL-MPOI	4.78	0.23	4.78
R1	0.21	1.98	1.98
R2	0.40	0.02	0.40
R3	0.19	0.65	0.69
R4	0.18	0.01	0.18
R5	0.32	0.01	0.32
R6	0.18	1.55	1.55
R7	0.13	1.01	1.01
R8	0.43	3.66	3.67
R9	0.79	0.11	0.82
R10	2.73	0.04	2.73
R11	2.63	0.02	2.63
R12	0.60	0.06	0.61

10 https://www.ccme.ca/en/resources/air/air/sulphur-dioxide.html

Table HC 2-1 Sulphur Dioxide (SO_2) Predicted 1-hour Air Concentrations.			
Receptor	**Project**	**Baseline**	**Application**
	3-year average of the annual 99th percentile of the daily maximum 1-hour average (µg/m³)		
R13	1.28	0.05	1.28
R14	0.14	4.97	4.98

The CCME published a 1-hour SO_2 CAAQS target of 170 µg/m^3 (65 ppb) by the year 2025. Acute HQs were calculated for all receptor locations based on this target concentration and are provided in Table HC 2-2.

Table HC 2-2 Sulphur Dioxide (SO_2) Acute HQ Results			
Receptor	**Project**	**Baseline**	**Application**
RSA-MPOI	2.4E-01	3.3E-02	2.4E-01
FL-MPOI	2.8E-02	1.4E-03	2.8E-02
R1	1.6E-02	2.9E-02	2.9E-02
R2	1.2E-03	1.2E-02	1.2E-02
R3	2.4E-03	1.2E-04	2.4E-03
R4	1.1E-03	3.8E-03	4.1E-03
R5	1.1E-03	5.9E-05	1.1E-03
R6	1.9E-03	5.9E-05	1.9E-03
R7	1.1E-03	9.1E-03	9.1E-03
R8	7.6E-04	5.9E-03	5.9E-03
R9	2.5E-03	2.2E-02	2.2E-02
R10	4.6E-03	6.5E-04	4.8E-03
R11	1.6E-02	2.4E-04	1.6E-02
R12	1.5E-02	1.2E-04	1.5E-02
R13	3.5E-03	3.5E-04	3.6E-03
R14	7.5E-03	2.9E-04	7.5E-03

For acute inhalation exposure to SO_2 (Table HC 2-2), HQs were predicted to be less than 1.0 at all receptor locations. The results indicate that acute exposure to project related SO_2 is not considered to pose a risk of adverse human health effects.

3. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.2, Page 16; Response to CEAA's Request for Additional Information, Question 17, Pages 2-38 to 2- 41

The EIS uses a 1-hour average of 199 µg/m³ exposure limit for NO_2. However, the Government of Canada recently established Canadian Ambient Air Quality Standards

(CAAQS), which replace the outdated National Air Quality Objectives (NAAQO). The new 1- hour average of 79 µg/m^3 (42 ppb) for NO_2 is substantially smaller than the NAAQO and comes into effect in 2025. Scientific analyses have found no evidence of a threshold for population-level effects associated with NO_2 exposure, and guideline values should not be construed as limits to which polluting up to is allowed. It should be acknowledged that health risks exist below the guidelines.

a) Revise the NO2 exposure limit to reflect the 1-hour NO2 CAAQS within the HHRA, as the project is expected to operate beyond 2025.

Response

The 1-hour NO_2 predictions were updated based on the Canadian Ambient Air Quality Standards (CAAQS) method[1]:

- 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations.

The revised NO_2 predictions are provided in Table HC 3-1.

Table HC 3-1 Nitrogen Dioxide (NO_2) Predicted 1-hour Air Concentrations.

Receptor	Project	Baseline	Application
	3-year average of the annual 98th percentile of the daily maximum 1-hour average (µg/m^3)		
RSA-MPOI	274.31	109.89	277.54
FL-MPOI	103.78	59.18	107.09
R1	26.38	86.47	86.48
R2	36.25	33.57	59.22
R3	24.39	87.52	87.53
R4	12.49	32.70	44.76
R5	19.59	33.02	50.79
R6	28.54	95.04	95.05
R7	19.54	85.03	85.03
R8	27.85	105.54	105.56
R9	86.24	42.65	90.50
R10	81.99	35.49	88.00
R11	85.37	34.10	91.57
R12	54.99	38.03	71.20
R13	60.55	36.40	73.61
R14	24.68	92.19	92.19

The CCME published a 1-hour NO_2 CAAQS target of 79 µg/m^3 (42 ppb) by the year 2025. Acute HQs were calculated for all receptor locations based on this target concentration and are provided in Table HC 3-2.

Table HC 3-2 Nitrogen Dioxide (NO_2) Acute HQ Results

Receptor	Project	Baseline	Application
RSA-MPOI	**3.5E+00**	**1.4E+00**	**3.5E+00**
FL-MPOI	**1.3E+00**	7.5E-01	**1.4E+00**
R1	3.3E-01	**1.1E+00**	**1.1E+00**
R2	4.6E-01	4.2E-01	7.5E-01
R3	3.1E-01	**1.1E+00**	**1.1E+00**
R4	1.6E-01	4.1E-01	5.7E-01
R5	2.5E-01	4.2E-01	6.4E-01
R6	3.6E-01	**1.2E+00**	**1.2E+00**
R7	2.5E-01	**1.1E+00**	**1.1E+00**
R8	3.5E-01	**1.3E+00**	**1.3E+00**
R9	**1.1E+00**	5.4E-01	**1.1E+00**
R10	**1.0E+00**	4.5E-01	**1.1E+00**
R11	**1.1E+00**	4.3E-01	**1.2E+00**
R12	7.0E-01	4.8E-01	9.0E-01
R13	7.7E-01	4.6E-01	9.3E-01
R14	3.1E-01	**1.2E+00**	**1.2E+00**

For acute inhalation exposure to NO_2 (Table HC 3-1), HQs were predicted to be greater than 1.0 at the RSA-MPOI, FL-MPOI, R1, R3, R6 through R11 and R14 receptor locations. There are no HQ's in excess of 1.0 at any other locations. At receptor locations R1, R3, R6 through R8 and R14 the HQ's are marginally elevated above 1.0 and almost entirely a result of predicted Baseline emissions. The remaining receptor locations (R9 through R11) also reported HQ's that were marginally above 1.0. For those locations within Project boundaries (Project and Application RSA-MPOI) and at the Project boundary (FL-MPOI), the Project emissions were predicted to contribute the majority of the HQ results.

Additional assessment of these results was conducted to determine whether they indicated a potential human health risk. This included the evaluation of the five year, time series data for all locations with an HR greater than 1.0 as well as an evaluation of the basis of the revised TRV. The time series data predicted 1 hour maximum concentrations for a period of five years; resulting in a total of 43,824 1-hour periods in 5 years (*note that the actual concentration from which to compare the CAAQS is the 98%ile of the 3 year average, however, the guideline value has been conservatively applied to all of the1-hour maximum predicted NO_2 concentrations*).

Overall, the predicted number of times that the CAAQS TRV was exceeded per year is low and for most receptor locations (with the exception of receptor locations FL-MPOI, RSA-MPOI, R6 and R8), the TRV is exceeded less than 2.85% of the time. Table HC 3-3 provides a summary of health effects caused at increasing concentrations of NO_2.

Table HC 3-3 Adverse Human Health Effects Caused at Varying Concentrations of NO_2

Concentration (μ/m^3)	Effect	Source
188	No effect	WHO (2000)
226	Slight functional impairment during exercise (asthmatics)	
940	Chest tightness and laboured breathing with exercise in 7 of 13 asthmatics tested. Slight burning of the eyes, slight headache eye irritation and headache.	NRC (2012)
22,560	Burning sensation in nose and chest	
47,000	Bronchiolitis and focal pneumonia with spontaneous recovery	

Comparison of the 1-hour NO_2 concentrations for RSA-MPOI, FL-MPOI, R1, R3, R6 through R11 and R12 to those concentration which illicit an adverse effect (Table HC 3-3) are provided in Figure 3-1 through Figure 3-11, respectively. These results indicate that with the exception of the RSA-MPOI none of the receptor locations reported concentrations greater than 188 $\mu g/m^3$ and all receptor locations (included RSA-MPOI) reported 1-hour NO_2 concentrations below 226 $\mu g/m^3$ which is the concentration reported to cause slight functional impairment in sensitive individuals during exercise (Table HC 3-3).

These results indicate that a sensitive individual would be unlikely to experience any adverse respiratory symptoms (shortness of breath, wheezing) at any of the receptor locations, but if such an incident occurred, the effect would be transient and occur only at the RSA-MPOI. Non-sensitive individuals would not be affected.

At the RSA-MPOI, the no effect level of 188 $\mu g/m^3$ was exceeded 0.26% of the time (Figure 3-1). The maximum predicted 1-hr concentration in 5-years is 671 $\mu g/m^3$, which is lower than the concentration of NO_2 known to cause an adverse health effect in exercising asthmatics (940 $\mu g/m^3$) but is elevated above the concentration known to cause slight functional impairment (226 $\mu g/m^3$). The number of times that the 1-hr concentration is predicted to exceed a value of 226 $\mu g/m^3$ is 10 times per year (approximately 0.12% of the time). The RSA-MPOI is located within the Mine Project Boundary, and thus is not expected to be accessible to the general population. Owing to the fact that the mine site area is restricted from the public during construction and operation activities and therefore potential for exposure is negligible, combined with the conservative nature inherent in the air modelling methodology, acute exposure to project related NO_2 is not considered to pose a risk of adverse human health effects.

At all other locations, predicted air concentrations are lower than the no effects limit provided by WHO (2000) and were elevated as compared to the CAAQS guidelines for relatively short durations of time (Figure 3-2 through Figure 3-11). Provided the conservative nature inherent in the air modelling methodology combined with the limited number of occurrences where modeled concentrations exceed the CAAQS guideline, acute exposure to project related NO_2 is not considered to pose a risk of adverse human health effects.

b) Given that health effects can occur even at concentrations below applicable guidelines, provide a discussion of additional mitigation measures to reduce the NO2 (1-hour) concentrations associated with the Project.

Response

Mitigation measures specific to reducing NOx were described in CR#1 Air Quality (Section 6.6. Air Quality Mitigation and Management). Mitigation measures for NOx emissions include the use of Tier 4 engines in heavy duty mine equipment. Benga has also committed to investigate alternative blasting agent (ammonium nitrate and fuel oil [ANFO]) formulations that reduce NO_x emissions during blasting.

References:

NRC (National Research Council). 2012. Acute Exposure Guideline Levels for Selected Airborne Chemicals. Volume 11.

WHO (World Health Organization). 2000. Air Quality Guidelines for Europe. Second Edition. WHO Regional Publications, European Series, No. 91.

4. Reference: Consultant Report #12 Human Health Risk Assessment, Section, 5.3.1, Pages 26-30, Tables 5.3.1-1 and 5.3.1-2

The toxicological reference value for benzene (580 µg/m^3) from the Texas Commission on Environmental Quality (TCEQ) was used in the HHRA. However, the more stringent Alberta Ambient Air Quality Objective (AAQO) for benzene (30 µg/m3) should be used to assess acute effects of benzene.

Revise the acute benzene exposure limit to the Alberta AAQO within the HHRA.

Response:

The Alberta Ambient Air Quality Objective (AAQO) for benzene (30 µg/m^3) was obtained from the United States Environmental Protection Agency (US EPA) toxicological review of benzene for non-cancer effects (US EPA 2002). Within this document, the US EPA derived a chronic reference concentration (RfC) of 30 µg/m^3 (US EPA 2002).

The US EPA's inhalation RfC of 30 µg/m^3 is considered to be the level at which no appreciable risk with lifetime chronic human exposure is expected to occur. The value was obtained by applying an uncertainty factor (UF) of 300 to the $BMCL_{ADJ}$ (lower 95% confidence limit of the benchmark concentration adjusted for continuous exposure) using data from Rothman *et al.* (1996) occupational exposure study. The 300-fold UF was included to account for effect level

extrapolation (3), intraspecies variability (10), subchronic to chronic extrapolation (3) and database deficiency (3). Although more stringent, the resultant RfC is not toxicological reference value (TRV) representative of an acute exposure. Health Canada guidance states that a chronic TRV can be used for acute exposure assessment if a suitable acute value is not available (HC 2010). The TRV developed by the Texas Commission on Environmental Quality (TCEQ) was identified as suitable.

The TCEQ developed a 1-hour reference value (ReV) of 580 µg/m^3 for benzene using the lowest observable adverse effect level (LOAEL) identified by Rozen *et al.* (1984), which was supported by two additional studies reporting hematotoxic effects in mice (Dempster and Snyder 1991; Corti and Snyder, 1996). The TCEQ (2007) converted the LOAEL of 10.2 ppm (33 mg/m^3) to a 1-hour human equivalent concentration (HEC) of 18.5 ppm (59 mg/m^3) which was then divided by a 100-fold uncertainty factor to account for use of a LOAEL (3), extrapolation from animals to humans (3) and human variability (10).

The TCEQ 1-hour ReV of 580 µg/m^3 is still considered the most appropriate TRV for evaluation of acute human health risk as the AAQO TRV of 30 µg/m^3 is based on a chronic RfC. However, in answer to this specific request the acute hazard quotients (HQs) were re-calculated for all receptor locations based on an acute benzene exposure limit of 30 µg/m^3 (Table HC 4-1).

Table HC 4-1 Benzene Acute HQ Results

Receptor	Project	Baseline	Application
RSA-MPOI	8.8E-03	9.5E-03	9.5E-03
FL-MPOI	2.7E-03	6.8E-04	2.7E-03
R1	3.6E-04	6.5E-05	4.0E-04
R2	2.7E-04	1.9E-03	1.9E-03
R3	1.1E-04	3.0E-05	1.4E-04
R4	1.8E-04	4.4E-05	2.0E-04
R5	3.0E-04	3.8E-03	3.8E-03
R6	2.7E-04	2.4E-03	2.4E-03
R7	3.1E-04	7.7E-03	7.7E-03
R8	1.4E-03	3.9E-04	1.5E-03
R9	1.2E-03	1.3E-04	1.2E-03
R10	1.4E-03	7.9E-05	1.4E-03
R11	6.9E-04	2.1E-04	7.6E-04
R12	5.1E-04	1.5E-04	5.3E-04
R13	2.8E-04	7.9E-03	7.9E-03
R14	3.5E-04	4.3E-03	4.3E-03

Using Alberta AAQO of 30 µg/m^3, (Table HC 4-1), HQs were predicted to be less than 1.0 at all receptor locations. The results indicate that acute exposure to project related benzene is not considered to pose a risk of adverse human health effects.

References

Alberta Environment (AENV). 2006. *Assessment Report on Benzene For Developing Ambient Air Quality Objectives (AAQO).* Air Policy Alberta Environment and Sustainable Resource Development 9th Floor, Oxbridge Place 9820 – 106th Street Edmonton, Alberta T5K 2J6.

Corti, M. and Snyder, C.A. 1996. *Influences of gender, development, pregnancy and ethanol consumption on the hematotoxicity of inhaled 10 ppm benzene.* Arch Toxicol 70:209-217. Cited In: TCEQ 2007.

Dempster, A.M. and Snyder, C.A. 1991. *Kinetics of granulocytic and erythroid progenitor cells are affected differently by short-term, low level benzene exposure.* Arch Toxicol 65(7):556-561. Cited In: TCEQ 2007.

Rothman, N., Li, Gl., Dosemeci, M., *et al.* 1996. *Hematotoxicity among Chinese workers heavily exposed to benzene*. Am J Med 29(3):236-246. Cited In: TCEQ 2007.

Rozen, M.G., Snyder, C.A., Albert, R.E. 1984. Depression in B- and T-lymphocyte mitogen-induced blastogenesis in mice exposed to low concentrations of benzene. Toxicol Lett 20:343-349. Cited In: ATSDR 2007.

Texas Commission on Environmental Quality (TCEQ). 2007. *Final Development Support Document: Benzene.* Prepared by Joseph T. Haney. Toxicology Section. October 2007.

United States Environmental Protection Agency (USEPA). 2002. *Toxicological Review of Benzene (noncancer effects). In Support of Summary Information on the Integrated Risk Information System (IRIS).* Washington, DC.

5. Reference: Consultant Report #12 Human Health Risk Assessment, Section 4.2 and 4.7, Pages 9 and 49-50

A planned development case (PDC) was not assessed in the HHRA, as the Air Quality Assessment did not identify any planned projects in the area. However, in the surface water quality assessment, the PDC included several projects (Crown's four timber operations, ATCO's Castle Rock Ridge to Chapel Rock Transmission Project, and Alberta Transportation's Highway 3 Realignment project) that fall within the air quality and human health RSA. There is uncertainty as to why these projects were not considered in the air quality assessment and the HHRA. The EIS also assumes no increase in vehicle and railway traffic. This may lead to an underestimation of health risk considering the already predicted exceedances of NO_2 and PM_{10} for this Project.

a) Provide a rationale as to why projects planned within the air quality and human health RSA (four timber operations, ATCO's Castle Rock Ridge to Chapel Rock Transmission Project and Alberta Transportation's Highway 3 Realignment Project) were not considered in the PDC of the air quality assessment, and subsequently the HHRA.

Response

Timber operations

Benga is aware that timber operations are ongoing in the region. Over the course of the mining operation, it is expected that these may continue in some fashion. As the operations generally are planned to include harvesting rather than sawmill or other processing operations, the incremental changes in overall emissions are expected to be limited, and accounted for in the conservative estimates of background air quality.

AltaLink

According to the AltaLink website (http://www.altalink.ca/project-files/updates/296/AltaLink%20Chapel%20Rock%20invite%20CRRCR%20update%20Final%20March%202018.pdf), the Chapel Rock to Pincher Creek Area Transmission Development includes:

- A new substation, named Chapel Rock, which will connect to the Alberta/British Columbia intertie transmission line located west of Highway 22.
- A new transmission line connecting the Chapel Rock Substation to either the existing Goose Lake or Castle Rock Ridge substations, both located north of Pincher Creek.

The AESO has also directed AltaLink to prepare a facility application to complete work to restore the capacity of the 500 kV intertie transmission line between British Columbia and Alberta to its original design. The Intertie Restoration Project includes:

- adding equipment underneath the intertie transmission line west of Highway 22;
- increasing the transmission line's ground clearance in certain locations; and
- work at the Bennett Substation near Calgary where the line terminates.

As of March 2018, the location of the new substation and potential routes for the new transmission line had not been determined. During construction of the line, some air emissions are expected to be associated with vehicle exhaust and perhaps dust from land clearing. However, as the route has not been determined, potential interaction with the Project cannot be established. When operational, no air quality issues are expected. Therefore, because the location of emissions, the emission rates, and the timing of the work are all unknowns, this project is not included in the PDC.

Highway 3

There are two elements to consider in determining the need for a PDC assessment: changes in traffic counts and changes in vehicle emissions.

Traffic Counts

Dispersion modelling of Highway 3 emissions (Appendix A to CR#1) assumed the future emissions and traffic count to be approximately constant. This was reiterated in the response to CEAA SIR#12 which presented rationale for non-increasing traffic emissions. The traffic assessment for the EIA (Hatch Mott McDonald 2015) indicated traffic counts over the last 7 years to be approximately constant.

The most recent AT plans for Highway 3, as provided by Hatch Mott McDonald (private communication), are:

- Vehicle traffic will increase at a rate of 1.5% per year. By 2050 for example, traffic volumes would be anticipated to increase by about 60%.
- When the Highway 3X corridor is developed roughly 40% of the traffic will remain on the old Highway 3 corridor and 60% will divert to the new Highway 3X freeway. Highway 3X will take a more southerly route, between 100 m and 200 m south of the current route, and farther from the Benga loadout.

Thus, the traffic count on Highway 3 is expected to increase by 1.5% per year, but counts on the road segment nearest the loadout will decrease relative to current levels.

Vehicle Emissions

Canada has released regulations to limit GHG emissions from passenger cars and light trucks from model year 2011 to 2016, based on the latest U.S. standards. The Canadian government anticipates that the average GHG emission performance of the 2016 Canadian fleet of new cars and light trucks would match the average level of 153 g CO_2/km. This would represent an approximate 20% reduction compared to the new vehicle fleet that was sold in Canada in 2007. Furthermore, the recent Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations establish progressively more stringent GHG emission standards for Canadian vehicles of model years 2017 and beyond (Environment Canada 2014). Figure 5-1 illustrates regulatory requirements in Canada to 2025 (from ICCT 2011).

The ICCT forecasts Canadian LD fleet carbon emissions to decrease by 47% from 2013 to 2025. The forecast corresponds to an annual decrease of about 3%. It is expected emissions would continue to decrease beyond 2025. During the same period Canadian MD and HD fleet emissions, harmonized with the USA, are forecast to decrease at about 0.6% per year (https://www.dieselnet.com/standards/ca/).

b) Provide a PDC in the HHRA to quantitatively demonstrate the potential effects of increased highway and railway traffic emissions on human health.

Response

A revised PDC assessment is unnecessary. AT expects the traffic count on Highway to increase at 1.5% per year, while LD fleet emissions are expected to decrease by 3% per year. Thus, while traffic is forecast to increase, highway emissions overall are expected not to increase. The Application case assessment presented in the EIA is expected to be a reasonable assessment of planned development in the region.

References

Environment Canada. 2014. Archived - Government of Canada Takes Further Action to Reduce Greenhouse Gases (GHGs) and Air Pollution from Cars and Trucks. http://news.gc.ca/web/article-en.do?mthd=advSrch&crtr.mnthndVl=11&crtr.mnthStrtVl=1&crtr.page=1&nid=886509&crtr.yrndVl=2014&crtr.kw=vehicles&crtr.yrStrtVl=2002&crtr.dyStrtVl=1&crtr.dyndVl=19.

International Council on Clean Transportation. 2011. Global Comparison of Light-Duty Vehicle Fuel Economy/GHG Emissions Standards. https://www.theicct.org/sites/default/files/ICCT_PVStd_Aug2011_web.pdf

Hatch Mott McDonald. 2015. Appendix 8: Traffic Impact Assessment.

6. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.3.2, Pages 32-33, Table 5.3.2-1

The acute respiratory irritant mixture does not include particulate matter (PM) as a component. Scientific data shows that exposure to $PM_{2.5}$ may cause effects including cough and lung function decrements. In addition to respiratory symptoms like coughing and wheezing, PM can penetrate deeper in the respiratory tract causing irritation that can trigger and exacerbate asthma. Excluding PM in the acute respiratory irritant mixture may result in an underestimation of health effects.

a) Include PM2.5 in the acute respiratory irritant mixture in the HHRA.

Response

$PM_{2.5}$ was added into the chemical toxicity endpoint group for acute respiratory irritation (Table HC 6-1) and the acute respiratory irritant mixture HQ was recalculated (Table HC 6-2).

Table HC 6-1 Toxicity Endpoint Groups		
Exposure Pathway and Duration	**Toxicity Endpoint**	**COPC**
Acute Inhalation	Respiratory Irritant	$PM_{2.5}$,NO_2, SO_2, Acetaldehyde, Acrolein, Xylenes, Chromium (III), Copper, Vanadium.

Table HC 6-2 Respiratory Irritant Mixture Acute HQ Results			
Receptor	**Project**	**Baseline**	**Application**
RSA-MPOI	**5.3E+00**	4.5E-01	**5.6E+00**
FL-MPOI	**2.3E+00**	6.6E-01	**2.5E+00**
R1	3.7E-01	9.9E-01	9.9E-01
R2	4.8E-01	4.5E-01	7.6E-01
R3	3.5E-01	9.1E-01	9.2E-01
R4	2.5E-01	4.4E-01	6.5E-01
R5	3.2E-01	4.4E-01	7.3E-01
R6	3.5E-01	**1.2E+00**	**1.2E+00**
R7	3.2E-01	9.6E-01	9.7E-01
R8	3.7E-01	**1.5E+00**	**1.5E+00**
R9	6.1E-01	5.4E-01	8.9E-01
R10	8.6E-01	4.6E-01	**1.1E+00**
R11	6.8E-01	4.5E-01	9.6E-01
R12	5.1E-01	4.9E-01	7.9E-01
R13	6.1E-01	4.7E-01	8.9E-01
R14	3.3E-01	**1.3E+00**	**1.3E+00**

For acute inhalation exposure to Respiratory Irritant Mixture (Table HC 6-2), HQs were predicted to be greater than 1.0 at the RSA-MPOI, FL-MPOI, R6, R8, R10 and R14 receptor locations. There are no HQ's in excess of 1.0 at any other locations. At receptor locations R6, R8 and R14 the HQ's are marginally elevated above 1.0 and almost entirely a result of Baseline emissions. The remaining receptor location (R10) also reported an HQ marginally above 1.0. For those locations within Project boundaries (Project and Application RSA-MPOI) and at the Project boundary (FL-MPOI), the Project emissions were predicted to contribute the majority of HQ results.

Overall, with the exception of those locations within the Project boundary, all HQ's were predicted to be ≤1.3. Provided the conservative nature inherent in both the toxicological reference value (TRV) and the air modelling methodology, acute exposure to project related respiratory irritants is not considered to pose a risk of adverse human health effects.

Risk of potential acute effects on humans from the Project are predicted to occur at both the RSA-MPOI (HQ = 5.6) and the FL-MPOI (HQ = 2.5). However, the MPOI locations are assuming the most conservative exposure and toxicological parameters apply; they are representative of worst-case exposure scenarios. The MPOI locations are assuming the most conservative exposure and toxicological parameters apply; they are representative of worst-case exposure scenarios. Due the number of conservative assumption include in the assessment of the MPOI locations, the likelihood that the predicted air concentrations would occur and that a person would happen to be at the MPOI locations for an acute period of time is very low.

It is important to note, that inclusion of $PM_{2.5}$ HQs calculate using the established TRV is overly conservative and is not supported by HHRA guidance for three reasons. Firstly, the health end point established for the TRV derivation is not respiratory irritation; instead, the impetus behind this guideline was the weight of available evidence for an association between acute exposure to ambient fine PM and increased population mortality and morbidity. Secondly, the guideline is based on a 24-hour exposure duration and is therefore sub-chronic in nature and does not reflect transient short-term (acute) 1-hr exposures (which is the exposure duration for all other chemicals considered within this group). Thirdly, $PM_{2.5}$ is not a chemical; it is the concentration of all particulates with a diameter of ≤ 2.5 µm, which would, by definition, include metals (chromium, copper and vanadium concentrations were scaled from $PM_{2.5}$) and the inclusion of $PM_{2.5}$ within this group effectively double counts the chemical concentration of those metals already being assessed.

b) Clarify if coal dust in the PM2.5 size range was included in the sum total potential human exposure of PM2.5 and PM10 from all sources (including coal dust).

Response

PM emissions (all size ranges) were based on combustion emissions, fugitive dust of all mining sources including coal dust, particulate from blasting, and fugitive (coal) dust from the rail loadout. Emissions also included secondary PM from chemical reactions in air.

The concentration of $PM_{2.5}$ used in the HHRA was modelled from two emission sources: diesel combustion and fugitive dust (CR#1 Air Quality, Section 4.2.2 and Appendix A). Fugitive dust emissions generated from Project activities and Wind Driven daily emissions included coal dust and maximum hourly emissions (kg/h) are presented in tables Table A4-3 and Table A4-4, respectively (CR#1 Air Quality, Appendix A).

7. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.2, Page 23-24

The HHRA should reflect local methods of collection, preparation and consumption of country foods. If there is no evidence to indicate otherwise, the assumption should be that unwashed vegetation (which may be impacted from dust-fall from the project) might be consumed. As such, dust and associated contaminants within the dust (e.g., metals) should be modeled where vegetation is expected to be harvested, to evaluate uptake of these contaminants, which would then be incorporated into the multi-media HHRA. All

contaminants that may be emitted by the project should be evaluated for their potential to be deposited on soil and vegetation that may be consumed by local people.

a) Indicate whether the vegetation samples collected as part of the HHRA were washed or rinsed prior to analysis.

Response

Vegetation samples were collected on two occasions: July 22-31, 2014 and September 5-9, 2014 (CR#12 HHRA, Appendix G). Samples were collected from parts of the plant typically consumed by humans and enough was collected to fill two 125 mL jars. Vegetation samples were not washed or rinsed prior to analysis.

b) If the vegetation samples were washed or rinsed prior to analysis, indicate if any adjustments were made to account for this.

Response

Vegetation samples were not washed or rinsed prior to analysis; no adjustment necessary.

c) Indicate if the highest predicted deposition rates at the applicable discrete locations were used in the modeling of above-ground plant concentrations, in addition to root uptake from soil and direct vapour uptake from air.

Response

Average predicted deposition rates were used at the applicable discrete locations in the modelling of above-ground plant concentrations. Except, in those instances where the measured plant tissue concentration was available for reference. In those cases, the 95%ile of the data were used.

d) Indicate whether the vegetation tissue concentrations reported in the HHRA are in wet or dry weight. Wet weight concentrations should be used to estimate exposure from consumption of produce if consumption rates are on a wet weight ('as consumed') basis.

Response

Vegetation tissue concentrations were calculated and subsequently reported on a dry weight basis (CR#12 HHRA, Appendix G); in accordance with the methodology presented in US EPA (2005). However, as a part of the HHERA multi-media model (MMM) for human exposure, MEMS converted all dry-weight values to their respective wet weight concentrations using a conversion factor specific to the moisture content of each food item. This was completed in order to account for the fact that consumption of produce rates were based on a wet weight ('as consumed') value. Moisture content was taken from US EPA (1997) and dry weight tissue concentration was converted to wet weight.

References

Health Canada. 2010. Supplemental Guidance on Human Health Risk Assessment for Country

Foods (HHRA$_{Foods}$). Federal Contaminated Site Risk Assessment in Canada.

United States Environmental Protection Agency (US EPA). 2005. Human Health Risk Assessment Protocol (Chapter 5: Estimating Media Concentrations). U.S. EPA Region 6. Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering.

US EPA. 1997. Exposure Factors Handbook. National Center for Environmental Assessment. Office of Research and Development. August, 1997.

8. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.2.2, Page 22, Table 5.2.2-1

While the EIS provides an assessment of inorganic mercury in the HHRA, there is no information on the potential health risks of methylmercury. Inorganic mercury can be transformed into methylmercury which bioaccumulates and biomagnifies in the aquatic food chain. Considering that there is the potential for mercury release and that fish consumption is a potential pathway of exposure, the exclusion of methylmercury may lead to an underestimation of health risk.

Provide an assessment of the potential health risks from dietary exposure to methylmercury within the HHRA, employing the appropriate toxicological reference value (TRV)[11]

Response:

Methylmercury (MeHg) is not a contaminant of potential concern (COPC) identified in the Project air emissions; however, elemental mercury was identified as a COPC due to its occurrence in soils and rock and therefore road and blasting dust was identified as a potential source of elemental mercury.

An estimate of potential risk of adverse human health effects associated with exposure to MeHg *via* dietary exposure was conducted. The predicted air concentrations of elemental mercury at the maximum point of impingement from both the regional study area (RSA-MPOI) and fence line (FL-MPOI) were conservatively used to estimate the surface water concentration of MeHg in a hypothetical lake located at each MPOI. There are no lakes within the local study area (LSA) or the project boundary (which contains the MPOI), only small watercourses. Potential exposure estimates based on deposition to a lake is an additional conservative assumption which purposefully results in an overestimate of potential risk of adverse health effects. The results of this conservative assessment indicated that potential exposure to MeHg *via* secondary consumption of fish does not pose a risk of adverse health effects. Details of the methods and assumption applied in the MeHg assessment are provided below.

11 Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Health Canada. Available at: https://www.canada.ca/en/healthcanada/services/food-nutrition/reportspublications/human-health-risk-assessmentmercury-fish-health-benefits-fishconsumption.html

Methylmercury concentrations are higher in large-bodied, longer-living animals; those at the top of the food chain like predatory fish. Methylmercury is produced primarily under anaerobic conditions, methylated mostly by anaerobic bacteria, particularly sulfate reducers and methanogens in aquatic sediments (Environment and Climate Change Canada, 2017). Therefore, the anaerobic conditions of lake sediments, rather than rivers, streams or creeks, have a higher potential for MeHg formation. To conservatively estimate the potential upper boundary of MeHg that may bioaccumulate in fish, a review of available lake conversion or translation factors for total to MeHg, along with bioaccumulation factors (BAF) for predatory fish relevant to human consumption from regulatory agencies were completed.

Due to the complexities in food chain modelling for mercury, methylmercury in fish has been reported to be more accurately estimated from dissolved methyl-mercury concentrations *via* a bioaccumulation factor (US EPA, 2001, 2009; RIVM, 2015). The US EPA has published a translation factor which can be used to estimate the proportion of dissolved MeHg from total mercury in surface water (US EPA, 2001, 2009). Published translation factors are available for rivers, estuaries and lakes. The translation factor of 0.032 (dissolved MeHg/total Hg) for lakes was applied herein.

A summary of the available reported BAF values, considering dissolved MeHg and wet weight, are presented in Table HC 8-1.

Table HC 8-1 Review of Bioaccumulation Factor (BAF) in Fish from Dissolved MeHg

BAF	Reference	Notes
2,670,000	US EPA, 2001	National BAF Value for trophic level four (wet weight), geometric mean of available values. No specific fish species is presented. Designed to estimate the central tendency of the concentrations of mercury in fish of a given trophic level from an average concentration.
680,000	US EPA, 2001	National BAF Value for trophic level three (wet weight), geometric mean of available values.
117,000	US EPA, 2001	National BAF for trophic level two (wet weight), geometric mean of available values.
3,162,278	RIVM, 2015	Median BAF for trophic level 3.5 – 4.5 (log 6.5), wet weight.
501,187	RIVM, 2015	Median BAF for trophic level 2.5 – 3.5 (log 5.7), wet weight.
85,700	ATSDR, 1999	Highest reported, rainbow trout. Wet or dry weight not indicated.

Health Canada has published a tolerable daily intake (TDI) for MeHg of 0.47 µg/mg-bw/d for the general adult population and 0.2 µg/mg-bw/d for women of child-bearing age and children <12 years old (Health Canada, 2010; Health Canada 2007). The TDI of 0.2 µg/mg-bw/d was applied herein for all age groups.

An Alberta First Nations adult fish ingestion rate of 54 g/d has been applied (Chan *et al.*, 2016); this rate was scaled to derive a fish ingestion rate for all other age groups. This regionally derived ingestion rate represents the mean portion size and frequency of fish consumption as

reported by consumers throughout the province of Alberta, and is thought to be based on the most current and local information available. As methylmercury is primarily formed in aquatic sediments and subsequently bioaccumulated up the aquatic food chain, terrestrial sources of methylmercury are not a significant source of exposure and only dietary exposure from fish has been considered. Resulting hazard quotients (HQs) for all age groups, applying the RSA-MPOI and FL-MPOI modelled deposition rates for elemental mercury, are presented below in Table HC 8-2.

Table HC 8-2 Methylmercury Hazard Quotients from Fish Ingestion

Study Area	Infant	Toddler	Child	Teen	Adult
RSA-MPOI	0.00	1.24	1.13	0.73	0.68
FL-MPOI	0.00	0.16	0.15	0.096	0.089

With the exception of the RSA-MPOI toddler and child which were slightly above 1.0, all remaining HQs were below 1.0. As per HHRA guidance, an HQ greater than is not necessarily an indication of potential health risks. It was concluded that based on the number of conservative assumption built into the assessment, the results at the RSA-MPOI are not indicative of potential health risks. Assessment of the RSA-MPOI and FL-MPOI are examples of worst-case exposure scenarios and predicted exposures and therefore potential risks at other receptors locations would be substantially lower. The multiple levels of conservatism applied in this this assessment includes:

- The application of the translation factor for lakes, which is higher relative to aerobic systems like rivers and creeks, assumes that fish are exposed only to lake water. No lake habitat is present in the regional study area, most of the aquatic habitat is characterized as low order creeks and streams.
- The use of the maximum available BAF of 2,670,000 assumes that all fish consumed are from trophic level four (food chain apex), while in reality fish from both trophic level three and four a reported as traditional food items (Chan et al., 2016).
- The use of predicted air concentrations from the RSA-MPOI and FL-MPOI.
- The use of deposition rate from within the project boundary to lakes outside the boundary is thought to be highly conservative.

The HQs derived from the elemental mercury deposition rate from both the RSA-MPOI and FL-MPOI are included for consideration; however, both rates over predict deposition for water bodies outside the project area. Given the conservatism built into the evaluation of methylmercury exposure from fish ingestion, no adverse health effects are predicted.

References:

Agency for Toxic Substance and Disease Registry (ATSDR). 1999. Toxicological Profile for Mercury. Us Department of Health.

Chan, L., O. Receveur, M. Batal., W. David, H. Schwartz, A. Ing, K. Fediuk, and C. Tikhonov.

2016. First National Food, Nutrition and Environment Study: Results from Alberta 2013. University of Ottawa.

Environment and Climate Change Canada. 2017. Canadian Mercury Science Assessment Report. ISBN: 978-0-660-0449-6.

Environment and Climate Change Canada, 2013. Mercury in the Food Chain.

Health Canada. 2010. Part II : Health Canada Toxicological Reference Values and Chemical-Specific Factors, version 2.

Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Bureau of Chemical Safety Food Directorate Health Products and Food Branch.

RIVM National Institute for Public Health and the Environment, the Netherlands. 2015. Derivation of a water-based quality standard for secondary poisoning of mercury.

United States Environmental Protection Agency (US EPA). 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury, final. EPA-823-R-01-001. *Table A-10.*

United States Environmental Protection Agency (US EPA). 2009. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, final. EPA-823-R-09-002.

9. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.3.2, Page 19, Table 5.1.3-2

Response to CEAA's Request for Additional Information, Question 18, Pages 2-41 to 2-43, Table 18-1

The EIS uses dietary composition based on data on Aboriginal food consumption patterns from Health Canada (2010a, b) and Wein et al. (1990). However, a source for the ingestion rates in Table 5.1.3-2 in the EIS for berry, Labrador tea, and cattail under "Ingestion of Plants" could not be located.

When summing the ingestion rates in the EIS (Table 5.1.3-2) for moose, grouse, hare, caribou and deer, the total ingestion rate is 220 g/day. However, in the response to Question 18 of the responses to CEAA, the ingestion rates in Table 18-1 for wild game meat equal 270 g/day.

a) Provide a source for the ingestion rates in Table 5.1.3-2 of the EIS for berry, Labrador tea and cattail.

Response

The ingestion rates presented in Table 5.1.3-2 of CR#12-HHRA were based on a conservative assumption on ingestion based on the data presented in Wein *et al.* (1991) and are consistent with other Environmental Impact Assessments (EIAs) having been completed, and accepted, in the province of Alberta (Intrinsic 2011). As part of the response to this SIR, Benga completed a

review of the assumptions originally included in derivation of the ingestion rates presented in Table 5.1.3-2 for berry, Labrador tea and cattail consumption.

The study conducted by Wein and others (1991) described the mean daily frequency and weight of consumption for a variety of food subgroups in the country foods diet of Native Canadians. The mean weight (expressed as grams of prepared edible portion consumed per day) for all ages and sexes was 5 g/day for berries. This represents approximately 6.7% of the total country food consumption as presented in the study, which also included meat [mammalian and avian] and fish. The total g/day food ingestion for meat and fish based on Richardson (1997) for the various age groups is provided in Table HC 9-1 and is consistent with those values presented in Health Canada (2010). The Health Canada (2010) published ingestion rates for meat and fish (g/d) and the calculated proportion of berry consumption (6.9%) presented in Wein *et al.* (1991) were combined to provide an estimate of berry ingestion at each life stage (Table HC 9-1).

Table HC 9-1 Consumption Rate Derivation for the Berry (g/day)

Receptor	Meat (Richardson 1997)	Fish (Richardson 1997)	Total (meat + fish)	Berry (Total * 6.7%)
Infant[1]	0	0	0	0
Toddler	85	95	180	12
Child	125	170	295	20
Teen	175	200	375	25
Adult	270	220	490	33
Worker[2]	0	0	0	0

[1]Receptor assumed to obtain 100% of sustenance from breast milk.
[2]Receptor would not acquire sustenance from country food diet. Receptor accounted for under the "Adult" scenario.

The ingestion rates for both Labrador Tea and Cattail were derived from Wien (1989) who reported an average plant consumption rate of 134 g per day, which was adjusted by the frequency of 2% for ingestion in Aboriginal households (Wien *et al.* 1991). This provides an estimated consumption for adults of 3 g per day (2% of 134 g) which was adjusted for body weight ratio for each life stage. The consumption rate for cattails was assumed similar to that of Labrador tea leaves and therefore an equivalent ingestion rate was applied (Table HC 9-2).

Table HC 9-2 Consumption Rate Derivation for the Berry (g/day)

Receptor	Cattail (Wein 1989 and Wein *et al.* 1991)	Labrador Tea (Wein 1989 and Wein *et al.* 1991)
Infant[1]	0	0
Toddler	1	1
Child	1	1
Teen	3	3
Adult	3	3
Worker[2]	0	0

[1]Receptor assumed to obtain 100% of sustenance from breast milk.

[2]Receptor would not acquire sustenance from country food diet. Receptor accounted for under the "Adult" scenario.

b) Explain the discrepancy between the ingestion rates noted in Table 5.1.3-2 of the EIS and the corresponding ingestion rates identified in Table 18-1 of the responses to CEAA's additional information requests.

Response

Table 5.1.3-2 of CR#12-HHRA provided the incorrect apportionment values for the specified food items (moose, grouse, hare, caribou and deer). The response to CEAA Question 18 (Table HC 18-1) provides the correct Consumption Rate (g/d) for Meat (mammalian and avian) of 270 g/d.

The study conducted by Wein and others (1991) described the mean daily frequency and weight of consumption for a variety of food subgroups in the country foods diet of Native Canadians The number of occasions of specific food item ingestion per year were investigated for Large Mammals, Small Mammals, Waterfowl and Uplands Birds (Table HC 9-3).

Table HC 9-3 Consumption Occasions Per Year (Wein at al. 1991)

Receptor	Occasions Per Year	% of Dietary Consumption
Large Mammals	128	-
Moose	58	45%
Caribou	53	41%
Bison	15	12%
Bear	2	2%
Small Mammals	27	-
Hare	18	67%
Muskrat	5	19%
Beaver	3	11%
Lynx	1	4%
Waterfowl and Upland Birds	31	-
Duck	13	42%
Goose	5	16%
Swan	1	3%
Spruce Hen	5	16%
Ruffled Grouse	4	13%
Ptarmigan	2	6%
Sharp-tail Grouse	1	3%

Based on the total number of occasions of ingestion reported per year, the frequency of ingestion was calculated for those food items accounted for in this EIA: moose, caribou, deer, grouse and hare. The large mammal category was apportioned to the moose, caribou and deer based on

ingestion frequency, and it was assumed that the hare, and grouse account for 100% of the small mammal and waterfowl and upland bird ingestion categories, respectively (Table HC 9-4).

Table HC 9-4 Consumption of Food Items based on % Occasion

Receptor	Occasions Per Year[1]	Frequency of Total Ingestion[2] (%)	Calculated Wildlife Ingestion[3] (Adult Scenario [g/day])
Moose	58	31.2	84.24
Caribou	35	18.8	50.76
Deer	35	18.8	50.76
Hare	27	16.7	45.09
Grouse	31	14.5	39.19

[1]Moose – obtained direct from Wein *et al.* 1991, Caribou and Deer are equal apportionment of the remainder (128-58)/2, Hare assumes all small mammals apportionment (27), grouse assumes all waterfowl and upland bird apportionment (31).
[2]% of diet based on frequency of overall ingestion (occasions per year÷186).
[3]Frequency of total ingestion multiplied by the age specific Wildlife Ingestion Rate (e.g. 31.2% x 270 g/day).

The summation of the Calculated Wildlife Ingestion rates presented in Table HC 9-4 totals 270 g/day (84.24 + 50.76 + 50.76 + 45.09 + 39.19 g/day).

c) Identify the primary sources for all ingestion rates used.

Response

The following sources were used in derivation of ingestion rates:

Health Canada. 2010. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) Version 2.0. Revised 2012. Federal Contaminated Site Risk Assessment in Canada.

Wein, E.E. 1989. Nutrient intakes and use of country foods by Native Canadians near Wood Buffalo National Park. Thesis presented to the Faculty of Graduate Studies, University of Guelph. February 1989.

Wein., E., Sabry, J. and F. Evers. 1991. Food Consumptions Patterns and Use of Country Foods by Native Canadians near Wood Buffalo National Park, Canada. Vol. 44, No.3. P. 196-205.

Richardson 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment.

10. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.3.1, Pages 26-32

Some of the toxicological reference values (TRVs) identified for the acute inhalation exposures were obtained from the American Conference of Governmental Industrial Hygienists (ACGIH) including acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorine, naphthalene, phenanthrene and pyrene. However, these are occupational toxicological reference values and are not intended for use for the general public as their use could potentially underestimate health risks.

a) Revise the HHRA using TRVs which are applicable to the general public, including sensitive receptors.

Response

No occupational toxicological reference values (TRVs) were applied to assess potential risk to the general public. Values from ACGIH were only used if no other suitable toxicological data were available and were modified with additional safety factors to account for sensitive individuals in the general population. The TRVs presented in CR#12 Human Health Risk Assessment (HHRA) are considered appropriate, and therefore applicable, to the general public (inclusive of concern for sensitive receptors). The TRV selection was conducted as per Alberta Guidance for HHRA in EIAs (AHW 2012) and are protective of sensitive individuals in the general population.

Complex mixtures of petroleum hydrocarbons (PHC) with limited data to describe toxicological properties were separated into aromatic and aliphatic groups (fractions) according to their size (carbon [C] length). Separation into groups was in effort to facilitate the development of exposure limits representative of each group of hydrocarbons; the basis of such grouping is that chemicals with similar physical chemistry are likely to operate under a similar mode of action (MA DEP 1994; TPHCWG 1997; MA DEP 2003; CCME 2008). In the case of acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene the chemicals were categorized, due to similar physical chemistry, under an Aromatic C9 to C16 group (CR#12 HHRA, Appendix B).

Review of available literature indicated that no acute inhalation exposure limits have been derived for aromatic C9-C16 petroleum hydrocarbons. Instead, the ATSDR (1999) have recommended naphthalene (aromatic C10) as a surrogate for this group, but do not provide an acute inhalation TRV. An occupational exposure limit for short-term exposure to naphthalene has been developed by the American Conference of Governmental Industrial Hygienists (ACGIH), and was selected for further assessment.

The ACGIH value of 79 mg/m^3 is for an acute 15 minute exposure. This exposure duration was adjusted to a 1-hour exposure duration following Habers rule (which assumes the inhalation toxic potential of a chemical is a constant that is a function of time and exposure concentration). Therefore, according to Habers rule, a 4-fold increase in exposure duration necessitates a 4-fold decrease in the exposure concentration. Using this assumption, an acute exposure limit of 20 mg/m^3 was determined for 1-hour exposure to naphthalene (79 ÷ 4 mg/m^3). A 10-fold

uncertainty factor was applied to account for the response of sensitive individuals present in the general public, resulting in an acute (1-hour) inhalation exposure limit of 2 mg/m^3 (20 mg/m^3 ÷ 10) .

The exposure limit of 2 mg/m^3 is considered a suitable surrogate TRV (exposure limit) for the Aromatic C9 to C16 group. The TRV is considered protective of the general public and sensitive receptors (owing to the 10-fold uncertainty factor) and does not require adjustment in the HHRA.

b) Provide rationales on a chemical- specific basis as to how the selected TRVs provide an adequate level of health protection for the general public including sensitive receptors.

Response:

A chemical-specific basis for all TRVs selected and the application of safety factors demonstrating protection of the general public, was provided in CR#12 HHRA, Appendix B for all COPC included in the HHRA.

Reference

Alberta Health and Wellness (AHW). 2012. Guidance on human health risk assessment for environmental impact assessment in Alberta. https://open.alberta.ca/publications/guidance-on-human-health-risk-assessment-for-environmental-impact-assessment-in-alberta

11. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.3.1, Page 30, Table 5.3.1-3

Appendix B: Toxicological Profiles, Section 11.2.1, Page B-59, Table B.11-4

A chronic oral exposure limit value of 1.4 mg/kg bw/day for benzo(a)pyrene was used in the HHRA (Table 5.3.1-3). However, a different chronic oral exposure limit value of 0.0000014 mg/kg bw/day was noted in Table B.11-4 in Appendix B. This potential editorial or conversion error may affect the overall risk characterization of benzo(a)pyrene.

a) Clarify the exposure limit value used for benzo(a)pyrene and revise the HHRA as necessary.

Response SIR HC-11:

The chronic oral exposure limit value presented in CR#12 Human Health Risk Assessment (HHRA), Table 5.3.1-3, is an editorial mistake. The original value presented for benzo[a]pyrene (Table 5.3.1-3) reflects the units of ng/kg bw/day which is equivalent to 0.0000014 mg/kg bw/day. The corrected version of this table is provided as Table HC 11-1 (editorial changes are in **bold**). The correct TRV was confirmed to have been used in calculation of risk, therefore, the editorial mistake does not have a material effect on the interpretation of risk within the HHRA.

Table HC 11-1 Chronic Oral Exposure Limits				
	Chemical	**Exposure Limit (mg/kg bw/d)**	**Agency**	**Toxicity Endpoint**
PAHs and VOCs	Acenaphthene	0.060	US EPA	liver
	Acenaphthylene	0.060	US EPA	liver
	Anthracene	0.3	US EPA	NOAEL
	Benzo(a)anthracene	BaP equivalent	-	gastrointestinal tumours
	Benzo(a)pyrene	**0.0000014**	US EPA	gastrointestinal tumours
	Benzo(b)fluoranthene	BaP equivalent	-	gastrointestinal tumours
	Benzo(g,h,i)perylene	BaP equivalent	-	gastrointestinal tumours
	Benzo(k)fluoranthene	BaP equivalent	-	gastrointestinal tumours
	Chrysene	BaP equivalent	-	gastrointestinal tumours
	Dibenzo(a,h)anthracene	BaP equivalent	-	gastrointestinal tumours
	Fluoranthene	BaP equivalent	-	gastrointestinal tumours
	Fluorene	0.040	US EPA	kidney, liver, spleen
	Indeno(1,2,3-cd)pyrene	BaP equivalent	-	gastrointestinal tumours
	Phenanthrene	BaP equivalent	-	gastrointestinal tumours
	Pyrene	0.030	US EPA	kidney
	Formaldehyde	0.150	Health Canada	kidney and GI
Metals	Aluminium	0.143	WHO	-
	Antimony	0.0002	Health Canada	Serum glucose and haematuria
	Arsenic	0.0000056	Health Canada	Cancer (bladder, lung, liver)

Table HC 11-1 Chronic Oral Exposure Limits				
	Chemical	**Exposure Limit (mg/kg bw/d)**	**Agency**	**Toxicity Endpoint**
	Barium	0.2	US EPA	kidney
	Beryllium	0.002	US EPA	Gastrointestinal
	Cadmium	0.0005	US EPA	kidney
	Chromium III	1.5	US EPA	-
	Chromium VI	0.0009	ATSDR	Gastrointestinal
	Cobalt	0.0014	RIVM	cardiovascular
	Copper	0.091 (0 - 4 yrs) 0.111 (5 - 11 yrs) 0.126 (12 - 19 yrs) 0.141 (20+ yrs)	Health Canada	Liver and gastrointestinal
	Manganese	0.047	US EPA	Nervous system
	Mercury	0.0003	US EPA	kidney
	Molybdenum	0.005	US EPA	Uric acid levels
	Nickel	0.011	OEHHA	Perinatal mortality
	Selenium	0.005	US EPA	selenosis
	Thallium	0.00001	US EPA	Hair follicle atrophy
	Uranium	0.0006	Health Canada	kidney
	Vanadium	0.002	RIVM	developmental
	Zinc	0.3	US EPA	ESOD activity

12. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.3.1.1, Page 25

The EIS states that “the basis for each available TRV was evaluated to select the most appropriate value, giving consideration to consistency with Alberta approaches, scientific defensibility, incorporation of most current information, and conservatism”. However, this does not appear to have been consistently applied in Appendix B, and it is unclear whether

the selected TRVs are adequately protective of human health and relevant to the site exposure characteristics.

For example, a one-hour exposure scenario was selected for acute inhalation of benzene, although supporting rationale for this exposure duration was not provided. Human health based TRVs exist for acute inhalation of vanadium (i.e., Ministry of the Environment and Climate Change (MOECC), Texas Commission on Environmental Quality (TCEQ)), but they were not selected due to "lack of supporting documentation."

In the absence of published TRVs for certain COPCs, Health Canada has developed guidance [12, 13, 14] on the development of TRVs and guidance on acute exposure to both carcinogenic and non-carcinogenic contaminants that outlines how acute TRVs may be revised.

a) Confirm that the selected TRVs are adequately protective of human health and relevant to the site exposure characteristics.

Response:

The applied process for selection of Toxicity Reference Values (TRVs) is described in CR#12 Section 5.3 and detailed in CR#12 Appendix B. Methods applied for TRV selection were compliant with Alberta guidance on HHRA in EIA(AHW 2011) and Health Canada guidance for environmental assessment (2010). For each chemical, a rigorous search of the available literature was conducted and included, but was not limited to, the following agencies:

- Alberta Environment and Parks (AEP);
- Health Canada;
- United States Environmental Protection Agency (US EPA);
- World Health Organization (WHO);
- Agency for Toxic Substances and Disease Registry (ATSDR);
- California Office of Environmental and Human Health Assessment (OEHHA);
- Texas Commission on Environmental Quality (TCEQ); and
- Netherlands National Institute for Public Health and the Environment (RIVM).

The lack of suitable source literature is often the cause of a lack of TRV from the aforementioned sources. While subsequent investigation of available source literature on toxicological effects for a specific chemical may have relevance, its absence from the most commonly sourced agencies is typically an indication that suitable studies have not been conducted.

12 Health Canada, 2010, Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM), Appendix B Guidance for Development of Toxicological Reference Values (TRVs) for Federal Contaminated Site Risk Assessments, in the Absence of Published Regulatory TRVs.
13 Health Canada, 2013, Federal Contaminated Sites Risk Assessment in Canada, Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites.
14 Health Canada , October 2016, Memorandum: A Primer for Evaluating Human Health Risk at Contaminated Sites for Chronic and Less-Than- Chronic Exposures to Chemicals

It is important to note that Benga is familiar with the source documentation provided for reference as part of this SIR. The HHRA has applied some aspects of the guidance including, but not limited to: selected TRV; assumption of acceptable risk; receptor characteristics; food consumption rates; and multipathway exposure modelling. However, each of the referenced Health Canada guidance documents were developed for assessment of contaminated sites. While the methodology employed within this EIA aligns with the intent of these documents, an EIA is not a contaminated site assessment; guidance for HHRA in EIA were given precedent (AHW 2011; HC 2010). For example, it was assumed that all receptors would be exposed for a lifetime and therefore neither the "*Interim Guidance on human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites*" nor "*A primer for Evaluating Human Health Risk at Contaminated Sites for Less-Than-Chronic Exposure to Chemicals*" are relevant to the HHRA.

The TRVs selected for the HHRA and presented in CR#12 Appendix B are compliant with Alberta and Federal HHRA EIA guidance, they are adequately protective of human health, are succinct in their analysis of the available toxicological information at the time of publication, and have relevance to Site exposure characteristics for both acute and chronic durations.

References

Alberta Health and Wellness (AHW). 2011. Guidance on Human Health Risk Assessment for Environmental Impact Assessment In Alberta. Government of Alberta. https://open.alberta.ca/dataset/aa836ee3-93ba-46de-8061-06013fe7f4ee/resource/f4707224-df9f-4b38-8be7-a7a0e8bfe798/download/Health-Risk-Enviro-Impact-Guide-2011.pdf

Health Canada (HC). 2010. Useful Information for Environmental Assessments. Cat.: H128-1/10-599E ISBN: 978-1-100-15153-3. www.healthcanada.ca

13. Reference: Consultant Report #12 Human Health Risk Assessment, Section 6.0, Pages 34-52

A target risk quotient of 1.0 was used in the multimedia HHRA. The use of 1.0 appears to be based on the final risk estimate of the HHRA being inclusive of the baseline risk (potential health risk associated with emissions from existing and approved developments in the region, as well as other non-industrial sources). However, although multiple environmental media and exposure pathways were identified for the HHRA (i.e. direct inhalation of air, direct contact with COPCs in soil, ingestion of local vegetation, ingestion of wildlife, contact with surface water and fish ingestion), only two environmental media (vegetation and soil) were considered for assessment of baseline risk. This may result in an incomplete baseline risk assessment.

a) Explain how the exposure pathways considered in the baseline risk assessment justify the use of a risk quotient of 1.0.

Response:

The baseline risk assessment included all of the environmental media and exposure pathways, not just exposure via vegetation and soil, and therefore is considered complete. To summarize, the exposure pathways considered in the HHRA for all case scenarios including baseline were:

- direct contact with chemicals of potential concern in soil (soil ingestion, dust inhalation and dermal contact);
- consumption of various plant food types (above ground leafy plants, root vegetables, fruits and berries, Labrador tea and cattail);
- consumption of various animal food types (fish, moose, grouse, snowshoe hare, waterfowl and deer); and
- ingestion of chemicals from surface water.

The baseline risk assessment did, however, include a sampling program which collected and conducted chemical analysis on vegetation and soil (CR#12 HHRA, Section 5.2.2). Where baseline analytical data were not available, exposure doses were modelled data as per the methods described by US EPA OSW (2005) and supported by Health Canada (2010a,b). Details of the multimedia exposure modelling completed for the HHRA are provided in CR#12 Appendix E.

The selection of an RQ of 1.0 is considered justified as all relevant exposure pathways were incorporated in calculation of the estimated daily intake (EDI). The CCME (2006) and Health Canada (2012) guidance documents on human health assessment include a fifth environmental media (consumer products) for consideration, but, reputable data is sparse, and this exposure pathway was considered negligible in comparison to those already included in derivation of the EDI.

References

Canadian Council of Ministers of the Environment (CCME). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. Winnipeg, Manitoba.

Health Canada. 2010a. Revised in 2012. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment, Version 2.0. Federal Contaminated Site Risk Assessment in Canada. Government of Canada.

Health Canada. 2010b. Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM). Federal Contaminated Site Risk Assessment in Canada. Government of Canada.

Unites States Environmental Protection Agency, Office of Special Waste (US EPA OSW). 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

14. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.2, Page 16

The HHRA assumes that there will be no changes to surface water quality for the reclaimed landscape as a result of the end pit lake. The EIS states that water quality in historical (i.e. existing) end pit lakes is similar to creeks and within water quality guidelines. However, it appears that the predicted water quality of the pit lake has not been compared to water quality guidelines, and the potential human health risk due to the consumption of fish from the end pit lake is also not discussed. These omissions represent a gap in the HHRA.

a) Assess the potential health risks associated with the Project's end pit lake.

Response:

The potential human health risk due to the consumption of fish from the end pit lake has not been discussed in the assessment because it will not be stocked and will remain non fish bearing following reclamation. Local fish species do not thrive in lentic (*i.e.*, still, fresh water) environments and important habitat features such as shoals will not be incorporated into the design of the end pit lake. The end pit lake will be reclaimed for visual appeal rather than for recreational use (swimming, or fishing); the slopes around the end pit lake will be reclaimed to a maximum slope angle of 23° and will include a highwall feature on the west side with slopes of 55° to 60°.

As discussed in Section C, Section C.5.3.6, Benga will mitigate in pit backfill inside the lake's drainage area in order to minimize the amount of selenium affected water from entering the lake. Horizontal drainage holes would be drilled at the 1,700 m elevation in the lake area to the east to allow the lake water to decant and report east into Gold Creek at final closure.

Water quality samples were collected from three historical end-pit lake stations as part of the baseline field program during July and October 2014 and February 2016 (CR#5 – Surface Water Quality Assessment Report). Water quality measured at end-pit lakes created by historical coal mines was considered a suitable surrogate for the anticipated water quality of the Project end-pit lake which will be constructed under similar conditions and for similar purpose. These water quality results were combined with modelled dissolved metal concentrations from SRK and compared to Health Canada drinking water quality guidelines. The results are provided in Table HC 14-1.

Table HC 14-1 Surface Water Quality Results (Human Health Risk).

Parameter	Health Canada DWQG (mg/L)		Max Concentration (mg/L)[15]	
	Aesthetic Objective (AO)	Maximum Acceptable Concentration (MAC)	Surrogate Lakes[2] (Total Metals)	Modelled Concentration[3] (Dissolved Metals)
Antimony	-	0.006	0.0038	0.00013
Arsenic	-	0.010	0.00063	0.00404
Barium	-	1.0	0.115	0.314
Boron	-	5	0.032	0.067
Cadmium	-	0.005	0.000116	0.0003
Chromium	-	0.05	0.00165	0.00011
Copper	1.0	-	0.00306	0.0007
Iron	0.3	-	**1.11**	0.0052
Lead	-	0.010	0.000959	0.00004
Manganese	0.05	0.1*	0.0396	**0.146**
Mercury	-	0.001	0.0000201	0.000056
Selenium	-	0.05	0.00904	0.0155
Silver	None required		0.000075	0.000009
Uranium	-	0.02	0.000659	0.000415
Zinc	5.0	-	0.0093	0.1234

[1]Concentrations of organic compounds were below analytical detection limits.
DWQG – Drinking Water Quality Guideline.
BOLD indicates measured concentration is elevated as compared to the applied guideline.
*Proposed MAC value (Health Canada 2016).

Based on the comparison of measured and modelled data to Health Canada (2017) DWQG value; iron and manganese were the only parameters reported at concentrations greater than applied guidelines.

The water quality guidelines for iron and manganese were created for aesthetic objectives and aren't health based (Health Canada 2017). Instead, the guidelines are based on taste and the potential to stain laundry and plumbing fixtures; these are not applicable guidelines for the assessment of human health. Additionally, Health Canada does not recommend a health based guideline for iron as there is no evidence of a dietary toxicity in the general population. Iron is not a human health concern for the end-pit lake.

Manganese was also elevated as compared to the draft MAC value of 0.1 mg/L proposed by Health Canada (Draft 2016). Health Canada based their recommended drinking water quality

15 Health Canada. 2017. Guidelines for Canadian Drinking Water Quality Summary Table. Available at: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html

guideline on the lowest observed adverse effect level (LOAEL) of 25 mg/kg bw/day taken from the work of Kern *et al.* (2010, 2011) and Beaudin *et al.* (2013) who assessed the effect of manganese exposure on neurodevelopmental endpoints on neonatal rats, and whose findings were consistent with those reported in other epidemiological studies (Bouchard *et al.*, 2011; Khan *et al*., 2011; Roehls *et al*., 2012; Oulhote *et al*., 2014). The LOAEL was adjusted by an uncertainty factor of 1000 for interspecies variation (10), intraspecies variation (10), and the use of a LOAEL rather than a NOAEL (10), which resulted in a tolerable daily intake (TDI) of 0.025 mg/kg bw per day. Health Canada's proposed MAC value of 0.1 mg/L was derived as followed:

$$MAC = \frac{\left(0.025 \frac{mg}{kg} \frac{bw}{day}\right) \times 7kg \times 0.5}{0.75\ L\ per\ day}$$

Where:

- 0.025 mg/kg bw day is the TDI;
- 7 kg is the body weight of an infant;
- 0.5 is the allocation factor for drinking water; and
- 0.75 L is the per day water ingestion estimate from Health Canada (1999).

The input parameters used in derivation of the proposed MAC by Health Canada (2016) do not reflect human receptor characteristics as published by Health Canada in 2012. In it, the average weight of an infant is 8.2 kg, and the water ingestion rate is lower at 0.3 L/day. The proposed MAC was updated using the more recently published exposure parameters from Health Canada (2012), and the resulting MAC was recalculated to be 0.34 mg/L.

$$MAC = \frac{\left(0.025 \frac{mg}{kg} \frac{bw}{day}\right) \times 8.2kg \times 0.5}{0.3\ L\ per\ day}$$

$$MAC = \ 0.34\ mg/L$$

The maximum concentration of manganese modelled for the end-pit lake was 0.146 mg/L, which is lower than the revised MAC. In addition, receptor characteristics for child, teen and adult exposures were also modelled based on Health Canada (2016) input parameters, and it was verified that the infant and toddler receptors (which result in the same revised MAC value) are the most sensitive age groups for development of the MAC. Magnesium is not a human health concern for the EPL.

It should be reiterated that surrogate lakes and modelled surface water concentrations are for mitigation and planning purposes only. These values and the conclusions presented should not be considered a substitute for actual surface water collected data and the potential for human health risk should be revisited upon decommissioning and Site closure.

15. Reference: Consultant Report #12 Human Health Risk Assessment, Section 5.1.4, Page 20

Response to CEAA's Request for Additional Information, Question 19, Pages 2-43 to 2-45

The HHRA indicates that since the Project will not release any chemicals into the groundwater or surface water, the COPCs were only based on air emissions. Considering that processing of the mined material at the plant is considered as part of the Project, there may be a need to consider potential COPC releases to surface water and/or groundwater. The EIS states that several users, within or near the LSA, rely on surface water or groundwater for domestic use (including drinking, showering or bathing).

Health Canada recommends that the water quality assessment identify and describe all sources of drinking and recreational water in the area that may experience a change as a result of the project. Such sources may include source water intakes for drinking water treatment plants and sources that are consumed directly (for example, private wells).

a) Provide information, including a map, of all sources of drinking water in the area used by Indigenous people within the LSA and RSA.

Response

No sources of drinking water within the Local Study Area (LSA) and Regional Study Area (RSA) have been identified by Indigenous groups. Within the LSA, since there are no wells or suitable springs, only Gold Creek and Blairmore Creek could practically be used for drinking water and this would occur infrequently.

b) Provide information, including a map, of all water bodies used for recreational purposes used by Indigenous people within the LSA and RSA.

Response

No waterbodies have been identified by Indigenous groups within the RSA or LSA as being used for recreational purposes. Practically within the LSA, there are no locations suitable for recreational use except for fishing.

c) Provide a rationale to support the assertion that the Project will not have an effect on surface water and groundwater quality.

Response

The mitigation measures proposed to ensure groundwater and surface water are not affected by the Project is summarized below.

The water management strategy for the Project is described in Section C – Project Description, Section C.5 – Water Management. 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 – Water Treatment.

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 10C, Section 3.2, Pages 10-12 and Section 4.2, Pages 19-20.

The hydrogeology and surface water quality assessments have taken these design features into account. Potential impacts and additional mitigations for each are summarized in Section E – Environmental Impact Assessment Summary, Sections E.3 – Hydrogeology, and Section E.5 – Water Quality.

In addition to the aforementioned sections, Benga also provided an additional water quality management report in 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.

d) If impacts to drinking water and recreational waters are predicted, include the exposure through consumption of groundwater and surface water and contact with surface water in the HHRA.

Response

Exposure through consumption of groundwater and surface water and contact with surface water was included in the HHRA. Although there were no permanent residences identified within the LSA, as a conservative assumption, the HHRA considered potential chronic exposure to surface water for residential receptors as part of the multi-media model (CR#10 Section 5.1.4).

Impacts to surface water were modelled assuming atmospheric deposition to a hypothetical waterbody which exists at the location of the maximum point of impingement (MPOI) within both the LSA and RSA. The modelled surface water concentration was included as the exposure concentration to calculate the estimated daily intake (EDI) for the following direct and indirect exposure pathways:

- direct contact with surface water (drinking water source, dermal contact during swimming and inadvertent ingestion);
- indirect exposure via consumption of food sources assumed to use the hypothetical surface waterbody as a primary watering source (e.g., mammals); and,

- indirect exposure via consumption of fish assumed to live in the hypothetical waterbody.

The HHRA did not consider impacts to groundwater as this was not identified as a suitable exposure pathway for consideration (refer to response SIR HC-15[c]).

The results of the HHRA indicated that exposure to COPC via surface water exposure would not pose a risk of adverse health effects.

16. Reference: Volume 1, Section C.9, Pages C-153 to C-168

More detail is required on the Project's potential to adversely impact source water quality (surface water or groundwater) due to abnormal conditions (i.e. leaks/spills, unexpected releases, run-off, flash flooding).

a) Identify downstream drinking water treatment facilities that may be affected by contaminant releases from the Project due to unexpected 'pulse' releases or emergency conditions.

Response:

Drinking water facilities that are located downstream of the proposed Project are provided on Figure HC.16 1. This figure outlines the four municipal groundwater wells used by the Municipality of Crowsnest Pass that are located downgradient of the Project, which supplies water to Blairmore, Frank and Bellevue. These four wells are located in Blairmore along 22nd Avenue, between 117th and 121st Streets. As described in Consultant Report (CR) #3, these wells are relatively shallow, with a production interval between 15 and 30 mbgs and completed within the alluvium of the Crowsnest River. These wells can be interpreted as targeting groundwater under the influence of surface water.

As indicated in CR #3, Section 5.4.2.2.2, there is no apparent ability for impacted groundwater to travel southward towards the Crowsnest River valley where the municipal wells utilize the alluvial aquifer and as a result, municipal water wells are not predicted to have any groundwater quality impacts associated with mine spoil and mining activities. This is based on the presence of a groundwater divide beneath Bluff Mountain interpreted from the review of groundwater flow and particle tracking.

b) Provide details within a water management plan and spill response plan as to how downstream drinking water treatment facilities and users (including Indigenous groups and individuals who use surface water bodies for drinking and recreational use) will be notified if parameters exceed guidelines.

Response:

As part of the Emergency Response Plan (ERP), Benga will maintain an inventory of surface water users and potential users along Blairmore and Gold creeks for a reasonable distance downstream on the Crowsnest River. Benga will conduct an exercise on an annual basis to test the accuracy and effectiveness of its notification protocols and to keep them updated.

In the event of an incident, Benga would contact as many of the users as possible by telephone and would simultaneously dispatch employees to contact nearby water users in person. Benga would post signage at recreational use areas such as camp grounds to warn of any water quality issues. The priority and order of contact may vary depending on the nature of the incident but normally, the closest and largest water users would be higher in priority than those further away.

Through the ERP, Benga will also establish communication and notification protocols with the Municipality of Crowsnest Pass and with the Piikani First Nation. Depending on the nature of the situation, these protocols may also trigger community notification procedures to reach a broader audience with the necessary information.

Since all drainage from the mine site is captured and collected and contained within the water management system, it is unlikely that there would be an uncontrolled release into a watercourse. As discussed in CEAA IR Round II Package, Attachment 2, SIR#24, environmental impacts of accidents and malfunctions that could adversely impact source water quality (*i.e.*, leaks/spill, unexpected releases, run-off, flash flooding) will be prevented and/or minimized through the implementation of design and operations safeguards, Standard Operating Policies and Procedures (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 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.

17. Reference: Consultant Report #2 Noise Impact Assessment (NIA), Section 2.1, Page 2

Consultant Report #12 Human Health Risk Assessment, Section 5.1.3, Page 17

The NIA states that although there are some residential receptors currently within the local study area (LSA), "for the purposes of the noise impact assessment it was assumed there will not be any residential receptors within the LSA prior to the start of mining activity." However, the Human Health Risk Assessment states that the public will only be prohibited from entering the mine permit boundary, but not the LSA.

a) Confirm the reason for not assuming any residential receptors in the LSA.

Response:

The noise report defines the LSA at the Mine Permit Boundary (MPB) line. It was assumed that all potential receptors within the MPB will be removed prior to the start of mining operations.

b) Clarify if the theoretical receptors at 1500 m are intended to account for reasonable foreseeable development as the setback being the closest distance permitted for residential dwellings.

Response:

The theoretical 1,500 m receptors are required as per the AER Directive 038 assessment criteria and are not related to any foreseeable development as a setback distance and should not be interpreted as such.

18. Reference: Consultant Report #2 Noise Impact Assessment, Section 2.1, Page 2

A single trapper cabin located outside the local study area (LSA) but within the regional study area (RSA) was not included in the noise impact assessment under the assumption that the cabin is used less than six weeks per year. However, Health Canada recommends identification and characterization of receptor locations including seasonal residences which includes Indigenous hunting and fishing cabins and seasonal camping places. Thus, it is recommended that noise effects at these receptors should be considered during occupied periods.

a) Provide information to support the duration of exposure at this single trapper cabin and include this receptor in the noise impact assessment.

Response:

It is confirmed that this trapper cabin is used well less than 6-weeks total per year and does not have any electricity or running water. Thus, as per the AER Directive 038, it is not considered a seasonably occupied dwelling and is not required to be included in the noise impact assessment. Further, information provided by the owners of the trapper cabin indicate that they only use it specifically to check their trap lines (*i.e.* commercial purposes) and do not stay for any notable length of time.

However, for information purposes, the noise levels associated with the Project were modeled at this location. The maximum Project related noise levels (when the mining equipment is at the closest location to the trapper cabin, *i.e.* slightly over 1,000 m) are 42.8 dBA during the day-time and night-time. The Baseline noise has been assumed, as per the AER Directive 038, to be 35 dBA during the night-time and 45 dBA during the day-time. As such, the change in %HA has been calculated as follows:

Receptor	Rated Baseline LDN (dBA)	Night +10 dB	Day +10 dB	Rated Baseline %HA		Maximum Project Rated LDN (dBA)	Night +10 dB	Day +10 dB	Rated Project + Rated Baseline LDN dBA)	Project + Rated Baseline %HA	Change in %HA
Michalsky Trapper's Cabin	45.0	YES	YES	1.1		52.8	NO	YES	53.5	3.4	2.3

The change in %HA is less than 6.5%. Even if the Baseline is assumed to be much quieter than the AER Directive 038 assumption, the theoretical maximum increase in %HA with a Project noise level of 42.8 dBA is only 3.1% because the Project noise is so low. Even with a very quiet Baseline noise level, it would take a Project related noise level of approximately 52 dBA before the change in %HA reaches at least 6.5%.

Further, as per the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*", the noise modeling results indicate a C-weighted Project noise level of only 56.8 dBC (well below 70 dBC) and the energy sum of the 31.5 Hz and 63 Hz octave bands is well below 70 dBZ. As such, the likelihood of low frequency rattles is low. [Refer to the response to question HC-22 for more detailed information pertaining to low frequency noise].

When comparing to the WHO night-time sleep disturbance criteria, this location is used for commercial purposes and is not considered a residence and certainly not a "vulnerable group". Thus, the recommended WHO limit of 40 dBA does not apply.

As such, the impact of the Project is considered acceptable, as per the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*".

19. Reference: Consultant Report #2 Noise Impact Assessment, Section 3.3, Pages 8 and 28

The projected operating life of the Mine is approximately 24 years and a total of three different mining years were selected as representative modelling scenarios (Years 1, 6, 18). The NIA indicates that as the mining years progress, the elevation of the south disposal area will increase and the activity will move closer to the two residential receptor locations to the east of the Mine Pit Boundary (assumed to be receptors MDRL009 (Res-301) and MDRL010 (Res-302)). Thus at Year 2, there will be increased equipment operating in the south disposal area. In order to represent a scenario with the highest potential noise levels, it is recommended that noise modelling at Year 2 be completed. Mining years should be selected to represent scenarios with the highest potential noise levels.

The NIA only assesses the potential impacts to operational noise and states that construction noise was not specifically regulated by Directive 038 and therefore not assessed. Health

Canada recommends that there be a characterization of the potential for change in the sound environment due to any project activity, including construction, operation and decommissioning.

a) Provide a comparison of the predicted noise levels during construction to baseline noise levels at each representative receptor or provide a rationale for its exclusion.

Response:

The modelled Mining activity includes pre-stripping, overburden/waste removal, coal extraction, backfill, and reclamation. Thus, construction, operation, and decommissioning phases associated with the Mine are occurring simultaneously and cannot be assessed separately. Including all of the components together represents a more conservative (*i.e.* reasonable worst-case) estimate of the noise impacts, as per Section 6.3.2 of the Health Canada document "Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017".

As it pertains to the Coal Handling and Processing Plant, the overland conveyor, and the rail loadout, there is no accurate means of predicting the noise levels associated with the construction or decommissioning activity because the details of the construction and decommissioning activity are unknown at this time. Mitigation recommendations provided in Appendix H of the Health Canada document "Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017" will be reviewed and implemented where feasible/reasonable and any potential residential construction noise complaints will be addressed on a case-by-case basis.

b) Provide a comparison of the predicted noise levels during decommissioning to baseline noise levels at each representative receptor or provide a rationale for its exclusion.

Response:

Refer to the response HC SIR 18(a).

c) Provide noise modelling results for Year 2 of the project.

Response:

There is an error in the text within the Consultant Report #2 Noise Impact Assessment, Section 5.4.1 which states that "At approximately Mining Year 02, there will be increased equipment operating in the south disposal area…". This pertained to the original noise assessment associated with the previous mine plan and the text was not updated as per the current mine plan. Within the current mine plan, Year 01 indeed represents the highest noise levels for receptors MDRL009 (Res-301) and MDRL010 (Res-302) due to the quantity of the equipment, the location of the equipment, and the elevation of the equipment relative to the residential locations. As such, noise modeling for Year 02 will not yield higher noise levels than Year 01 at these locations.

d) Clarify if the mining years selected represent scenarios with the highest potential noise levels.

Response:

The current mine plan was reviewed for the 2016 noise impact assessment and the modeling scenarios represent the highest potential noise levels for all of the residential and theoretical 1,500 m receptors

20. Reference: Response to CEAA's Request for Additional Information, Question 20, Tables 20-2 and 20-3

In the responses to CEAA's request for additional information, an assessment of the change in %HA (highly annoyed) for potentially impacted Indigenous communities was provided. However, the response does not provide a determination of the rating level used in the calculation of the change in %HA.

a) Describe all applicable adjustments made in estimating the change in %HA.

Response:

The assessment of the change in %HA has been updated, as per the recent methods specified in Appendix F of the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*". In particular, the night-time and day-time Rating Levels have been assessed for each receptor location for the Baseline and Project noise scenarios. Table HC 20-1 provides the updated results with indication of the Rating Levels for each receptor. The overall conclusions remain the same, with the change in %HA still well below the recommended maximum of 6.5%

Table HC 20-1: %HA Assessment Results at Residential Receptors

Receptor (Distance From MPB)	Rated Baseline LDN (dBA)	Night +10 dB	Day +10 dB	Rated Baseline %HA		Maximum Project Rated LDN (dBA)	Night +10 dB	Day +10 dB	Rated Project + Rated Baseline LDN (dBA)	Project + Rated Baseline %HA	Change in %HA
Res-301 (200 m)	55.0	YES	YES	4.1		47.8	NO	YES	55.8	4.6	0.4
Res-302 (130 m)	55.0	YES	YES	4.1		48.2	NO	YES	55.8	4.6	0.5
R-001 (1,025 m)	47.7	YES	YES	1.6		48.7	YES	YES	51.3	2.6	0.9
R-002 (950 m)	38.2	YES	YES	0.5		49.2	YES	YES	49.6	2.1	1.6
R-003 (1,000 m)	38.9	YES	YES	0.5		48.4	YES	YES	48.9	1.9	1.4
R-004 (1,025 m)	39.4	YES	YES	0.6		48.4	YES	YES	48.9	1.9	1.4
R-005 (1,035 m)	40.1	YES	YES	0.6		48.5	YES	YES	49.1	2.0	1.3
R-006 (890 m)	45.6	NO	YES	1.2		49.1	YES	YES	50.7	2.4	1.2

Table HC 20-1: %HA Assessment Results at Residential Receptors

Receptor (Distance From MPB)	Rated Baseline LDN (dBA)	Night +10 dB	Day +10 dB	Rated Baseline %HA		Maximum Project Rated LDN (dBA)	Night +10 dB	Day +10 dB	Rated Project + Rated Baseline LDN (dBA)	Project + Rated Baseline %HA	Change in %HA
R-007 (990 m)	47.2	NO	YES	1.5		45.7	YES	YES	49.5	2.1	0.5
R-008 (950 m)	47.2	NO	YES	1.5		45.4	YES	YES	49.4	2.0	0.5
R-009 (840 m)	49.5	NO	NO	2.1		46.9	YES	YES	51.4	2.6	0.6
R-010 (610 m)	56.4	NO	NO	5.0		48.3	YES	YES	57.1	5.4	0.4
R-011 (440 m)	56.1	NO	NO	4.8		48.3	YES	YES	56.8	5.2	0.4
R-012 (350 m)	53.2	NO	NO	3.3		49.4	YES	YES	54.7	4.0	0.7
R-013 (660 m)	60.6	NO	NO	8.3		48.4	YES	YES	60.8	8.5	0.3
R-014 (480 m)	59.3	NO	NO	7.1		49.0	YES	YES	59.7	7.4	0.3
R-015 (550 m)	51.7	NO	NO	2.7		49.7	YES	YES	53.8	3.6	0.9
R-016 (1,090 m)	48.0	NO	YES	1.7		48.2	YES	YES	51.1	2.5	0.8
R-017 (925 m)	48.0	NO	YES	1.7		48.9	YES	YES	51.5	2.6	1.0
R-018 (750 m)	47.9	NO	YES	1.7		48.7	YES	YES	51.4	2.6	0.9
R-019 (1,050 m)	45.0	NO	YES	1.1		48.0	YES	YES	49.8	2.1	1.0
R-020 (1,090 m)	44.7	NO	YES	1.1		48.3	YES	YES	49.9	2.2	1.1
R-021 (890 m)	46.9	NO	YES	1.5		48.9	YES	YES	51.0	2.5	1.0
R-022 (960 m)	46.6	NO	YES	1.4		49.5	YES	YES	51.3	2.6	1.2
R-023 (840 m)	47.4	NO	YES	1.6		47.9	NO	YES	50.7	2.4	0.8
R-024 (820 m)	48.7	NO	YES	1.9		49.3	NO	YES	52.0	2.8	1.0
R-025 (870 m)	47.0	NO	YES	1.5		49.3	NO	YES	51.3	2.6	1.1
R-026 (1,010 m)	46.1	NO	YES	1.3		48.7	NO	YES	50.6	2.4	1.0
R-027 (1,100 m)	46.4	NO	YES	1.4		48.8	NO	YES	50.8	2.4	1.0
R-028 (940 m)	48.1	NO	YES	1.7		48.9	NO	YES	51.5	2.7	1.0
R-029 (980 m)	47.8	NO	YES	1.7		49.8	NO	YES	51.9	2.8	1.2
R-030 (1,110 m)	43.9	NO	YES	1.0		48.1	NO	YES	49.5	2.1	1.1
R-031 (1,190 m)	42.6	NO	YES	0.8		47.5	NO	YES	48.7	1.9	1.0
R-032 (530 m)	55.8	NO	NO	4.6		52.3	NO	YES	57.4	5.6	1.0
R-033 (600 m)	54.9	NO	NO	4.1		52.1	NO	YES	56.7	5.1	1.1
R-034 (600 m)	55.9	NO	NO	4.7		52.5	NO	YES	57.6	5.7	1.1
R-035 (670 m)	53.9	NO	NO	3.6		52.0	NO	YES	56.1	4.8	1.1
R-036 (570 m)	59.9	NO	NO	7.6		53.1	NO	YES	60.7	8.4	0.8
R-037 (720 m)	54.8	NO	NO	4.1		52.3	NO	YES	56.8	5.2	1.1
R-038 (640 m)	59.5	NO	NO	7.2		53.0	NO	YES	60.4	8.1	0.8

Table HC 20-1: %HA Assessment Results at Residential Receptors

Receptor (Distance From MPB)	Rated Baseline LDN (dBA)	Night +10 dB	Day +10 dB	Rated Baseline %HA		Maximum Project Rated LDN (dBA)	Night +10 dB	Day +10 dB	Rated Project + Rated Baseline LDN (dBA)	Project + Rated Baseline %HA	Change in %HA
R-039 (380 m)	55.8	NO	NO	4.6		52.3	NO	YES	57.4	5.6	1.0
R-040 (370 m)	55.4	NO	NO	4.4		54.2	NO	YES	57.9	5.9	1.6
R-041 (370 m)	55.2	NO	NO	4.2		54.5	NO	YES	57.9	5.9	1.7
R-042 (370 m)	55.1	NO	NO	4.2		54.6	NO	YES	57.8	5.9	1.7
R-043 (370 m)	55.1	NO	NO	4.2		54.7	NO	YES	57.9	6.0	1.8
R-044 (360 m)	55.1	NO	NO	4.2		54.6	NO	YES	57.8	5.9	1.7
R-045 (350 m)	55.0	NO	NO	4.1		54.5	NO	YES	57.8	5.9	1.7
R-046 (340 m)	55.1	NO	NO	4.2		54.5	NO	YES	57.8	5.9	1.7
R-047 (380 m)	55.7	NO	NO	4.5		54.6	NO	YES	58.2	6.2	1.7
R-048 (360 m)	55.7	NO	NO	4.5		54.2	NO	YES	58.0	6.0	1.5
R-049 (350 m)	55.8	NO	NO	4.6		53.5	NO	YES	57.8	5.9	1.3
R-050 (330 m)	55.7	NO	NO	4.5		53.1	NO	YES	57.6	5.7	1.2
R-051 (280 m)	55.2	NO	NO	4.2		51.6	NO	YES	56.7	5.2	0.9
R-052 (270 m)	55.2	NO	NO	4.2		50.4	NO	YES	56.4	5.0	0.7
R-053 (260 m)	55.2	NO	NO	4.3		49.0	NO	YES	56.2	4.8	0.5
R-054 (250 m)	55.3	NO	NO	4.3		48.1	NO	YES	56.0	4.7	0.4
R-055 (240 m)	55.3	NO	NO	4.3		47.5	NO	YES	55.9	4.7	0.4
R-056 (300 m)	56.5	NO	NO	5.0		48.6	NO	YES	57.2	5.5	0.4
R-057 (250 m)	56.3	NO	NO	4.9		45.9	NO	YES	56.7	5.1	0.2
R-058 (210 m)	56.0	NO	NO	4.7		45.6	NO	YES	56.4	5.0	0.2
R-059 (110 m)	56.0	NO	NO	4.7		45.5	NO	YES	56.4	5.0	0.2
R-060 (80 m)	57.6	NO	NO	5.8		45.1	NO	YES	57.9	5.9	0.2
R-061 (110 m)	56.9	NO	NO	5.3		45.1	NO	YES	57.2	5.5	0.2
R-062 (90 m)	58.6	NO	NO	6.5		51.4	YES	YES	59.4	7.2	0.6
R-063 (90 m)	59.4	NO	NO	7.2		51.2	YES	YES	60.0	7.7	0.6
R-064 (170 m)	56.2	NO	NO	4.8		51.3	YES	YES	57.4	5.6	0.8
R-065 (170 m)	56.3	NO	NO	4.9		51.0	YES	YES	57.5	5.6	0.7
R-066 (130 m)	57.4	NO	NO	5.6		50.9	YES	YES	58.3	6.3	0.6
R-067 (130 m)	58.6	NO	NO	6.5		50.6	YES	YES	59.2	7.0	0.5
Hospital (70 m)	55.9	NO	NO	4.7		54.4	NO	YES	58.2	6.2	1.6

21. Reference: Consultant Report #2 Noise Impact Assessment, Sections 3.0 – 5.0

Response to CEAA's Request for Additional Information, Question 20

The NIA 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 EIS provides mitigation for blasting noise and vibration, it is not clear if the contribution of blasting noise was determined.

a) Update the quantitative noise assessment to include applicable adjustments for impulsive noise (i.e. blasting noise) and discuss the potential impacts to human health from exposure to predicted noise level.[16]

Response:

Noise from blasting can vary significantly due to the size of the charges (*i.e.* charge weight), the depth of the charges, the location of the charges, the weather conditions, the topographical information, and numerous other factors. Blasting noise is very project specific and will differ from project to project (unlike machinery and equipment noise which is very transferable from one site to another). The most common method for predicting blasting noise is associated with the United States Bureau of Mines (USBM) from the "*Report of Investigation 8485: Structure Response and Damage Produced by Airblast From Surface Mining*" which provides for a peak sound pressure level based on distance, charge weight of explosives per delay and the so-called "Confinement Constant" which can vary significantly. Both the charge weight of explosives per delay and the Confinement Constant are unknown at this time and will vary for each blast. When using the USBM prediction method, small changes in the Confinement Constant alone can easily change the predicted peak sound pressure level by ±15 dBA or more with additional uncertainty associated with the charge weight. Thus, given all of the variables associated with blasting, there is no method of accurately predicting the noise levels that will result from the blasting operations until blasting actually starts and on-site and surrounding area sound level measurements can be conducted. Even on-site data from blasting is still only minimally useful in future blast noise modeling because the variables change for each blast. As a result, an accurate quantitative assessment and associated potential impacts on human health cannot be conducted at this time and blasting noise mitigation information has been provided within the noise impact assessment which will reduce the overall impact of blasting noise on adjacent receptors.

b) Indicate the peak pressure level.

Response:

Please see response HC SIR 21(a)

16 Health Canada suggests the use of the US EPA's sonic boom criterion (US EPA 1974) as a blasting mitigation noise level for blasting that lasts less than one year. For blasting exposures more than one year, Health Canada advises following the recommendations in ISO 1996-1:2003).

c) Calculate or describe the effect on the change in %HA.

Response:

Please see response HC SIR 21(a)

22. Reference: Consultant Report #2 Noise Impact Assessment, Section 5.0, Page 13

The NIA shows a potential for low frequency noise (LFN) which it attributes to locomotives operating at the rail loadout at the southern portion of the Project. LFN may induce vibrations in buildings that may be perceptible or cause a "rattle" in these environments. The EIS indicates that peak sound levels are 63 to 125 Hz, with a possibility to exceed Health Canada's recommendation when levels approach 70 dBC.

For sources that operate at night in rural environments, a dBC limit between 60-65 dBC has been recommended to minimize community complaints/annoyance associated with LFN.[17] It is not clear in the NIA as to how the Proponent will determine if a noise complaint is due to LFN.

The NIA states that noise monitoring should be conducted during normal operations. As well, that if at the start of the project there is a LFN complaint, the Proponent will conduct a survey in accordance with Directive 038. However, there is no information as to how these complaints will be resolved.

a) Provide a discussion of the potential effects related to rattles.

Response

There is specific low frequency information indicated in Appendix C.2 of the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*". Specifically:

> *"To prevent rattles from low-frequency noise and the associated annoyance from this effect, ANSI (2005) indicates that the (energy) sum of the sound levels in the 16-, 31.5-, and 63 Hz octave bands be less than 70 dBZ".*

Within the Consultant Report #2 Noise Impact Assessment, noise source order-ranking information is provided within Appendix V for the residential receptors with the highest modeled noise levels associated with the Project. This data was used to determine the dBZ energy sum of the 31.5 Hz and 63 Hz octave band noise source contributions from all sources at each of the receptors [Note: the 16 Hz noise level information is not available for any of the project noise sources, and rarely is]. The maximum low frequency energy sum noise level was at Blairmore Resident R-42 (one of the closest residents to the rail loadout) with a value of 67.6 dBZ. Further, all of the noise modeling results indicate that the noise levels at all receptors will be below

17 Broner N., Sinclair K.M. 2011. A Simple Outdoor
Criterion for Assessment of Low Frequency Noise Emission. Acoustics Australia. 39(1): 7-14.

70 dBC. Given that all of the receptors will have low frequency noise levels below 70 dBZ, and overall noise levels below 70 dBC, the likelihood of low frequency rattles is low.

b) Describe the potential mitigation for low frequency noise and rattles.

Response

Any noise mitigation pertaining to low frequency noise and rattles would need to be assessed on a case-by-case basis and cannot be evaluated until such time as a complaint is filed.

c) Provide details as to how a noise complaint will be assessed to determine if it is due to LFN.

Response

For this project, the AER is the regulatory body with authority to assess complaints. As such, if any noise complaint is filed, the AER Directive 038 noise complaint investigation procedures will be followed. Within the AER Directive 038 noise complaint investigation procedures, there is a process of determining the nature of the noise complaint, with specific methods for determining a low frequency noise complaint. There is a noise measurement and assessment procedure for overall noise levels as well as specific low frequency noise levels as well as potential low frequency noise penalties and mitigation requirements. If required, noise mitigation for low frequency noise will be assessed and addressed on a case-by-case basis in compliance with the requirements of the AER Directive 038.

d) Clarify if all complaints that mention noticeable rattles/vibrations will be assumed to be due to LFN and therefore sufficient to trigger an acoustical audit.

Response

Refer to response HC SIR 22 (c).

e) Provide details as to how LFN complaints will be resolved.

Response

Refer to response HC SIR 22 (c).

23. Reference: Consultant Report #2 Noise Impact Assessment, Section 5.4, Pages 10-11

There is uncertainty as to the impacts of the Project on sleep. The World Health Organization (WHO) has published night-time noise guidelines that are intended to protect the public, including the most vulnerable groups, from adverse health effects associated with

sleep disturbance due to night-time noise. The recommended annual average is 40 dBA Ln outdoors.[18]

a) Describe the noise levels at night from the Project and if they are expected to increase above 40 dBA at night at receptor locations when they were originally below that level.

Response

An assessment of the night-time noise levels relative to the WHO criteria is provided in Table HC 23-1. All of the locations with a cumulative (i.e. Baseline + Project) noise level greater than 40 dBA are highlighted in yellow, as are all of the locations at which the Baseline noise levels are already above 40 dBA. There are 7 locations at which the Project noise will increase the Baseline noise from below 40 dBA to above 40 dBA. At each of these locations, the increases in noise levels are relatively low (maximum of 3.6 dBA) and at all but one location, the noise levels associated with the Project are lower than the Baseline noise. Further, the change in %HA is well below 6.5% at all locations. As such, the overall noise impact is minimal.

b) Describe mitigation measures that will be implemented to address situations where the annual average night-time guideline is exceeded.

Response:

Based on the information provided in the response to part (a) and given that the maximum Project related noise level is only 44.7 dBA and given that all receptors with modeled noise levels are in an urban environment with existing elevated noise levels, noise mitigation is not warranted.

Table HC 23-1 Relative Project Impacts

Receptor (Distance From MPB)	Baseline Night (dBA)	Project Night (dBA)	Cumulative Night (dBA)	Relative Increase (dBA)	Change in Rated %HA
Res-301 (200 m)	35.0	37.7	39.6	4.6	0.4
Res-302 (130 m)	35.0	38.2	39.9	4.9	0.5
R-001 (1,025 m)	30.3	32.3	34.4	4.1	0.9
R-002 (950 m)	30.8	32.8	34.9	4.1	1.6
R-003 (1,000 m)	31.5	32.0	34.8	3.3	1.4
R-004 (1,025 m)	32.0	32.0	35.0	3.0	1.4
R-005 (1,035 m)	32.7	32.1	35.4	2.7	1.3
R-006 (890 m)	38.3	32.7	39.4	1.1	1.2
R-007 (990 m)	39.8	29.3	40.2	0.4	0.5
R-008 (950 m)	39.8	29.0	40.1	0.3	0.5

18 World Health Organization (WHO). 2009. *Night Noise Guidelines for Europe*. Hurtley, C. (Ed). Available online at: http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2009/night-noise-guidelines-for-europe

Table HC 23-1 Relative Project Impacts

Receptor (Distance From MPB)	Baseline Night (dBA)	Project Night (dBA)	Cumulative Night (dBA)	Relative Increase (dBA)	Change in Rated %HA
R-009 (840 m)	42.2	30.5	42.5	0.3	0.6
R-010 (610 m)	49.1	31.9	49.2	0.1	0.4
R-011 (440 m)	48.8	31.9	48.9	0.1	0.4
R-012 (350 m)	46.1	33.0	46.3	0.2	0.7
R-013 (660 m)	53.7	32.0	53.7	0.0	0.3
R-014 (480 m)	52.6	32.6	52.6	0.0	0.3
R-015 (550 m)	44.8	33.3	45.1	0.3	0.9
R-016 (1,090 m)	41.1	31.8	41.6	0.5	0.8
R-017 (925 m)	41.1	32.5	41.7	0.6	1.0
R-018 (750 m)	41.0	32.3	41.5	0.5	0.9
R-019 (1,050 m)	38.1	31.6	39.0	0.9	1.0
R-020 (1,090 m)	37.8	31.9	38.8	1.0	1.1
R-021 (890 m)	39.9	32.5	40.6	0.7	1.0
R-022 (960 m)	39.7	33.1	40.6	0.9	1.2
R-023 (840 m)	40.4	37.9	42.3	1.9	0.8
R-024 (820 m)	41.8	39.3	43.7	1.9	1.0
R-025 (870 m)	40.0	39.3	42.7	2.7	1.1
R-026 (1,010 m)	39.2	38.7	42.0	2.8	1.0
R-027 (1,100 m)	39.6	38.8	42.2	2.6	1.0
R-028 (940 m)	41.3	38.9	43.3	2.0	1.0
R-029 (980 m)	41.1	39.8	43.5	2.4	1.2
R-030 (1,110 m)	37.0	38.1	40.6	3.6	1.1
R-031 (1,190 m)	35.6	37.5	39.7	4.1	1.0
R-032 (530 m)	49.1	42.3	49.9	0.8	1.0
R-033 (600 m)	48.2	42.1	49.2	1.0	1.1
R-034 (600 m)	49.3	42.5	50.1	0.8	1.1
R-035 (670 m)	47.3	42.0	48.4	1.1	1.1
R-036 (570 m)	53.3	43.1	53.7	0.4	0.8
R-037 (720 m)	48.2	42.3	49.2	1.0	1.1
R-038 (640 m)	52.9	43.0	53.3	0.4	0.8
R-039 (380 m)	49.1	42.3	49.9	0.8	1.0
R-040 (370 m)	48.7	44.2	50.0	1.3	1.6
R-041 (370 m)	48.4	44.5	49.9	1.5	1.7
R-042 (370 m)	48.3	44.6	49.8	1.5	1.7

Table HC 23-1 Relative Project Impacts					
Receptor (Distance From MPB)	**Baseline Night (dBA)**	**Project Night (dBA)**	**Cumulative Night (dBA)**	**Relative Increase (dBA)**	**Change in Rated %HA**
R-043 (370 m)	48.3	44.7	49.9	1.6	1.8
R-044 (360 m)	48.3	44.6	49.8	1.5	1.7
R-045 (350 m)	48.2	44.5	49.7	1.5	1.7
R-046 (340 m)	48.3	44.5	49.8	1.5	1.7
R-047 (380 m)	48.9	44.6	50.3	1.4	1.7
R-048 (360 m)	48.9	44.2	50.2	1.3	1.5
R-049 (350 m)	49.0	43.5	50.1	1.1	1.3
R-050 (330 m)	48.9	43.1	49.9	1.0	1.2
R-051 (280 m)	48.4	41.6	49.2	0.8	0.9
R-052 (270 m)	48.4	40.4	49.0	0.6	0.7
R-053 (260 m)	48.5	39.0	49.0	0.5	0.5
R-054 (250 m)	48.5	38.1	48.9	0.4	0.4
R-055 (240 m)	48.5	37.5	48.8	0.3	0.4
R-056 (300 m)	49.8	38.5	50.1	0.3	0.4
R-057 (250 m)	49.5	35.9	49.7	0.2	0.2
R-058 (210 m)	49.2	35.6	49.4	0.2	0.2
R-059 (110 m)	48.9	35.5	49.1	0.2	0.2
R-060 (80 m)	50.3	35.1	50.4	0.1	0.2
R-061 (110 m)	49.7	35.1	49.8	0.1	0.2
R-062 (90 m)	51.3	35.0	51.4	0.1	0.6
R-063 (90 m)	52.0	34.8	52.1	0.1	0.6
R-064 (170 m)	49.2	34.9	49.4	0.2	0.8
R-065 (170 m)	49.3	34.6	49.4	0.1	0.7
R-066 (130 m)	50.2	34.5	50.3	0.1	0.6
R-067 (130 m)	51.5	34.2	51.6	0.1	0.5
Hospital (70 m)	48.6	44.4	50.0	1.4	1.6

24. Reference: Consultant Report #2 Noise Impact Assessment, Section 4.0, Page 11

The NIA states that "there are no specific Municipal, Provincial, or Federal criteria for comparing the relative increase in noise levels (i.e. how much the noise levels will increase with the addition of the Project related noise)."

a) Clarify this statement given that Health Canada's recommended criteria of % change in highly annoyed [19, 20] is intended to assess the relative increase in project noise.

Response:

The statement within Consultant Report #2 Noise Impact Assessment related to assessment of the relative increase in noise levels was provided prior to the release of the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*". Regardless, an assessment of the change in %HA has been conducted (information provided in the response to HC SIR 20) and the results indicate that the increase in noise levels associated with the Project will be less than the recommended maximum of 6.5%.

25. Reference: Consultant Report #2 Noise Impact Assessment rail alignment and loadout, Section 4.1, Page 7

With regards to low frequency noise, the NIA states that "there is already a notable amount of low frequency noise within the area without having a dominant low frequency noise. The noise sources associated with the Project also have a notable amount of low frequency noise which will be less intrusive relative to the existing conditions than if there was very little existing low frequency noise."

a) Provide information to support the above statement.

Response:

The Consultant Report #2 Noise Impact Assessment of Rail Alignment and Loadout was written specifically to provide additional information requested by area stakeholders through the stakeholder engagement process. It was not written with specific reference to criteria within the AER Directive 038 or the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*". The statement regarding low frequency noise was meant to provide some context to the reader (*i.e.* the general public) regarding the potential subjective impact of the low frequency noise associated with the Project. In general, the subjective impact of any new noise source is partially determined by the relative increase compared to the noise levels without the new noise source, among other factors. The larger the relative increase in noise levels, the larger the subjective impact. This does not address the overall noise exposure and potential annoyance, nor was it intended to.

19 Health Canada. 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.
20 Michaud, D. S., Bly, S. H. P. and Keith, S. E. 2008. Using a change in percentage highly annoyed with noise as a potential health effect measure for projects under the Canadian Environmental Assessment Act. Canadian Acoustics. 36, 13–30.

26. Reference: Consultant Report #2 Noise Impact Assessment, Section 3.2, Page 7

Consultant Report #2 Noise Impact Assessment rail alignment and loadout

The NIA states that it did not account for the background noise associated with current vehicle traffic or current rail line activity since these are not noise sources which are regulated by the AER or Alberta Utilities Commission (AUC). As well, the assessment of noise related to vehicle traffic was not conducted. However it appears that in the NIA rail alignment and loadout assessment rail and traffic noise was considered.

In addition to the noise impact assessment (NIA), an NIA specific to the rail alignment and loadout was provided. However, there is uncertainty as to the purpose of the rail alignment and loadout assessment.

a) Clarify how road and rail noise levels affect the assessment.

b) Clarify the purpose of the noise impact assessment in the rail alignment and loadout document.

Response:

It is important to note that the Consultant Report #2 Noise Impact Assessment is specific to the requirements of the regulating authority which is the AER. Specifically, the requirements of the AER Directive 038. Within an assessment specific to the AER Directive 038, road and rail noise (not associated with the Project) are not to be included as noise sources in the assessment. Rather, non-project related road and rail noise sources are accounted for in the determination of the permissible sound levels and the assumed ambient sound levels.

However, as per the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*", the effects of the existing road and rail noise have been assessed through baseline noise monitoring and baseline noise modeling (results provided in Consultant Report #2 Noise Impact Assessment of Rail Alignment and Loadout) and included in the assessment of the change in %HA which is discussed in the response to response to HC-20.

The purpose of the Consultant Report #2 Noise Impact Assessment of Rail Alignment and Loadout was to provide additional information requested by area stakeholders through the stakeholder engagement process. The information presented in the report is not a requirement of the AER Directive 038 assessment criteria which is why it is not provided in the Consultant Report #2 Noise Impact Assessment.

27. Reference: Consultant Report #2 Noise Impact Assessment Rail Loadout, Section 4.2, Page 9

The NIA states that the increases in noise arising from the operating rail alignment and associated loadout components are expected to fall within the range of 5.0 dBA, which the NIA states is an accepted maximum tolerable increase for residential receptors. However, in most cases project noise is noticeable and for this reason, it is Health Canada's view that noticeability should not be used as a criterion as it can be misleading.

a) Provide a discussion of the uncertainties in predictions of increases in noise.

Response:

The Consultant Report #2 Noise Impact Assessment of Rail Alignment and Loadout was written specifically to provide additional information requested by area stakeholders through the stakeholder engagement process. It was not written with specific reference to criteria within the AER Directive 038 or the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*". The discussions within the report addressing the relative increases in noise levels are meant to provide residents with a frame of reference when reviewing the information, based on general information available within the AER Directive 038.

A discussion pertaining to the uncertainty associated with the noise modeling predictions is provided in Section 3.4 of the Consultant Report #2 Noise Impact Assessment.

28. Reference: Consultant Report #2 Noise Impact Assessment, Section 3.4, Page 9 and Section 5.4, Pages 28-29

Consultant Report #2 Noise Rail Alignment and Loadout, Section 3.2, Page 5

The NIA notes that "an open pit mine is a dynamic project with every changing equipment locations and area topography", thus impacting predictions over the lifetime of the Project. As such, Health Canada recommends that a community engagement and a noise complaint resolution plan be provided. The NIA does not currently provide the likelihood of complaints from the Project. The noise associated with the proposed re-building of the displaced sections of the golf course was also not included in the NIA.

a) Describe the likelihood of complaints due to the Project.[21, 22]

Response:

Section 5.4.1 of the Health Canada document "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, January, 2017*" addresses the issue of Noise Complaints. As stated in the document:

> *"Summarizing the US EPA document, Michaud et al. (2008) state that a "no reaction" response corresponded to a normalized outdoor daynight sound level (Ldn) of 55 dBA for the intruding noise."*

The results of the noise modeling indicate noise levels associated with the "intruding" noise (i.e. Project noise) will be below 55 dBA L_{dn} at all receptor locations indicating a "no reaction"

21 Health Canada. 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.
22 Michaud, D. S., Bly, S. H. P. and Keith, S. E. 2008. Using a change in percentage highly annoyed with noise as a potential health effect measure for projects under the Canadian Environmental Assessment Act. Canadian Acoustics. 36, 13–30.

response. In addition, the change in %HA is below 6.5% for all receptors, indicating a low likelihood of noise complaints associated with the Project.

b) Provide details on a formal community engagement plan and noise complaint resolution plan. These plans should also address noise associated with the proposed re-building of displaced sections of the golf course which was not included in the NIA.

Response

With regards to re-building the Golf Course it is important to note that the re-building is an independent project to be completed irrespective of the Mine Project and that the construction work is currently underway and will be completed before the Mine Project begins. It has been included in the overall community engagement plan and the noise complaint resolution plan, but the AER Directive 038 noise complaint requirements have not been applied because the Golf Course clearly not considered a receptor by the AER.

E. NATURAL RESOURCES CANADA

1. Terrain Hazards

It is NRCan's view that the proponent should evaluate the landslide potential beyond the immediate vicinity of infrastructures (e.g., pit walls and storage dumps). NRCan recommends that the evaluation of landslide risk needs to include steep ground above infrastructure.

NRCan requests information on landslide potential that exists in the LSA that could impact project activities and infrastructure. Please include the methodology followed to evaluate the landslide risk in the area.

Response

Please see Appendix E-1 – Terrain Assessment.

2. Seismicity

Benga Mining CEAA Conformity IR Responses November 27, 201. Geology and Geochemistry Section 10/11, Seismic Activity attachment 2-27-29., Effects of Potential Accidents or Malfunctions Section 23 pg. 62-64, Contingency Plans Section 24 pg. 79-87.

The proponent discusses faults in the vicinity of the project (e.g., Section B – Geology and Geotechnical, B.1.1, B.2.4, B.8.6; Appendix 9 – Section 6.1, Section 9.2). Section B table 8.6-1, under effects of the environment on the project attachment 2, the proponent refers to faults /pit wall failure.

NRCan requests that the proponent provide any evidence for surface faulting or postglacial faulting within the project site.

Response:

The Grassy Mountain deposit is structurally complex as a result of compressional deformation from the southwest during the Columbian (Jurassic) and the Laramide (Cretaceous) orogenies. Target coal seams occur in three main zones along the limbs of anticlines with axial planes that plunge to the north and within synclines formed on topographic highs. Anticlines are overturned in the north of the deposit and are transected by a series of reverse faults that generally dip steeply (up to 80^{o}) to the west with associated drag folds. Major faults limit the extent of economic coal zones both laterally and at depth.

Twelve reverse faults that dip to the west at 50^{o} – 80^{o} have been identified and modelled with throws between 5 m and 200 m. Fault displacement and axial dip appear to be variable along the fault planes. Small reverse faults occur as splays from the major faults and create imbricate structures in the southwest and north of the deposit. Faults cause repetition of coal seams, drag folding adjacent to major faults (Photo 3.5) and thickening of coal seams along the axial planes of folded strata, such as Seam No. 2 (Photo 3.6).

Photo 3.5: Seam No. 4 Drag Fold Adjacent to a Major Fault

Reverse faults and shear structures unable to be identified with the current drill hole spacing, are likely to exist throughout the deposit and these also cause thickening of coal seams. Evidence of structural disturbance includes geophysical logs, lithology logs, outcrop observations such as brecciation, slickensides, iron oxide on fracture surfaces, caliper breakout, 'spikes' in the sonic log response and scattered dipmeter readings. The presence of reverse faults is often indicated by seam repetition or an increased thickness of a particular lithological unit. Disturbed zones that can occur over an interval of a few meters were recorded in historical descriptive logs as broken or sheared, breccia and slickensides.

Photo 3.6: Seam No.2

Identification of reverse faults and adjacent zones of disturbance is important when assessing potential stability issues in the pit wall and floor and to identify structurally complex zones where faulting can affect coal product yields and coal quality characteristics through contamination and increased proportion of fines. Bedding dips along fold limbs and between reverse faults varies considerably over relatively short distances and folds can locally produce rolls. In the west of the deposit, strata generally dip towards the west at 25^{o} in the south up to 60^{o} in the north. In the east of the deposit, seams occur along the east (up to 90^{o} dip) and west (up to 45^{o} dip) flanks of an anticline.

3. Explosives Manufacture and Storage

Benga Mining CEAA Conformity IR Responses November 27, 2017. Effects of Potential Accidents and Malfunctions, 23. Environmental Effects of Accidents and Malfunctions, page 2-78.

Based on information provided by the proponent, the project will likely require an explosives factory licence which would allow both manufacturing and storage. For explosives storage activities, the proponent (or their contractor) will need at least two storage facilities (magazines) - one for detonators and one for blasting explosives/accessories (e.g. boosters and detonating cord). The explosives plant or factory listed in the construction schedule would include parking for a Mobile Processing Unit, garage/wash bay, silo storage (for emulsion) and magazine(s) for ANFO, detonators and accessories.

NRCan noted a reference to the Australian AEISG Code of Practice for emulsion explosives. Australian authorities allow the use of a UN3375 (Class 5.1) classification for emulsion

explosives, whereas this is not allowed in Canada. Consequently, the quantity-distance requirements for storage facilities is different in Canada.

NRCan requests that the proponent provide the appropriate reference, in the EIS, to Canada's Standard for Explosives Quantity-Distance requirements, as required by the Explosives Regulations, 2013

Response:

The following response is an update to Addendum 4 (November 24, 2017 – Agency IR Responses), Attachment 2, IR#23b and replaces the previous version to reflect Canada's Standard for Explosives Quantity-Distance requirements (CAN/BNQ 2910-510/2015), as required by the Explosives Regulations, 2013 (SOR/2013-211).

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) (Addendum 4 [November 24, 2017 – Agency IR Responses], Attachment 2, IR#23b, 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 (Addendum 4 [November 24, 2017 – Agency IR Responses], Attachment 2, IR#23b, Figure 23-1).

During construction, the total quantity of explosives required for blasting are provided in Table NRCan3-1.

Table NRCan 3-1 Construction Explosives Requirements [1]

Location	Volume to be blasted (m^3)	Rock Density (t/m^3)	Tonnes Blasted (t)	Powder Factor (kg/BCM)	Explosives Required (kg)	Start Date	End Date	Duration (months)	Typical Monthly Consumption of Explosives (t)
Rail Loop	275,000	2.4	660,000	0.5	137,500	Q1 2019	Q3 2019	6	22,917
Overland Conveyor and Access Road	270,000	2.4	648,000	0.5	130,000	Q2 2019	Q3 2019	5	26,000
Product Stockpile	95,000	2.4	228,000	0.5	47,500	Q3 2019	Q1 2020	6	7,917
Coal Handling Processing Plant and MIA	450,000	2.4	1,080,000	0.5	225,000	Q2 2019	Q4 2019	5	45,000
Miscellaneous	150,000	2.4	360,000	0.5	75,000	Q1 2019	Q4 2019	10	7,500
Total	1,240,000		2,976,000		615,000				109,333

1. Formerly Table 23-3 in Addendum 4 (November 24, 2017 – Agency IR Responses), Attachment 2, IR#23b

During construction, the total amount of explosives to be used is estimated at approximately 615 t. This value is provided as an estimate only and may fluctuate once construction activities commence. This estimate is based on 0.5 kg of explosives per BCM 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 bulk (ANFO or ANFO blend) explosives that will be stored at the facility at any one time during the construction phase is estimated to be 20 t based on the maximum size of a mobile manufacturing unit if for some reason it cannot leave the site (*e.g.*, weather, mechanical failure, no driver due to sickness).

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 SOR/2013-211, 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 SOR/2013-211, 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 NRCan 3-2 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 (Addendum 4 [November 24, 2017 – Agency IR Responses], Attachment 2, IR#23b, Figure 23-1).

Table NRCan 3-2 Distances from the Explosives Storage Facility to Vulnerable Features [1]

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

Table NRCan 3-2 Distances from the Explosives Storage Facility to Vulnerable Features [1]	
Feature	**Construction Explosives Storage Facility**
Security Building	1,300 m
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

1. Formerly Table 23-4 in Addendum 4 (November 24, 2017 – Agency IR Responses), Attachment 2, IR#23b

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

- 2 x 10-20 t High Explosives magazines (one for boosters and one for detonators);
- 80 t tank for ammonium nitrate emulsion storage;
- 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.

The 2 x 10 t High Explosives magazines will be located in a different location to the Bulk Explosive (AN and ANE) Depot, and at least 120 m apart (Table C.2, D2 distance for Net Explosive Quantity 120 t, CAN/BNQ 2910-510/2015). A mound between and either side of the High Explosives magazines will allow them to be 22 m from each other. For the Bulk Explosives Depot, if a mound is placed between the ammonium nitrate prill storage (60 t) and the Mobile Processing Unit (20 t each) park up location and ammonium nitrate emulsion storage tank (and is at least separated by 11.3 m), then the Net Explosive Quantity for the bulk explosive magazine can be calculated as 120 t as a worst-case scenario. Further bunding surrounding the Mobile Processing Unit park up location inside the facility (to prevent knock-on explosive effect) would reduce the Net Explosive Quantity to 80 t.

In complying with CAN/BNQ 2910-510/2015, the location for the High Explosives magazine and Bulk Explosive Depot needs to maintain the minimum separation distances as prescribed in Table C.2, Net Explosive Quantity 20 t and 120 t (CAN/BNQ 2910-510/2015) and is reproduced below in Table NRCan 3-3. The relevant distances for the proposed magazine location, as shown in Table NRCan 3-2, exceeds these requirements.

Table NRCan 3-3 Minimum Separation Distances [1]

Infrastructure/Activity	High Explosives Magazine	Bulk Explosive Depot
Pit surface blasting activities	610 m	1,100 m
Inhabited Building distance with 20 or more people	610 m	1,100 m
Critical fuel depots	610 m	1,100 m
>15 kV powerlines	610 m	1,100 m
Medium traffic (haul roads and public roads 500 to 5,000 vehicles per day)	405 m	730 m
Other explosive magazines	66 m	120 m
Underground pipelines	33 m	60 m
Electrical substations	45 m	45 m

1. Based on Table C.2, Net Explosive Quantity 20 t and 120 t (CAN/BNQ 2910-510/2015)

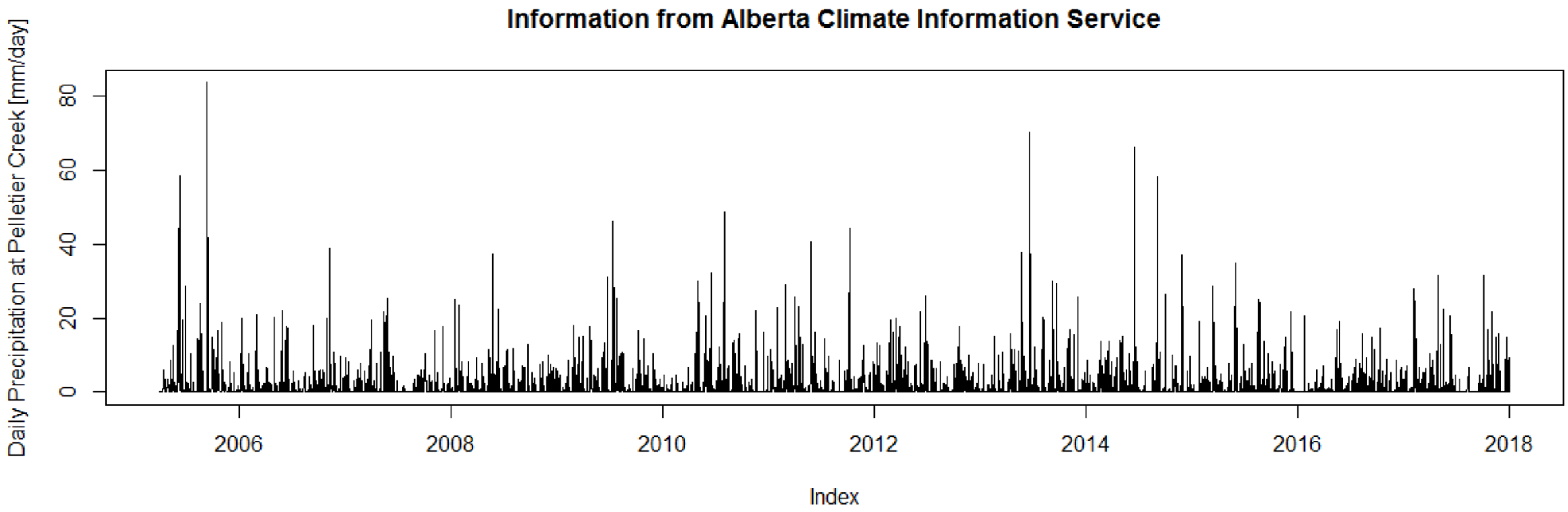
As part of the Standard Operating Policies and Procedures that will be developed prior to mine operations, a spill plan for liquids such as diesel will be incorporated to ensure the requirements for a rapid and correct response for clean up and remediation of any potential hydrocarbon or chemical spills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

FIGURES

ENVIRONMENT CANADA AND CLIMATE CHANGE



RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

DAILY PRECIPITATION RECORDED BY ALBERTA CLIMATE INFORMATION SERVICE FOR PELLETIER CREEK (3051R4R)

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 28, 2018

FIGURE
1-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\ECCC-1-1 Daily Precip Pelletier Cr 14-00201.mxd

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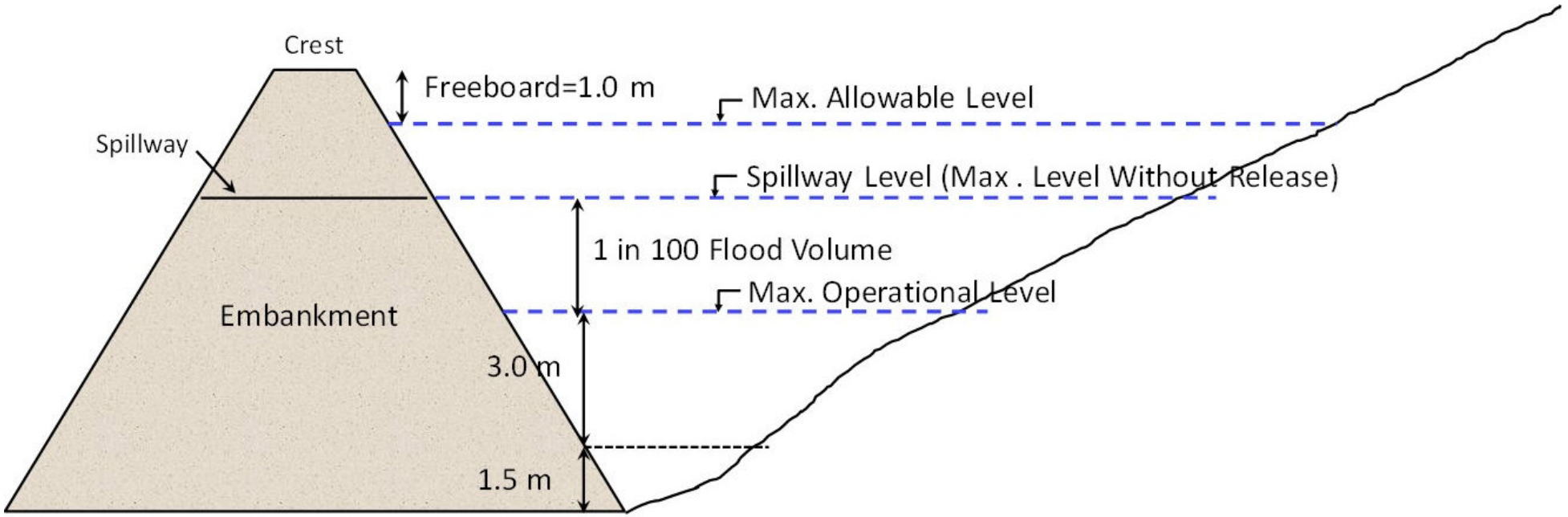

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

DESIGN APPROACH - SURGE PONDS AND RAW WATER POND

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: MAY 7, 2018

FIGURE
5-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\ECCC-5-1 Desgin Approach Surge and Raw Water Ponds 14-00201.mxd

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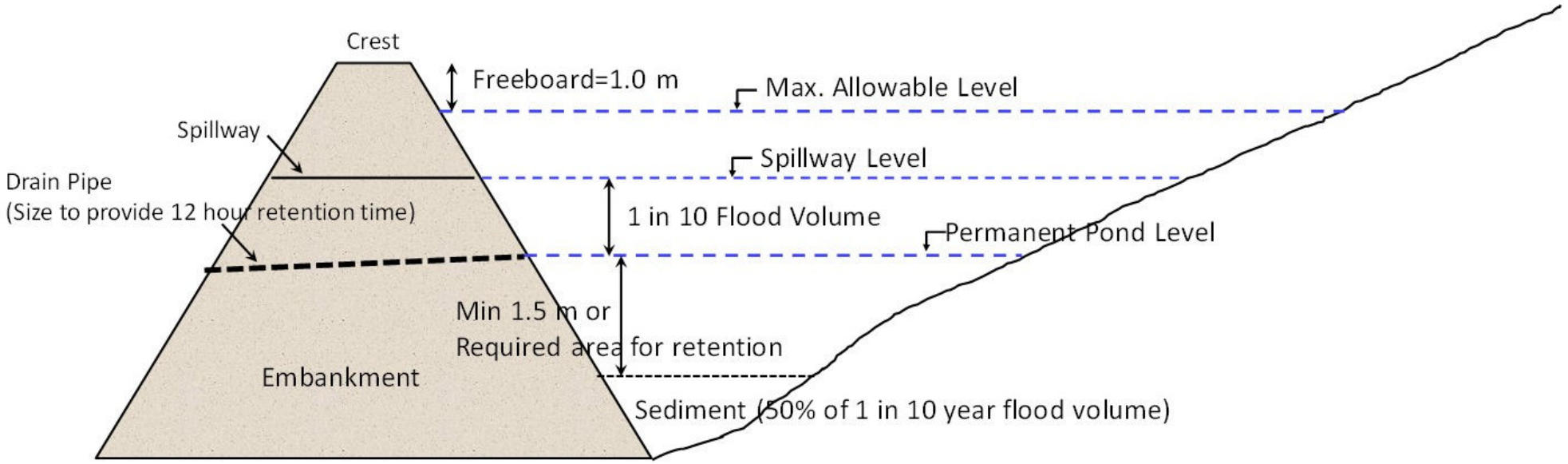

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

DESIGN APPROACH - SEDIMENT PONDS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: MAY 7, 2018

FIGURE
5-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\ECCC-5-2 Design Approach Sediment Ponds 14-00201.mxd

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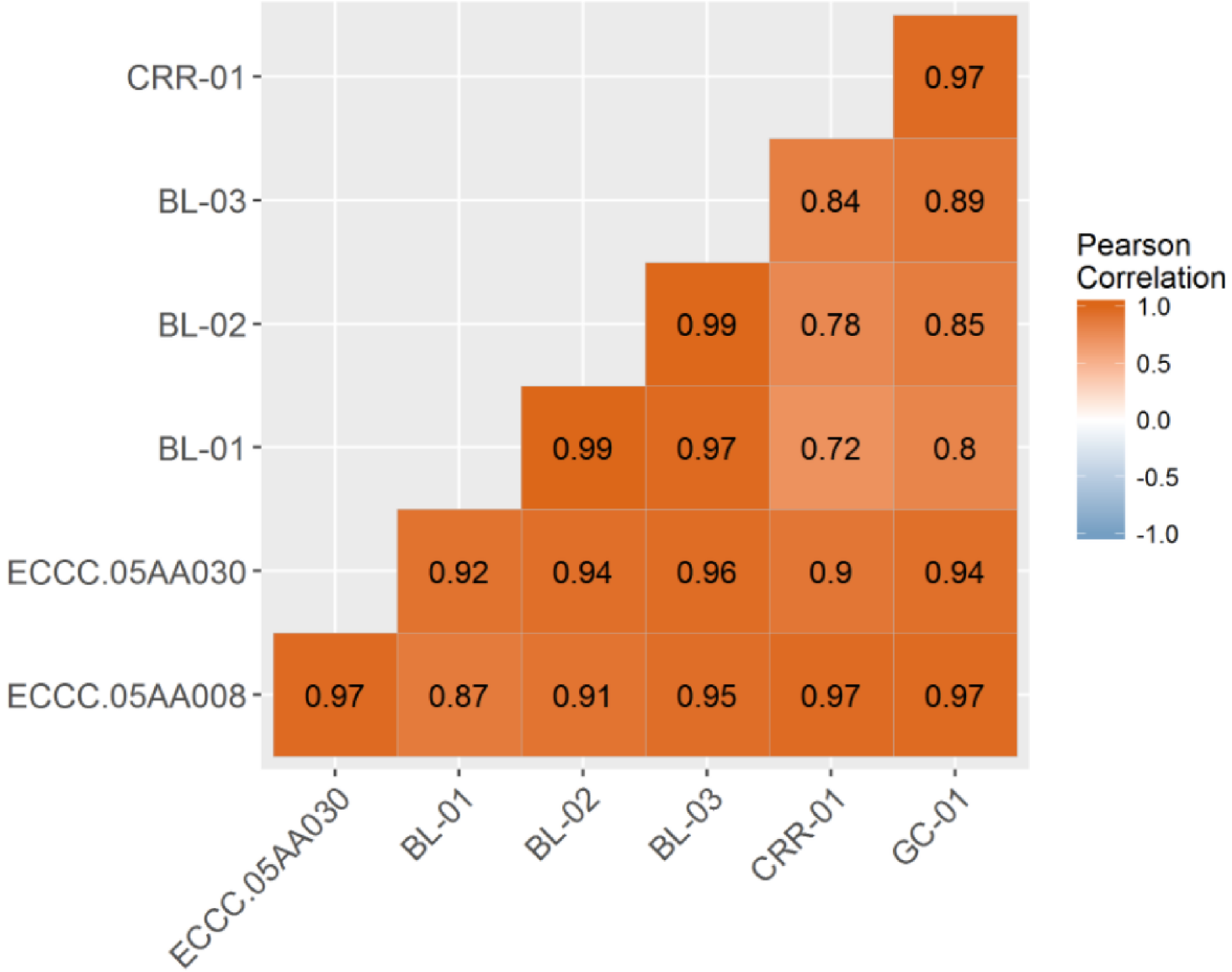

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

PEARSON CORRELATION MATRIX FOR LOCAL FLOW STATIONS AND WATER SURVEY OF CANADA STATIONS AT GOLD CREEK NEAR FRANK (05AA030) AND CROWSNEST RIVER AT FRANK (05AA008)

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
7-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 7-1 Pearson Correlation 05AA030 05AA008 14-00201.mxd

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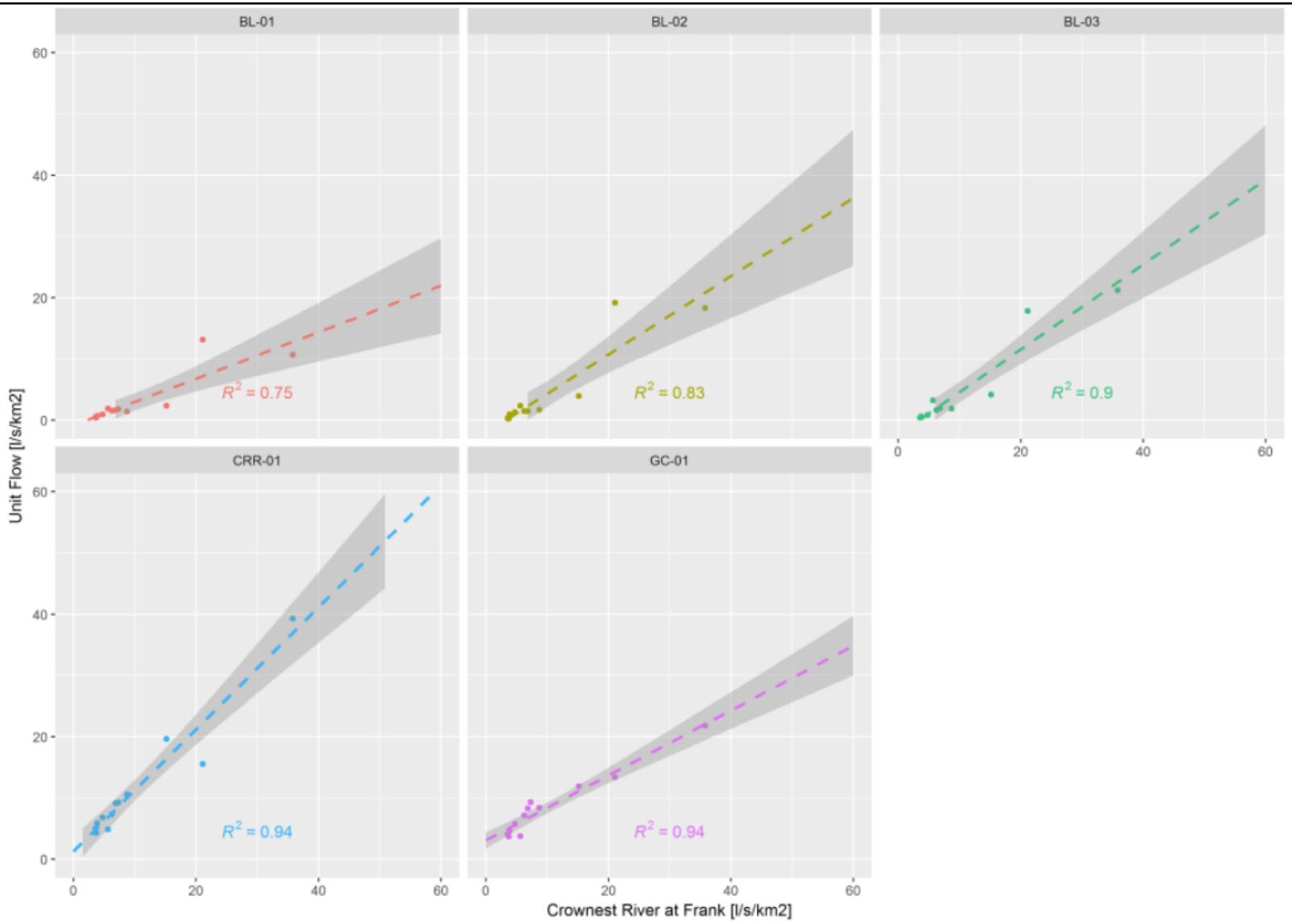

Note: In grey band is presented 95% confidence interval

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

LINEAR CORRELATION OF LOCAL STREAMFLOW MONTHLY UNIT FLOWS AGAINST CROWSNEST RIVER AT FRANK FLOWS (WATER SURVEY OF CANADA STATION 05AA008) WITH 95% CONFIDENCE INTERVALS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
7-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 7-2 Linear Correlation 05AA008 14-00201.mxd

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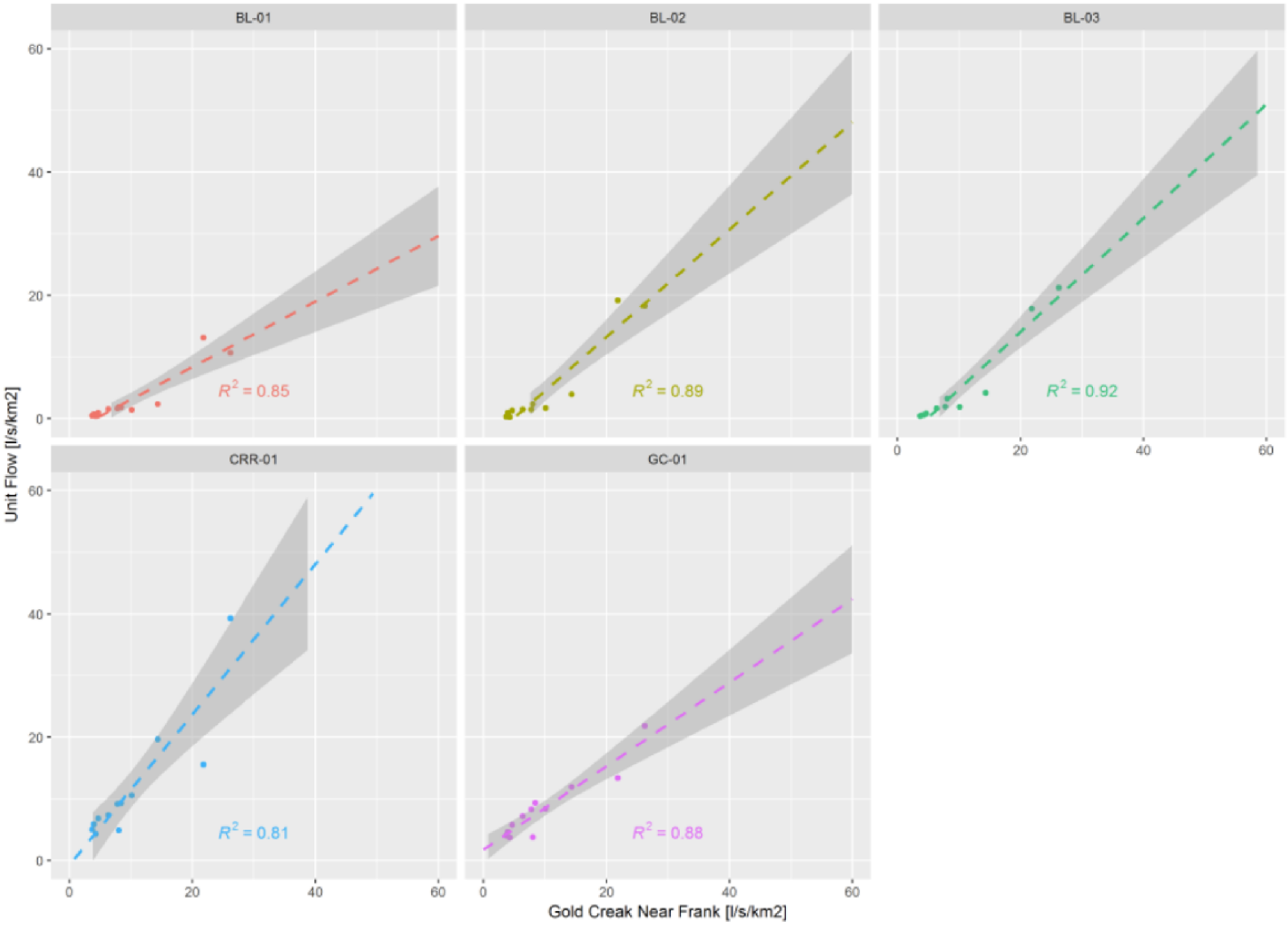

Note: In grey band is presented 95% confidence interval

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

LINEAR CORRELATION OF LOCAL STREAMFLOW MONTHLY UNIT FLOWS AGAINST GOLD CREEK NEAR FRANK FLOWS (WATER SURVEY OF CANADA STATION 05AA030) WITH 95% CONFIDENCE INTERVALS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
7-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 7-3 Linear Correlation 05AA030 14-00201.mxd

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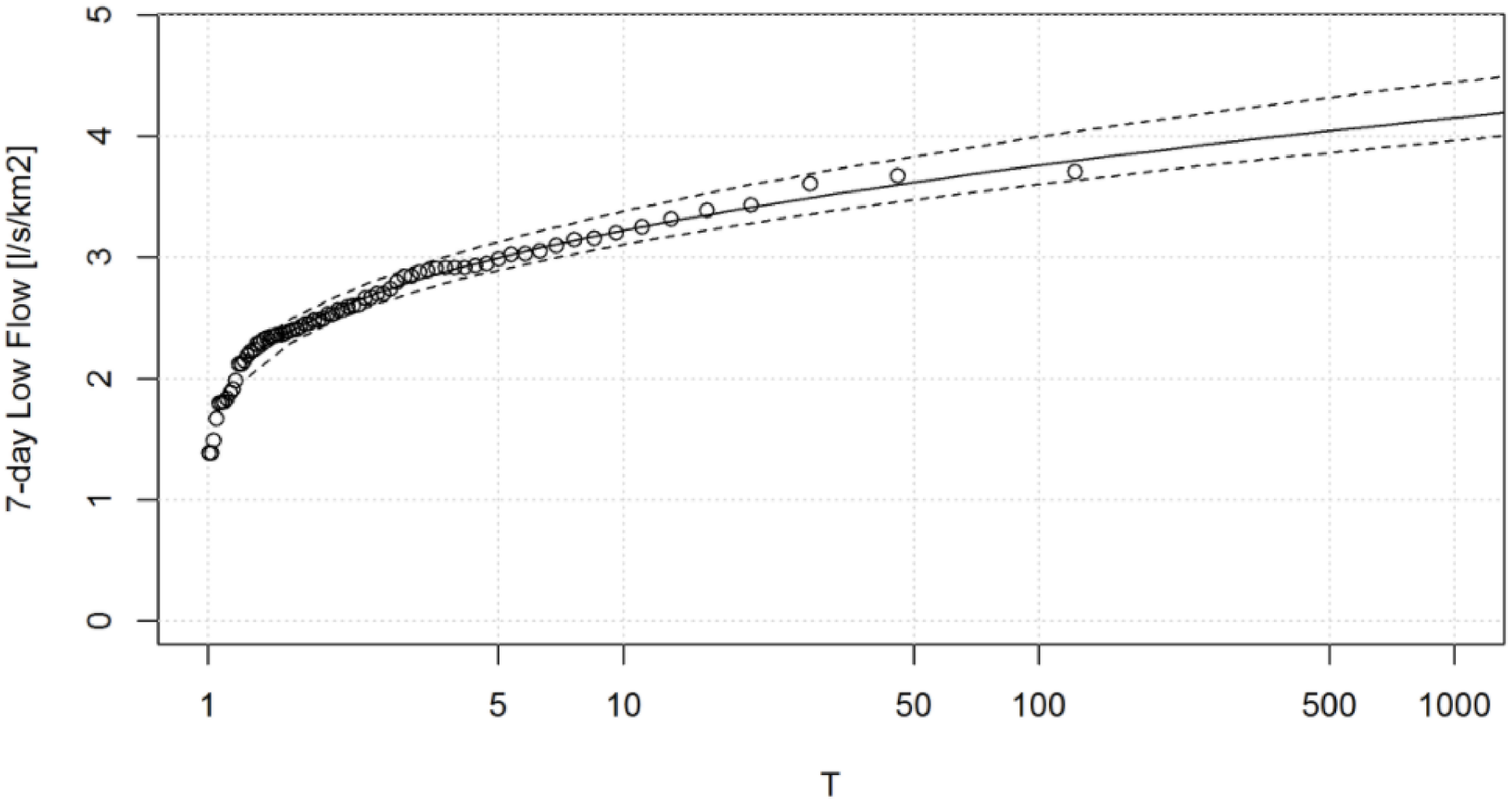

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

CROWSNEST RIVER 7Q10 FLOW RESULTS AND THE NORMAL DISTRIBUTION

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
8-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 8-1 Crowsnest R 7Q10 14-00201.mxd

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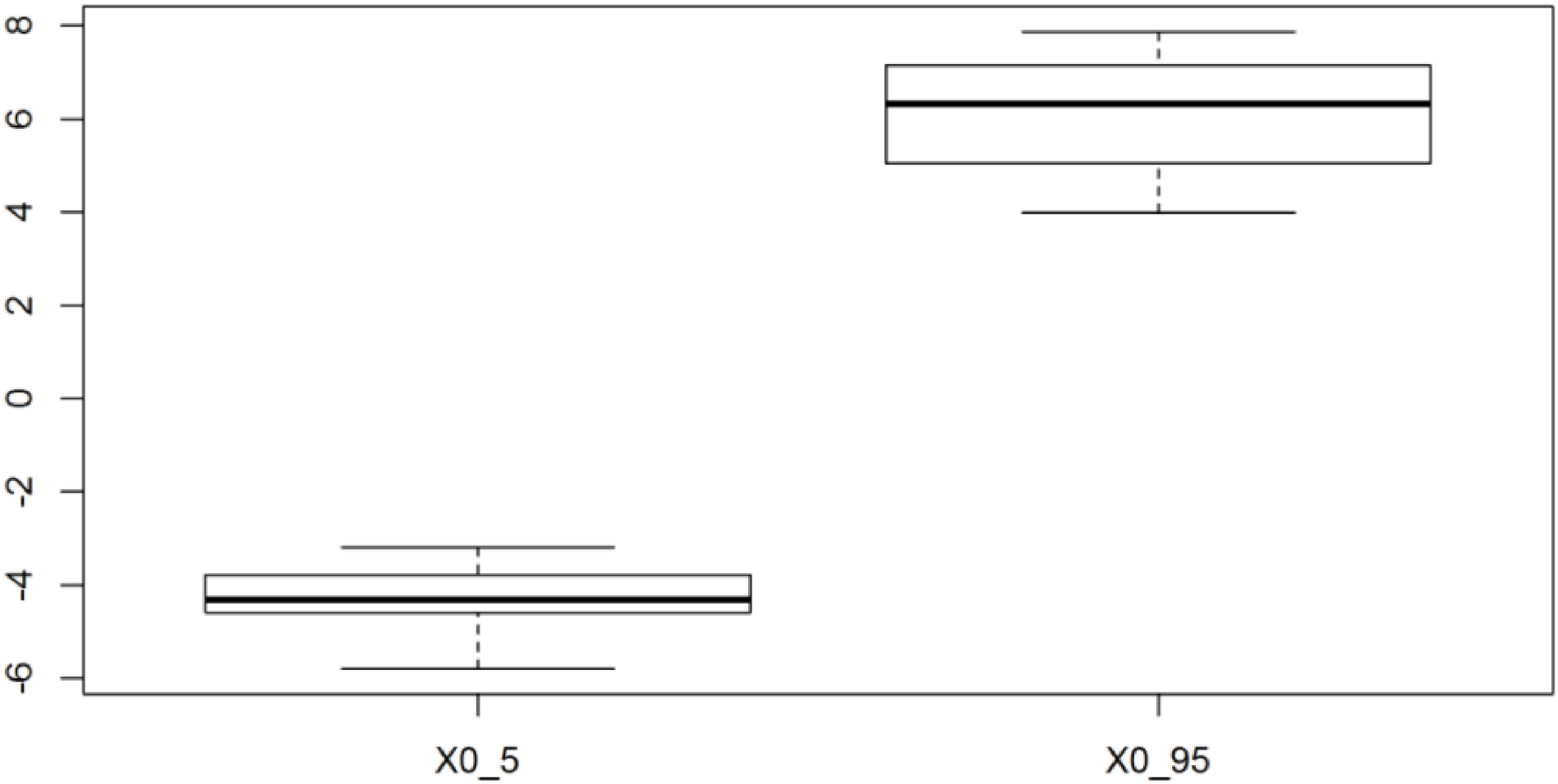

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

BOX PLOT FOR UNIT PEAK FLOWS, COMPARING THE 5TH AND 95TH PERCENTILE RESULTS OF ACTUAL FLOW MEASUREMENTS WITH THE NORMAL DISTRIBUTION PREDICTED FLOW RESULTS FOR CROWSNEST RIVER AT FRANK

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
8-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 8-2 Box Plot 14-00201.mxd

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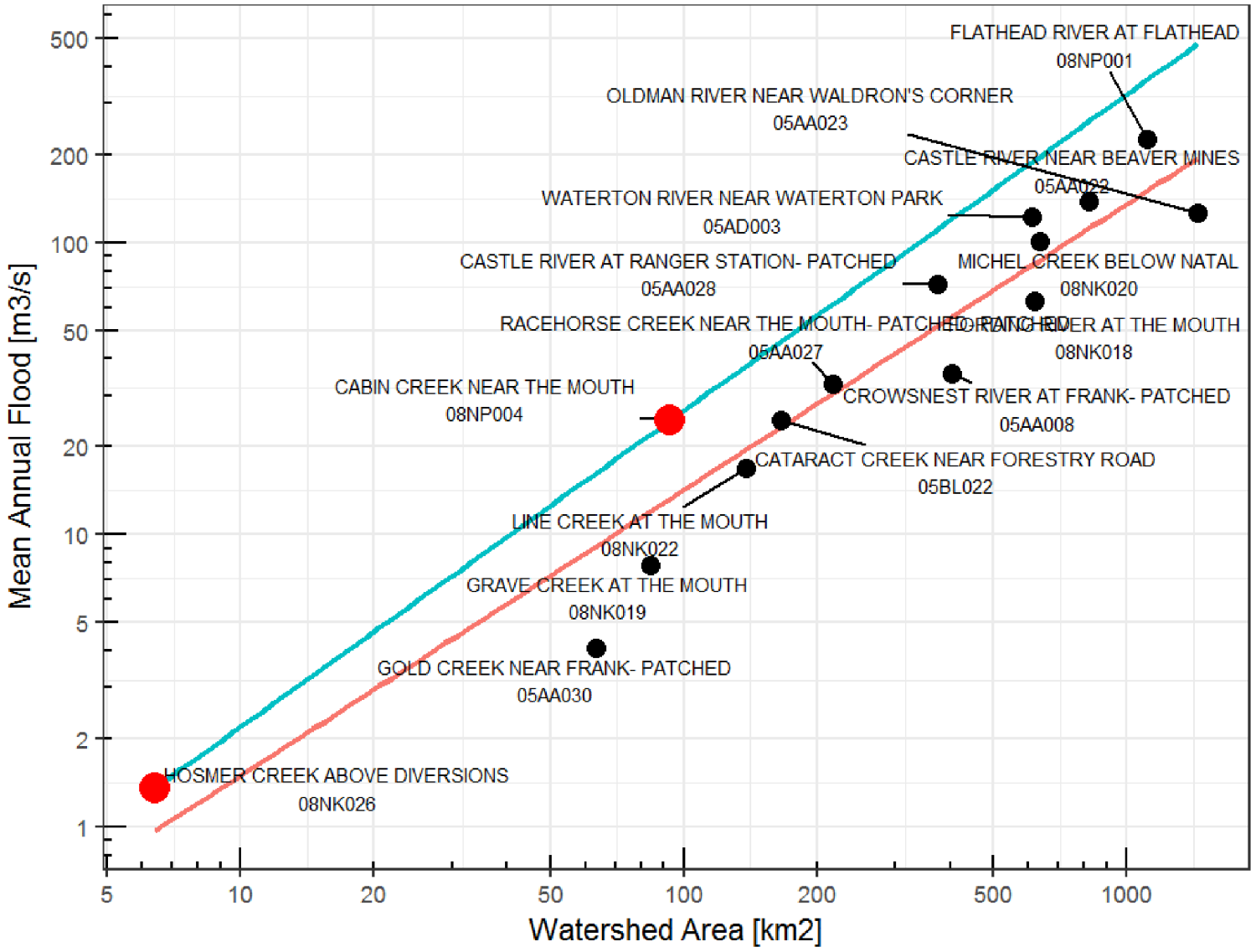

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

MEAN ANNUAL FLOOD BASED ON THE INDEX FLOOD METHOD (FROM HYDROLOGY BASELINE)

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
8-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 8-3 Mean Annual Flood 14-00201.mxd

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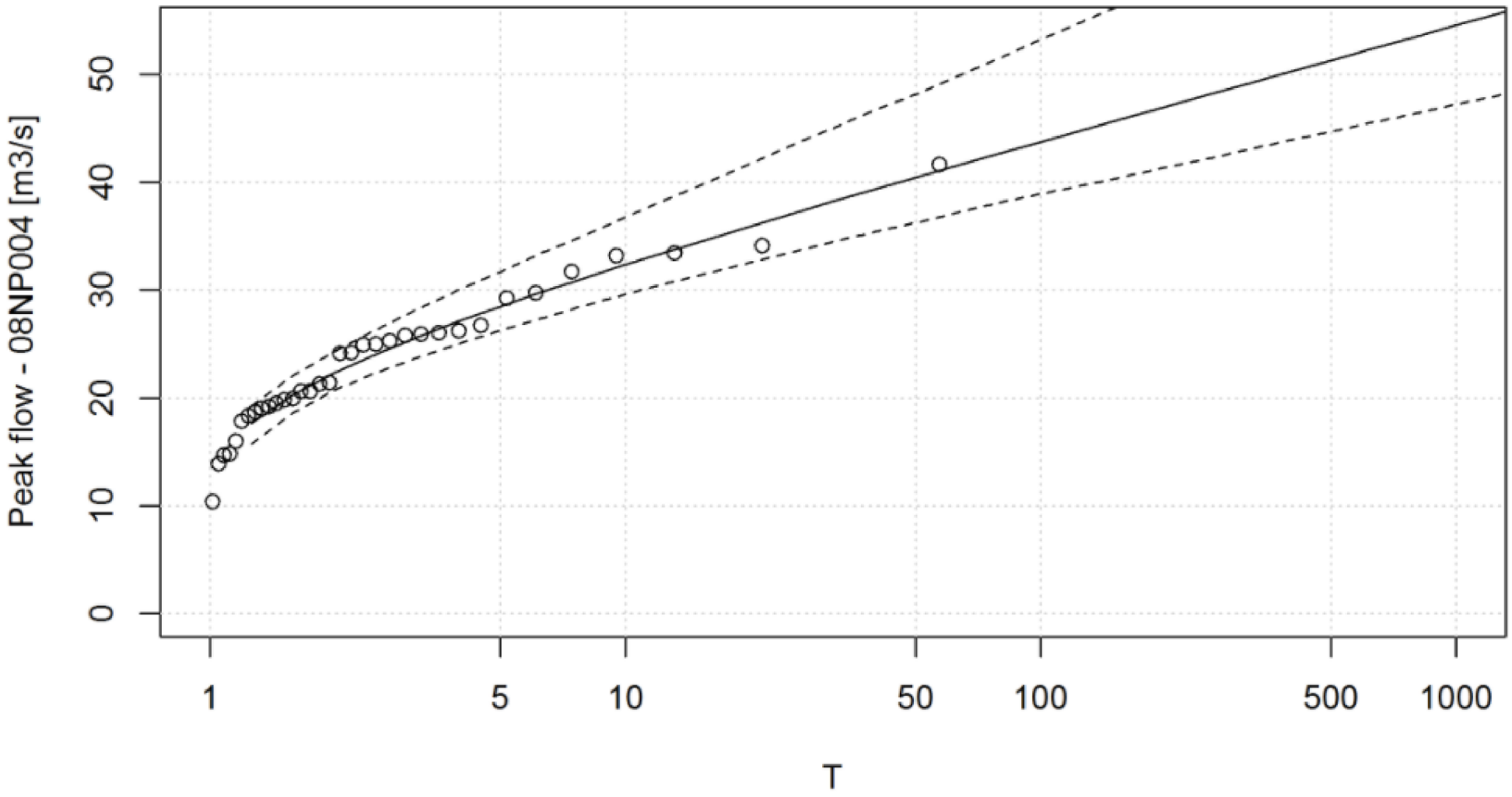

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

STATION 08NP004 ANNUAL UNIT PEAK FLOWS AND LOG NORMAL DISTRIBUTION WITH 5TH AND 95TH PERCENTILE CONFIDENCE BANDS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
8-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 8-4 Station 08NP004 14-00201.mxd

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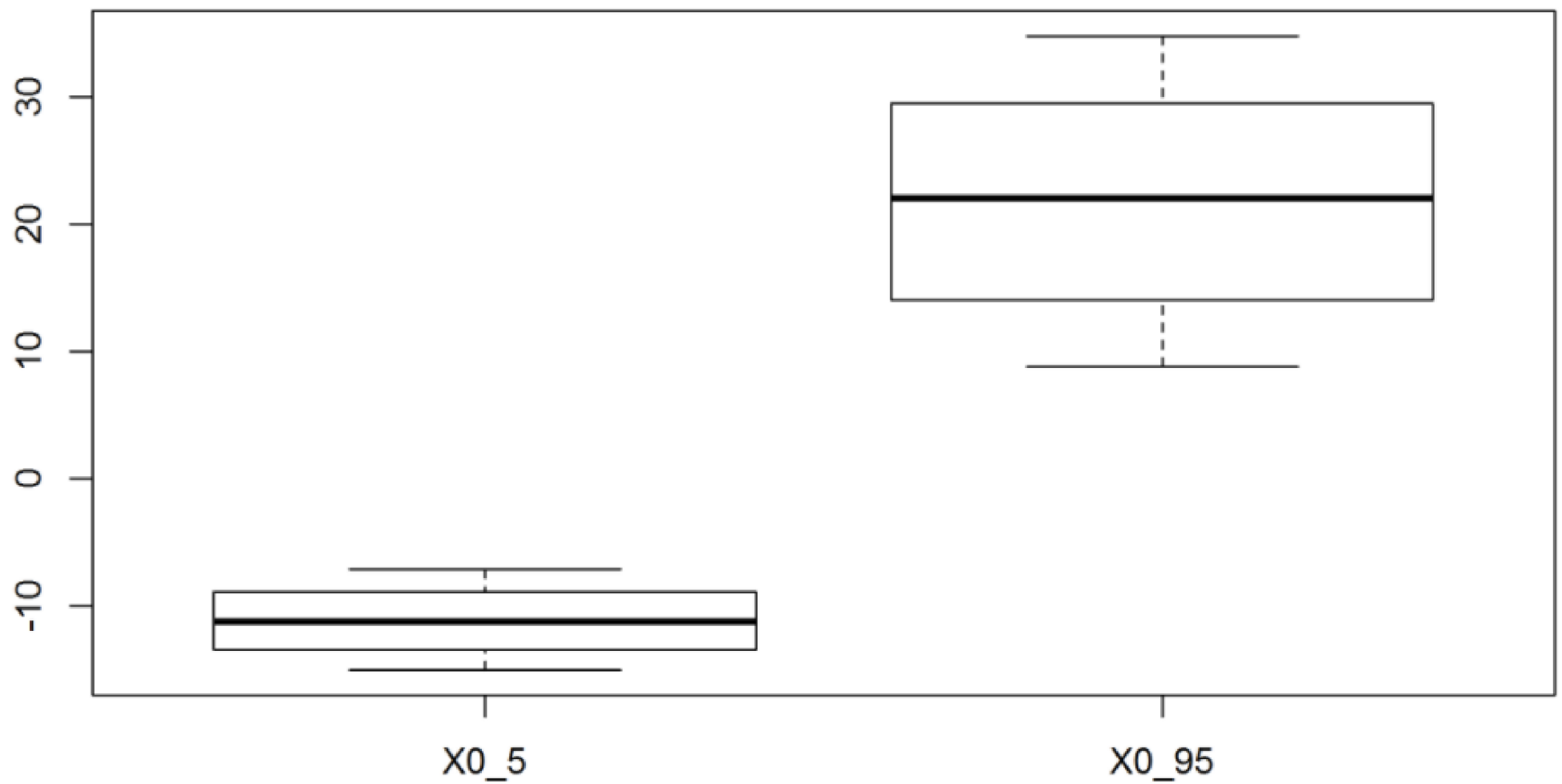

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

BOX PLOT FOR UNIT PEAK FLOWS, COMPARING THE 5TH AND 95TH PERCENTILE RESULTS OF ACTUAL FLOW MEASUREMENTS WITH THE NORMAL DISTRIBUTION PREDICTED FLOW RESULTS FOR STATION 08NP004

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
8-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 8-5 Box Plot Station 08NP004 14-00201.mxd

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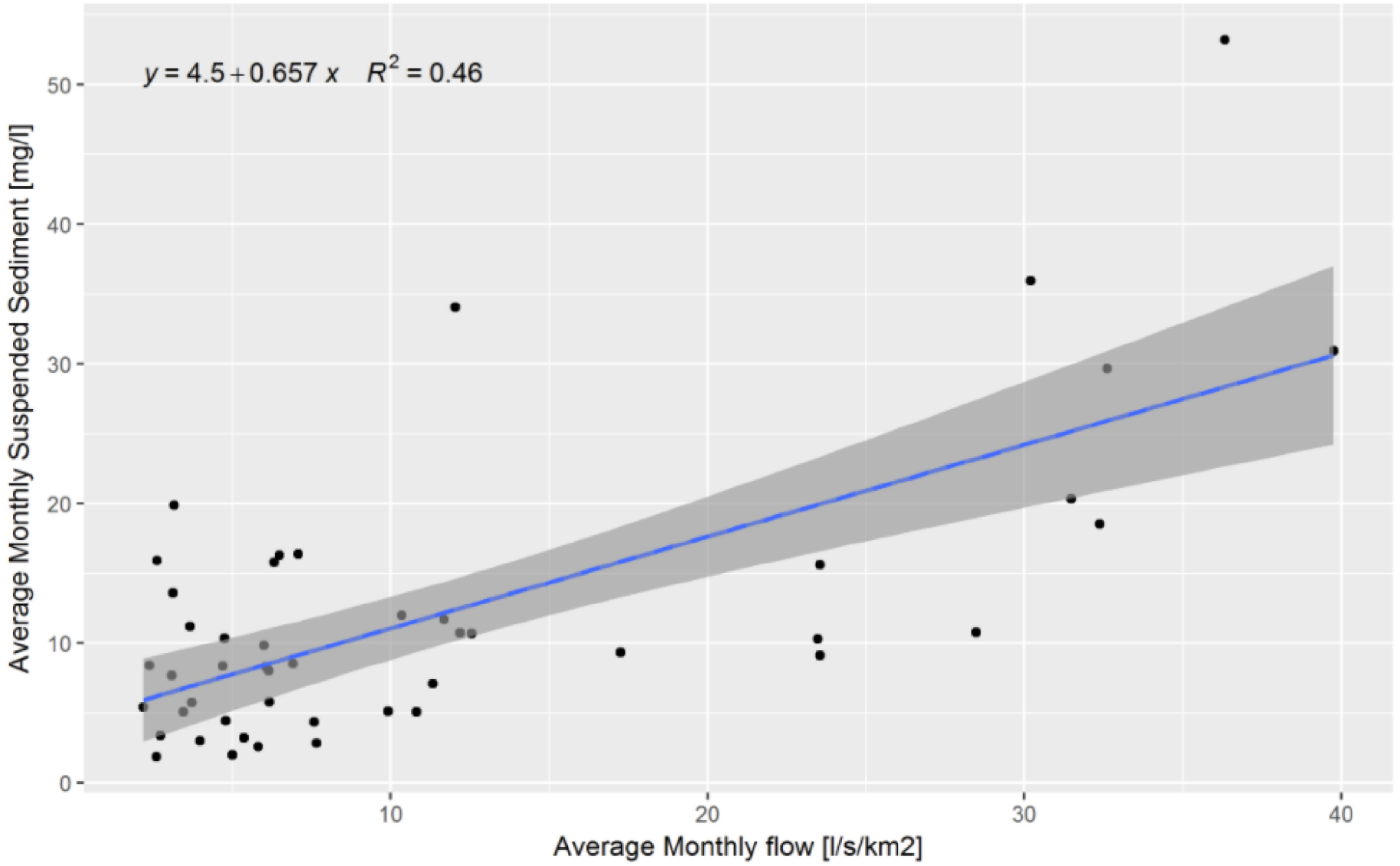

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

CROWSNEST RIVER SUSPENDED SEDIMENT MEASUREMENTS VERSUS CORRESPONDING STREAMFLOW

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 27, 2018

FIGURE

9-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\CEAA\Fig 9-1 Crownest R Susp Sed 14-00201.mxd

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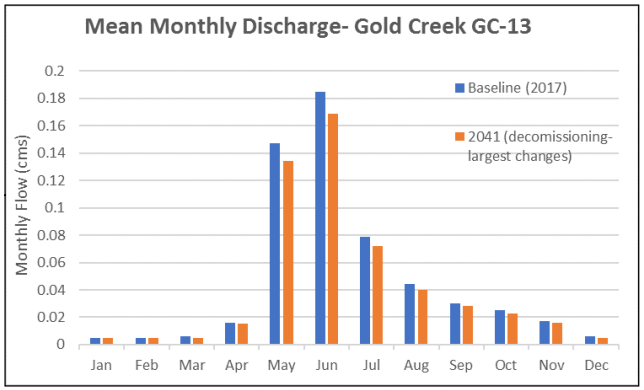
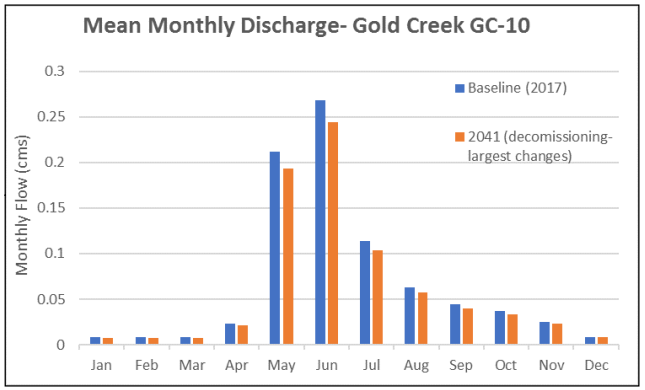
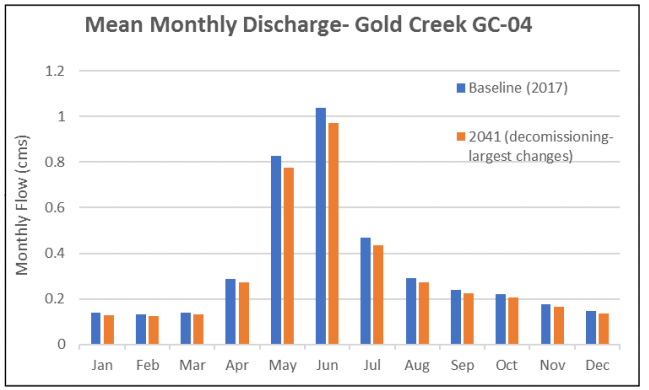
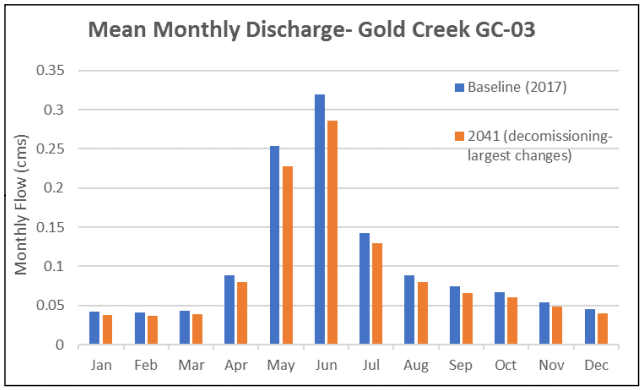
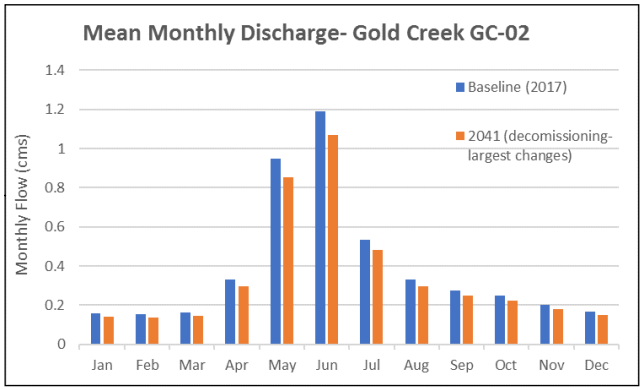
DEPARTMENT OF FISHERIES AND OCEANS











RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

GOLD CREEK – MEAN MONTHLY FLOW FOR BASELINE (2017) AND DECOMMISSIONING THAT SHOWS THE LARGEST CHANGE (2041)

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 30, 2018
FIGURE	12-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFO\DFO-12-1 Mean Monthly Flow Gold Cr 14-00201.mxd

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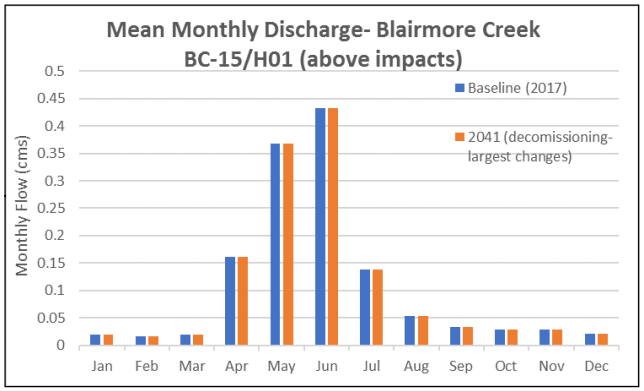

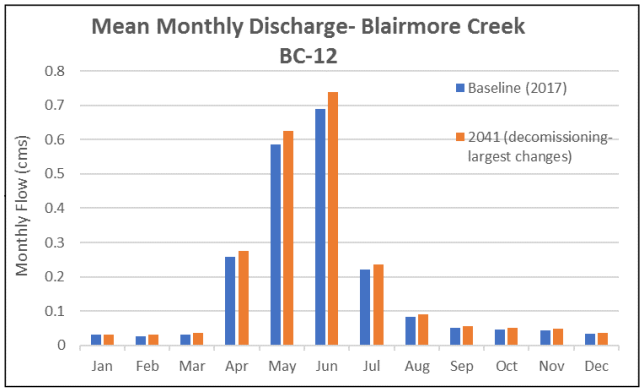

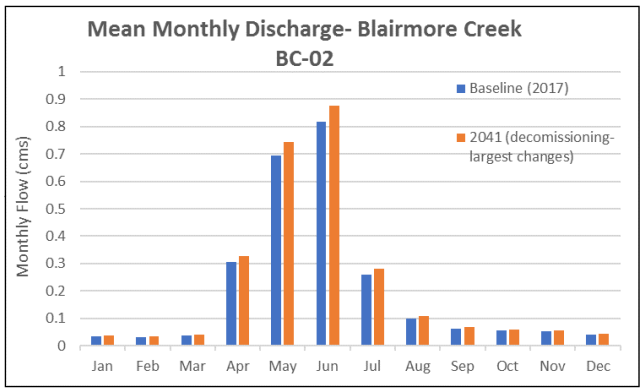

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

BLAIRMORE CREEK – MEAN MONTHLY FLOW FOR BASELINE (2017) AND DECOMMISSIONING THAT SHOWS THE LARGEST CHANGE (2041)

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 30, 2018

FIGURE
12-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\DFO\DFO-12-2 Mean Monthly Flow Blairmore Cr 14-00201.mxd

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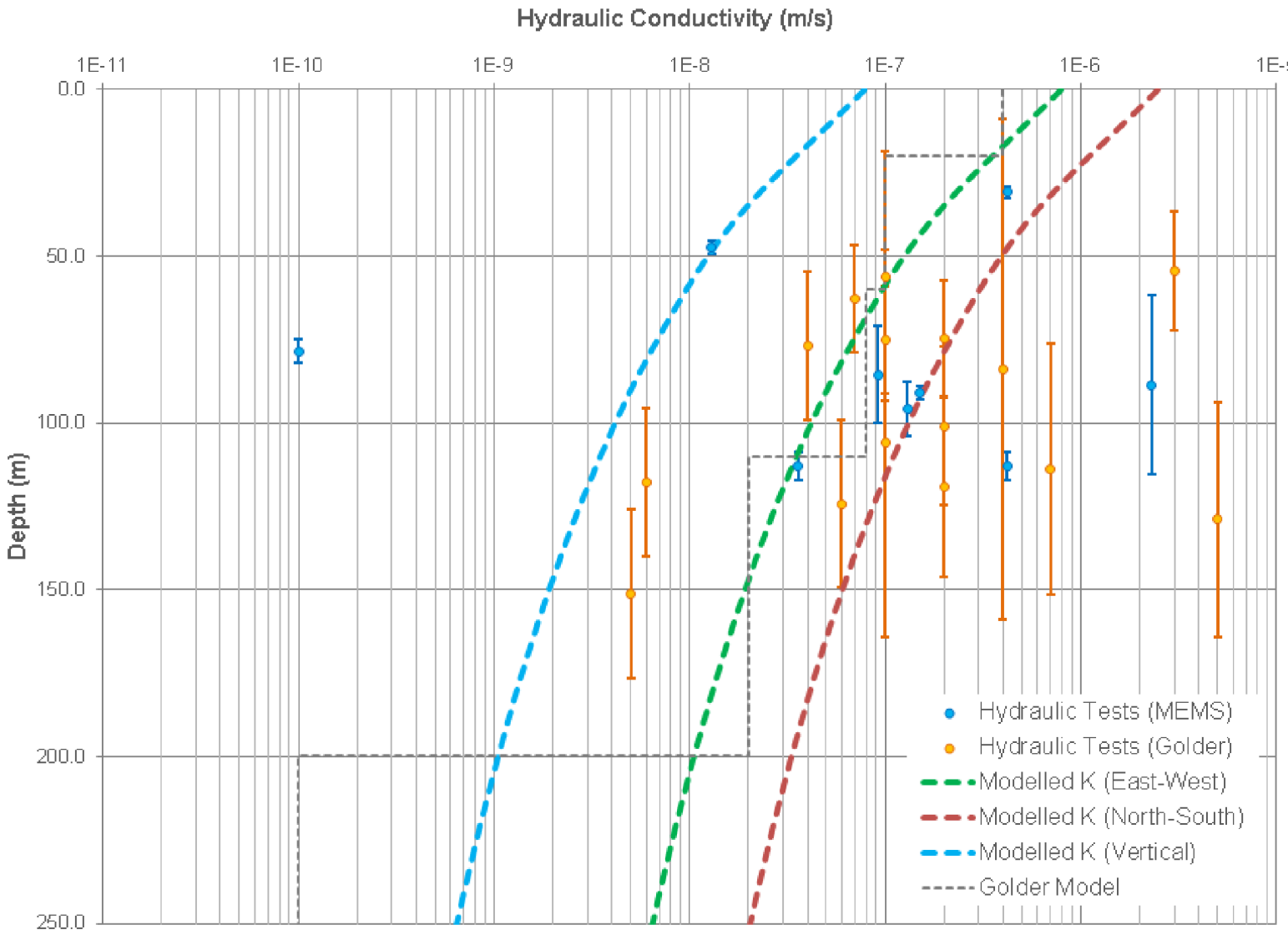

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

COMPARISON OF SIMULATED K RANGE TO ON-SITE MEASUREMENTS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
17-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\DFO\Fig 17-1 Comparison K Range 14-00201.mxd

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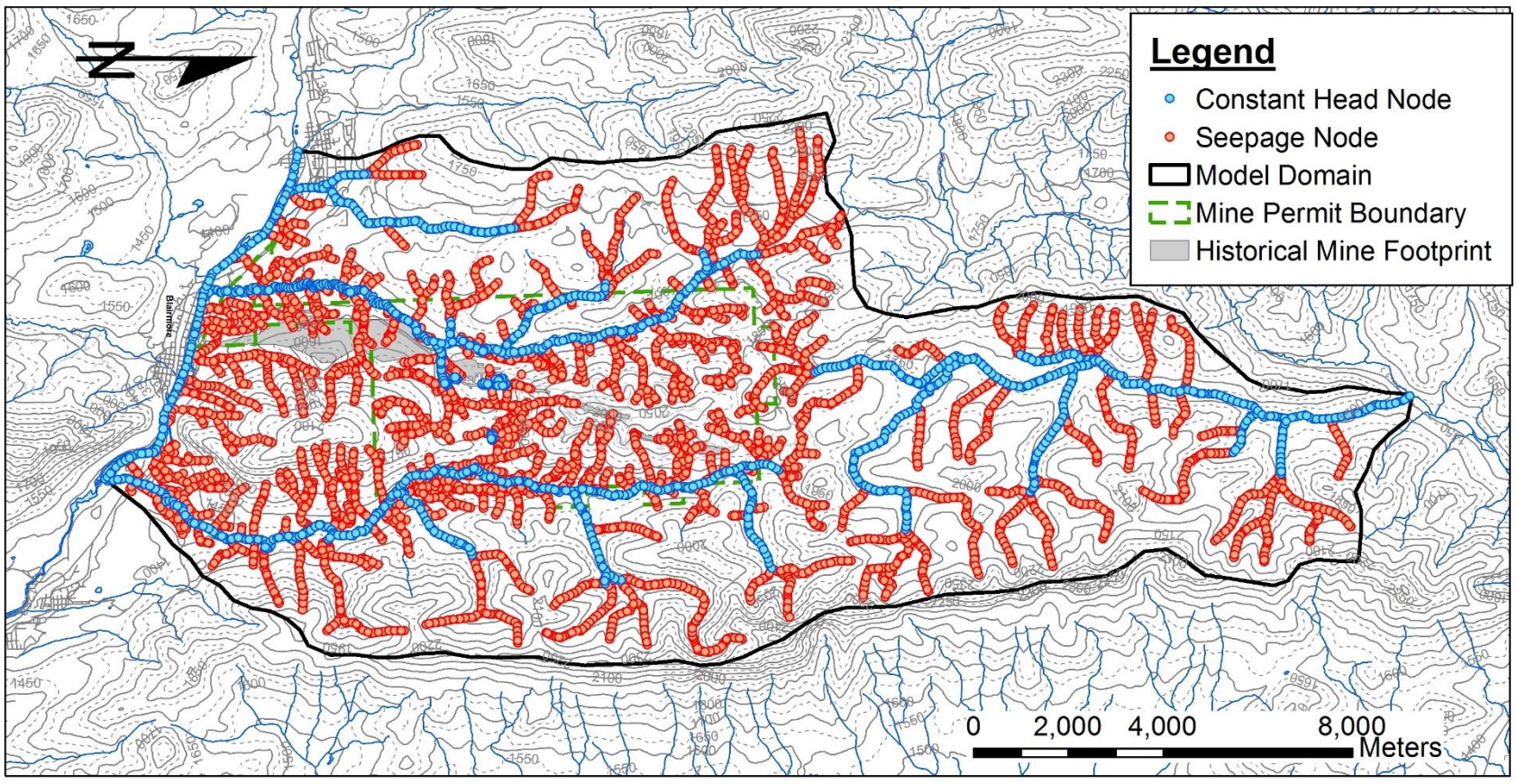
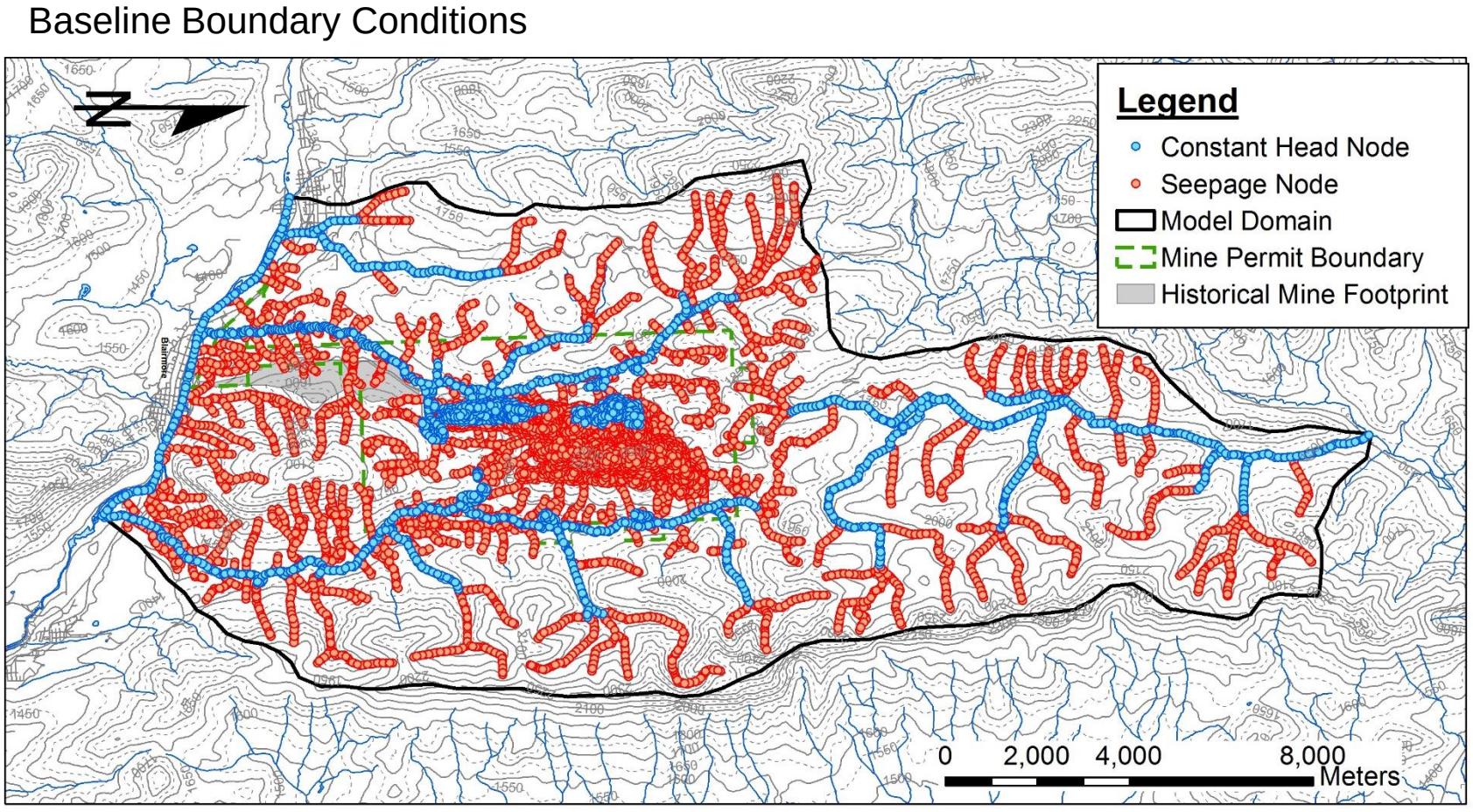
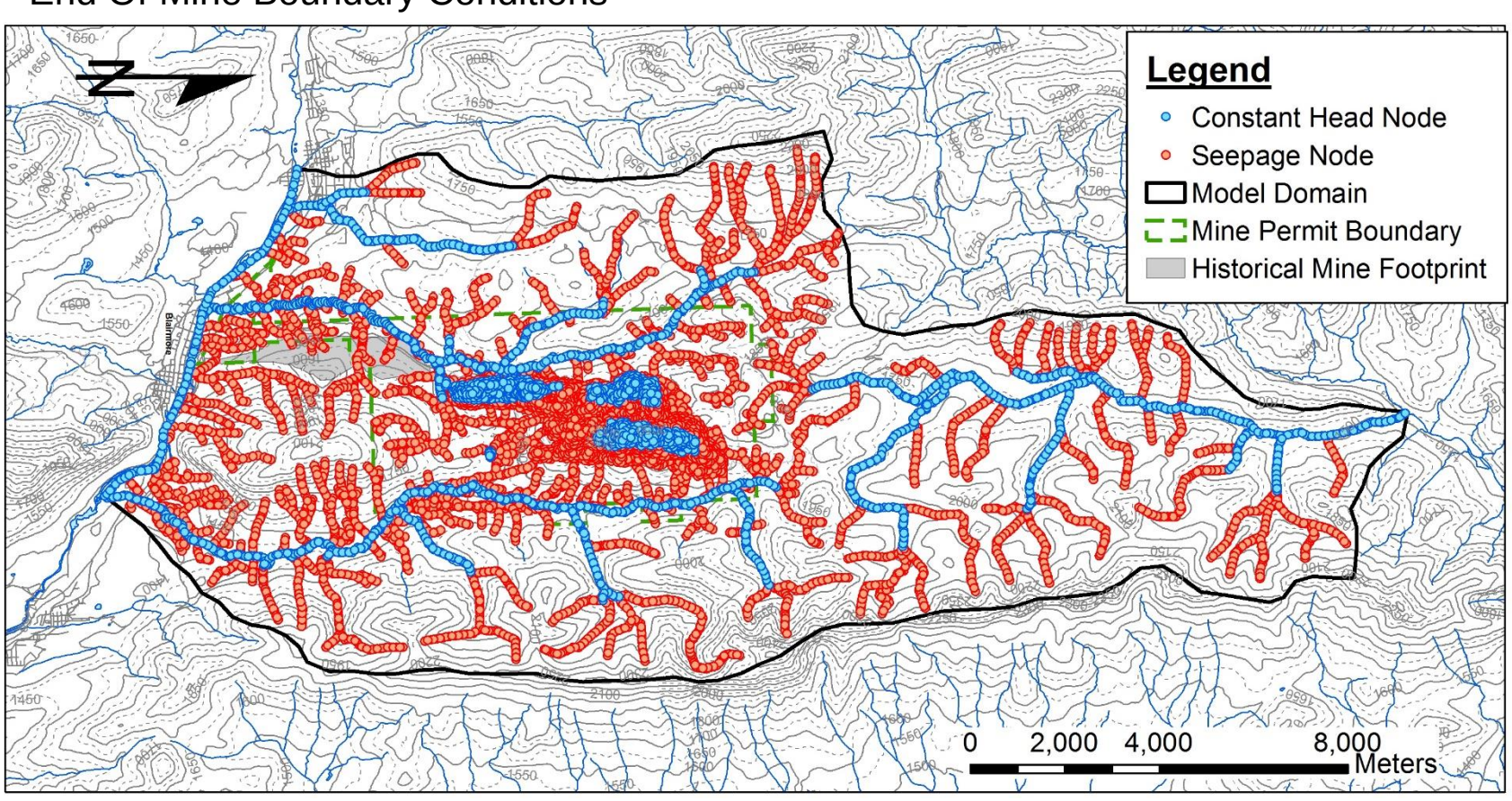


Baseline Boundary Conditions

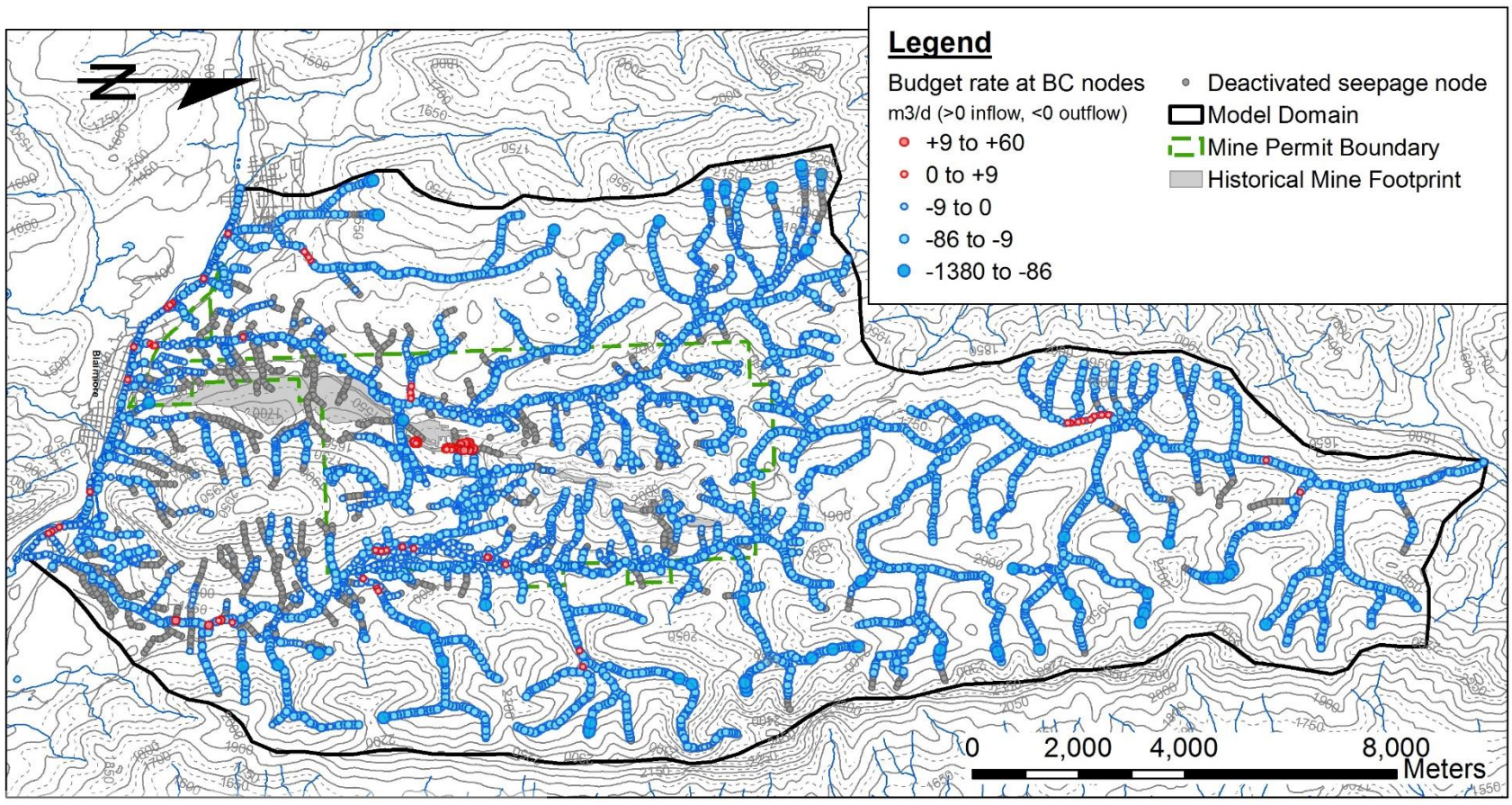


End Of Mine Boundary Conditions

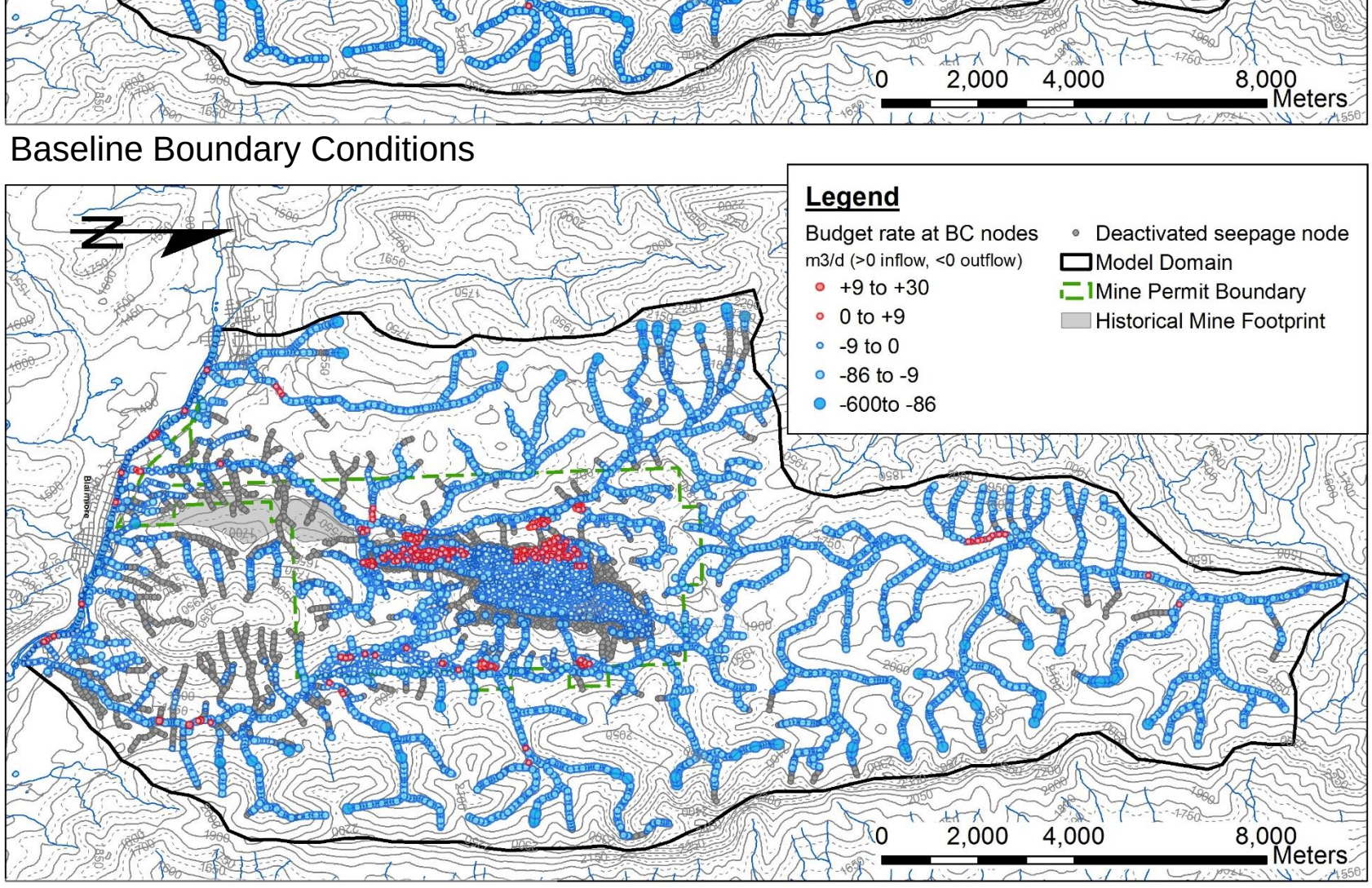


Long Term Closure Boundary Conditions

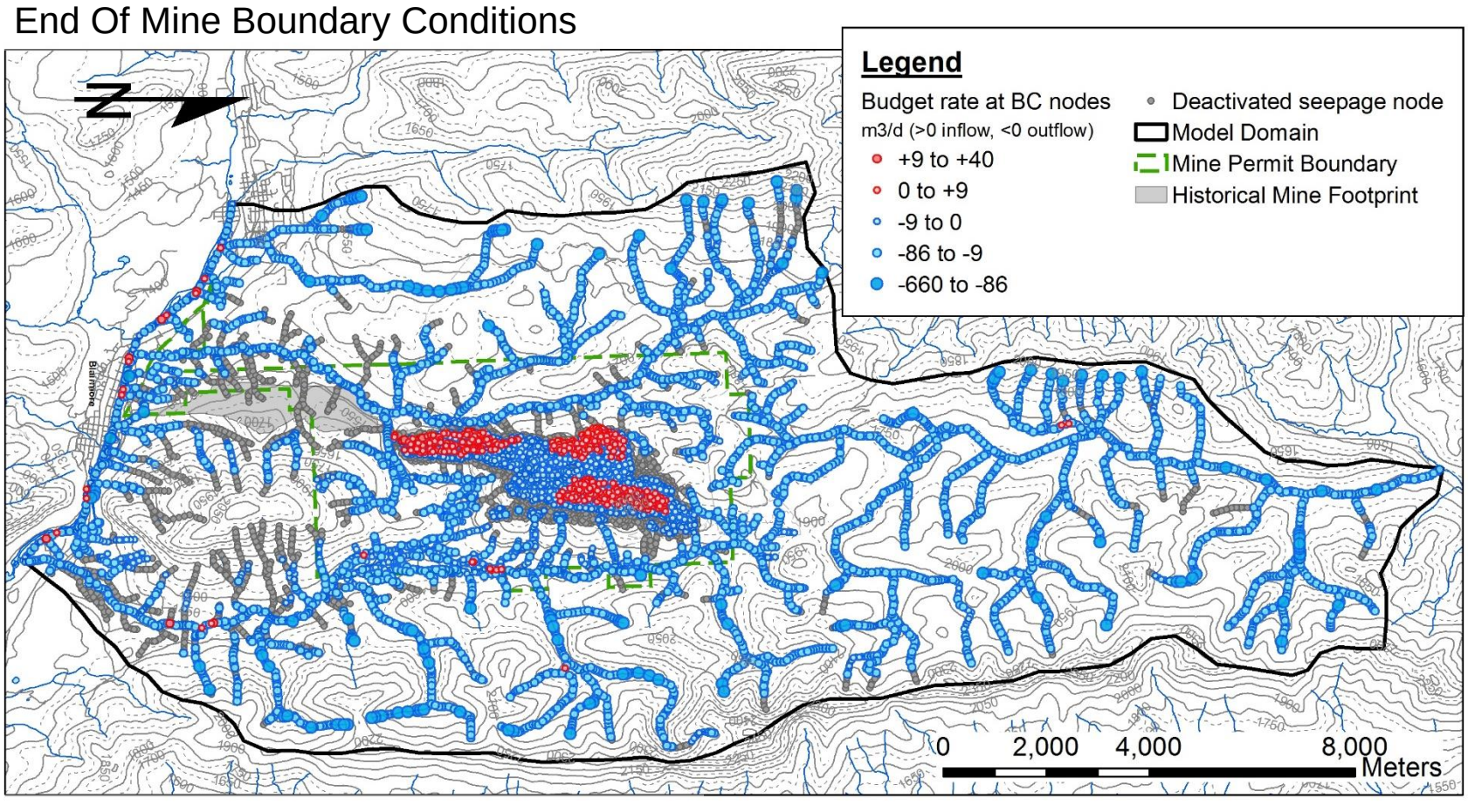
srk consulting	RIVERSDALE RESOURCES	Grassy Groundwater Model
		Boundary Conditions
Job No: 1CM029.005 Filename: Fig1&2_ SIRs_Model_BC.pptx	Grassy Mountain Coal Project	Date: Apr. 2018 / Approved: GF / Figure: **21-1**



Baseline Boundary Conditions

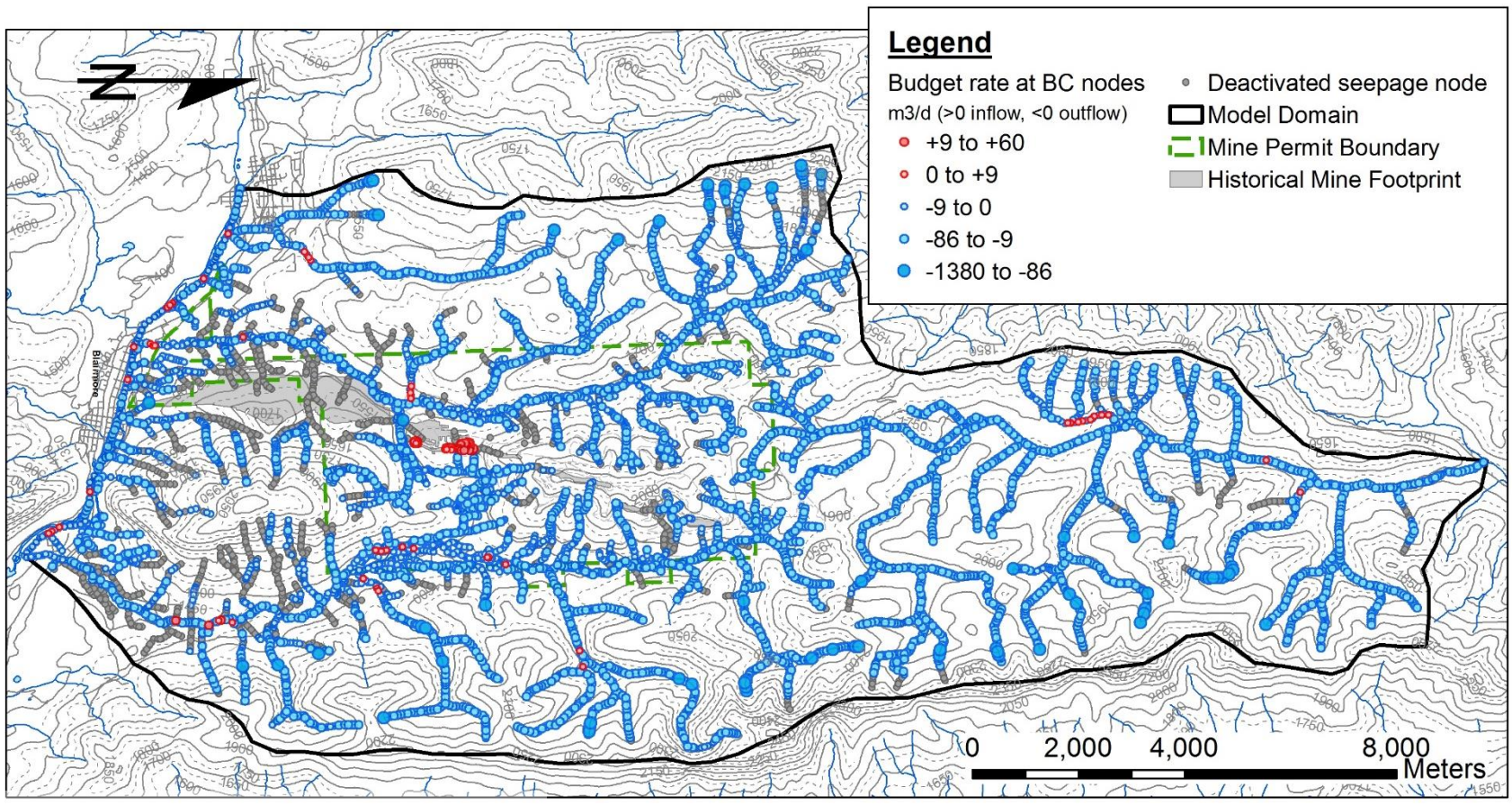


End Of Mine Boundary Conditions

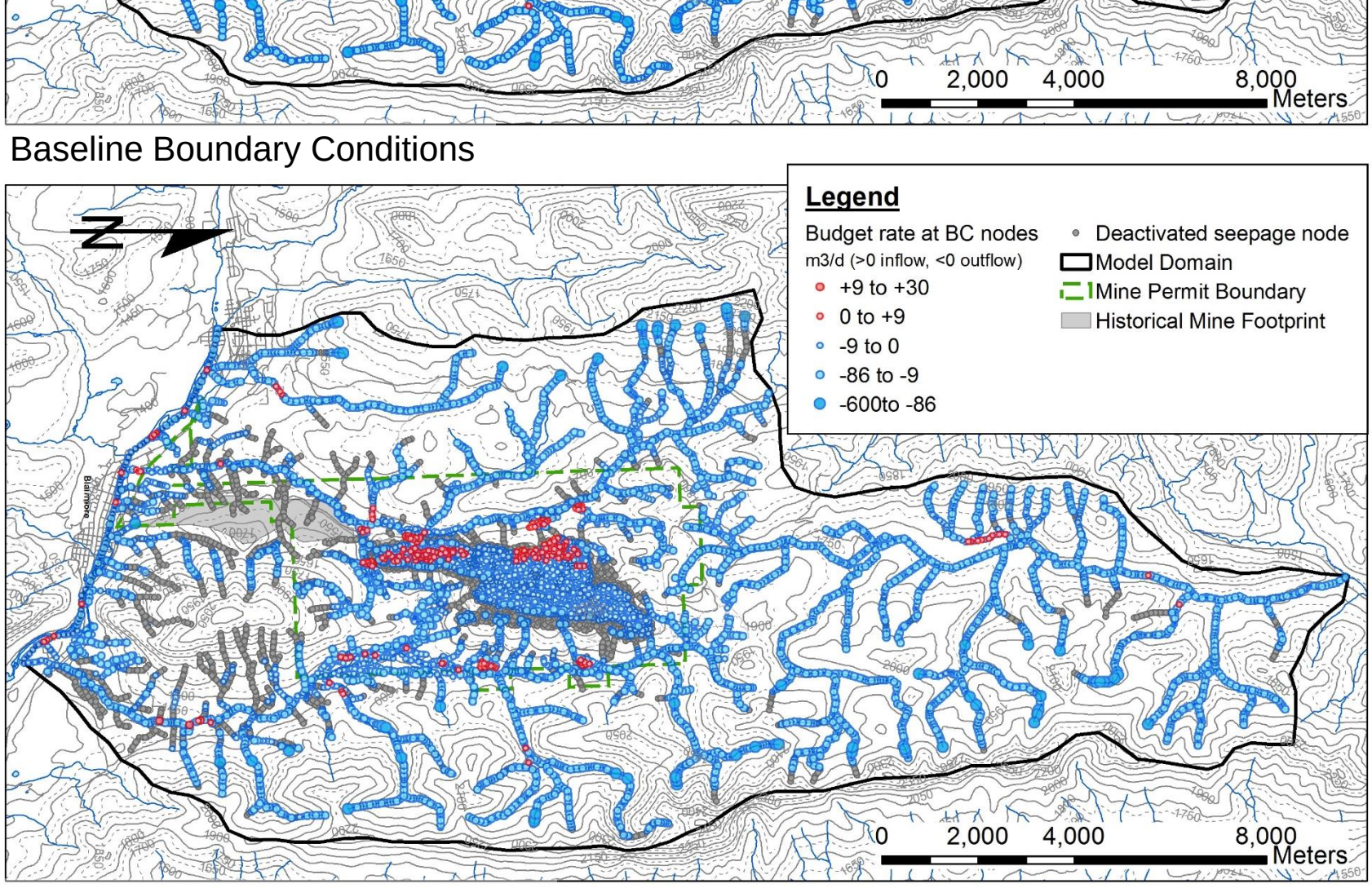


Long Term Closure Boundary Conditions

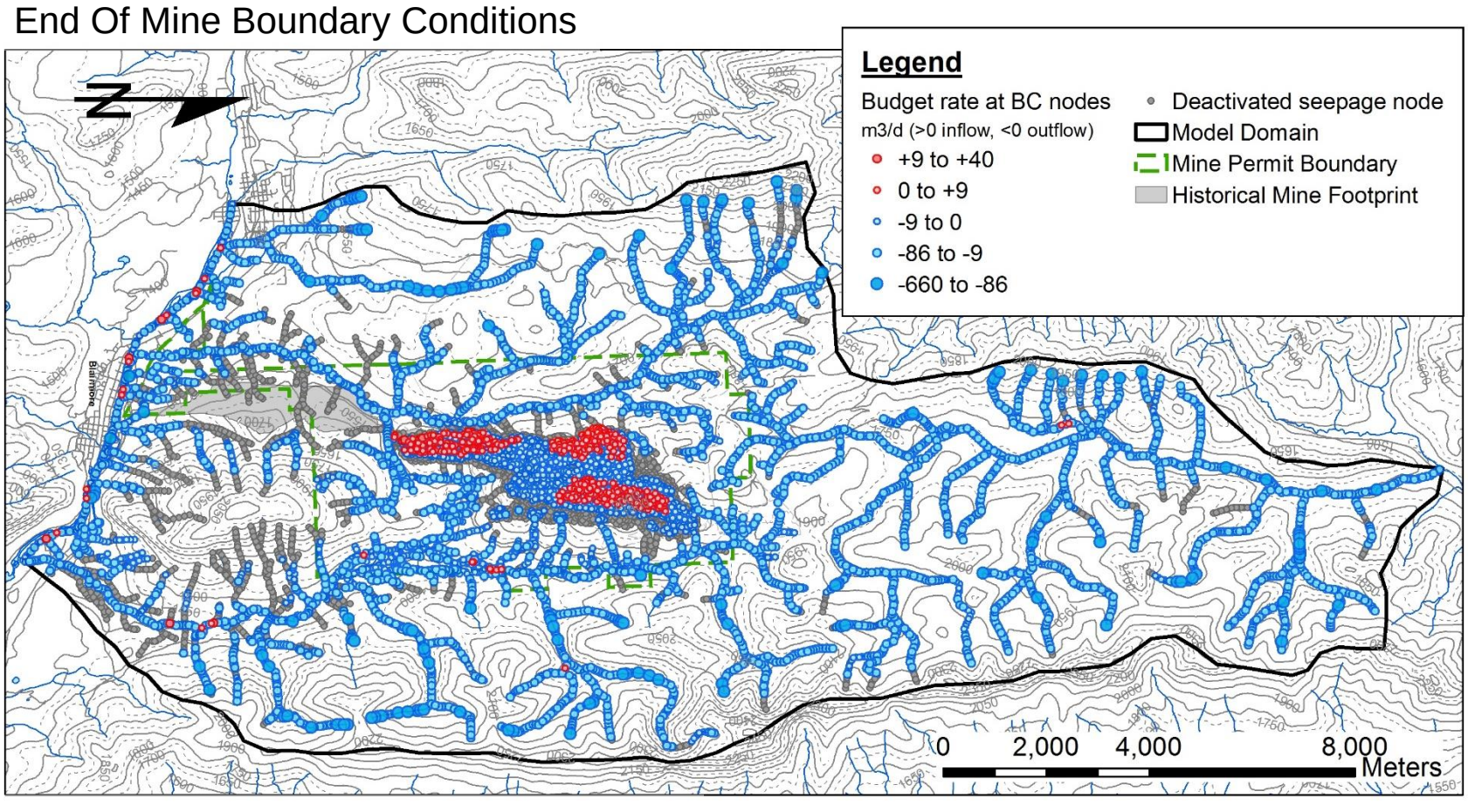
srk consulting	RIVERSDALE RESOURCES	Grassy Groundwater Model
		Simulated groundwater gains and losses at all boundary conditions
Job No: 1CM029.005 Filename: Fig_ SIRs_Model_BC.pptx	Grassy Mountain Coal Project	Date: Apr. 2018 / Approved: GF / Figure: **22-1**



Baseline Boundary Conditions

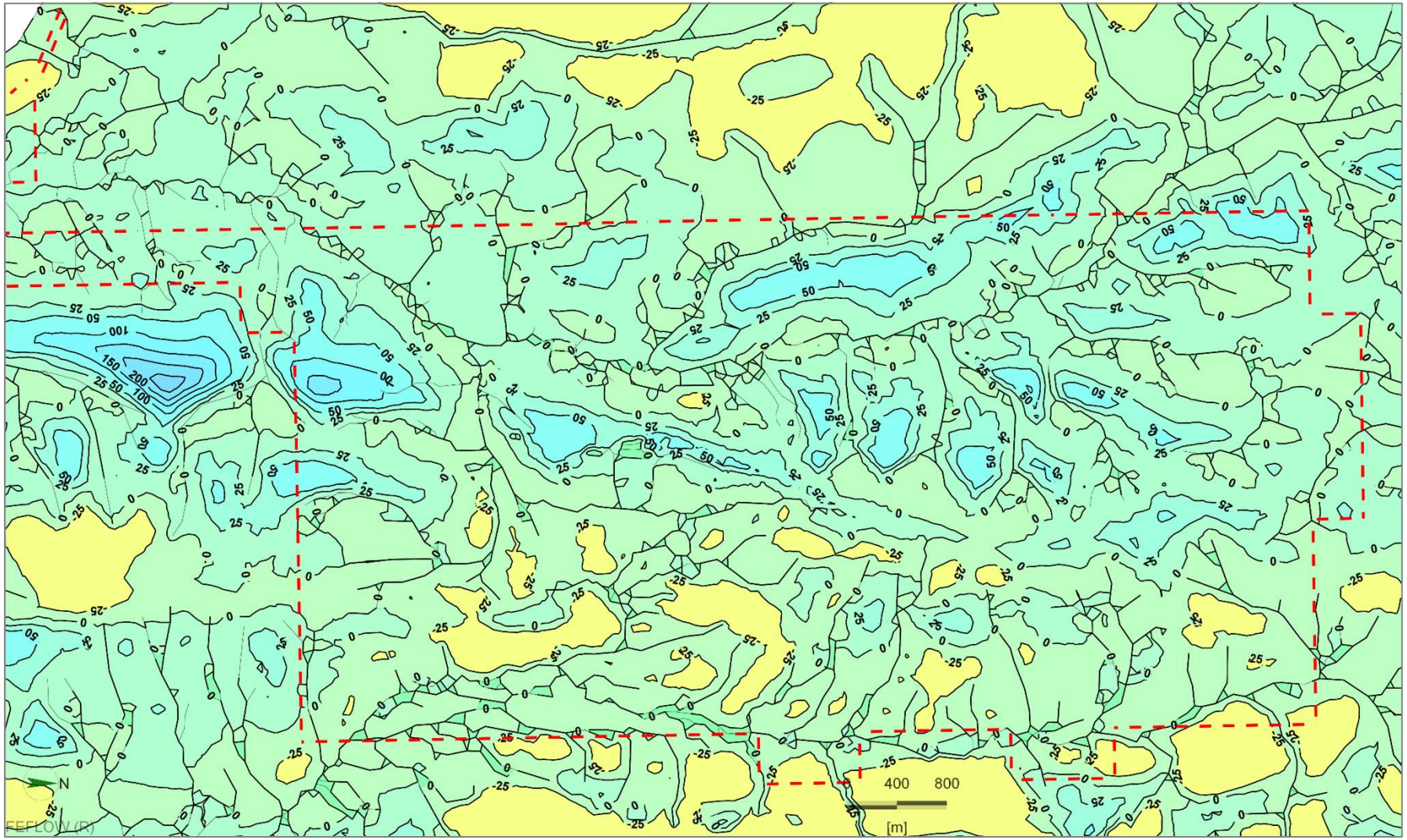


End Of Mine Boundary Conditions



Long Term Closure Boundary Conditions

srk consulting	RIVERSDALE RESOURCES	Grassy Groundwater Model
		Simulated groundwater gains and losses at all boundary conditions
Job No: 1CM029.005 Filename: Fig_ SIRs_Model_BC.pptx	Grassy Mountain Coal Project	Date: Apr. 2018 / Approved: GF / Figure: **24-1**



Depth to Groundwater
- Fringes -
[]
- >250
- 200 ... 250
- 150 ... 200
- 100 ... 150
- 50 ... 100
- 25 ... 50
- 0 ... 25
- -25 ... 0
- < -25

srk consulting

RIVERSDALE RESOURCES

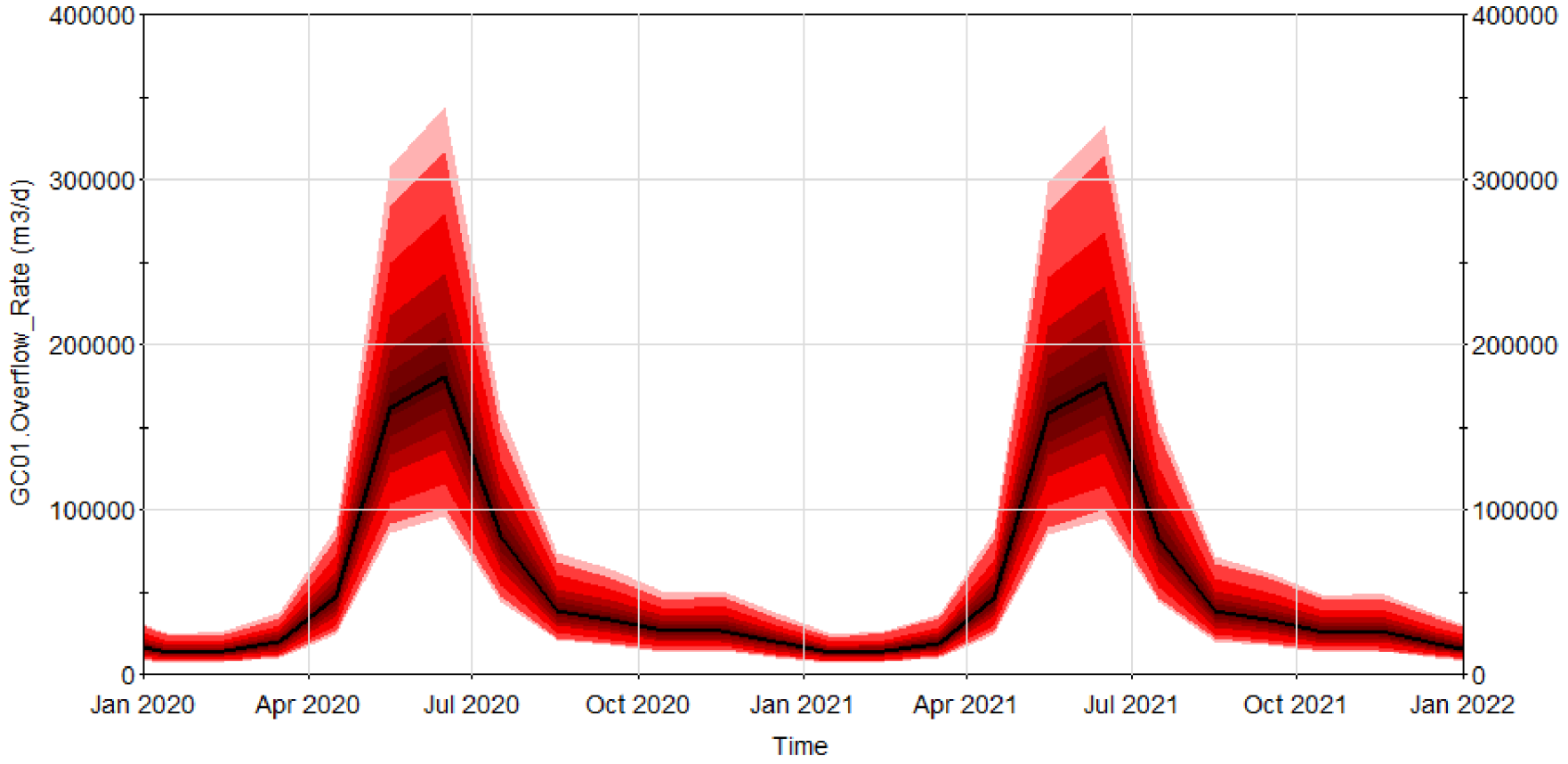
DFO SIRs February 7, 2018

Simulated Depth to Water Table, Baseline

Job No: 1CM029.011
Source: Fig3_ SIRs_DepthGW_Baseline.pptx

Grassy Mountain Coal Project

Date:	Approved:	Figure:
Apr. 2018	GF	**25-1**



Statistics for GC01.Overflow_Rate

Min..1% / 99%..Max
1%..5% / 95%..99%
5%..15% / 85%..95%
15%..25% / 75%..85%
25%..35% / 65%..75%
35%..45% / 55%..65%
45%..55%
50%

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

EXAMPLE OF MONTE CARLO RESULTS:
PROBABILITY DISTRIBUTION OF FLOWS AT GC-01

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
27-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFOFig 27-1 Monte Carlo Results 14-00201.mxd

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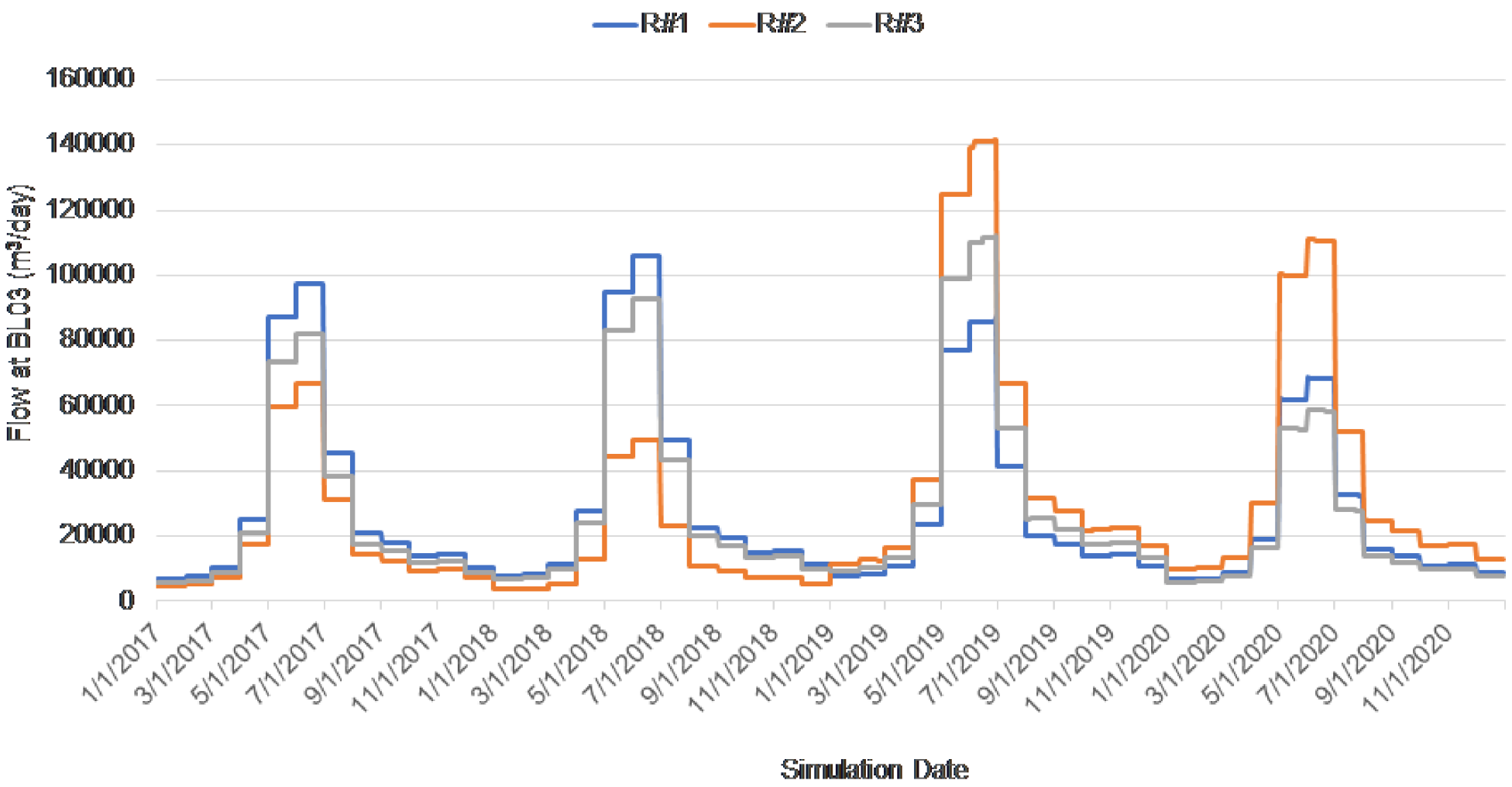

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

EXAMPLE OF STOCHASTIC MODEL ITERATIONS

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 27, 2018
FIGURE	27-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\DFO\Fig 27-2 Stochastic Model Iterations 14-00201.mxd

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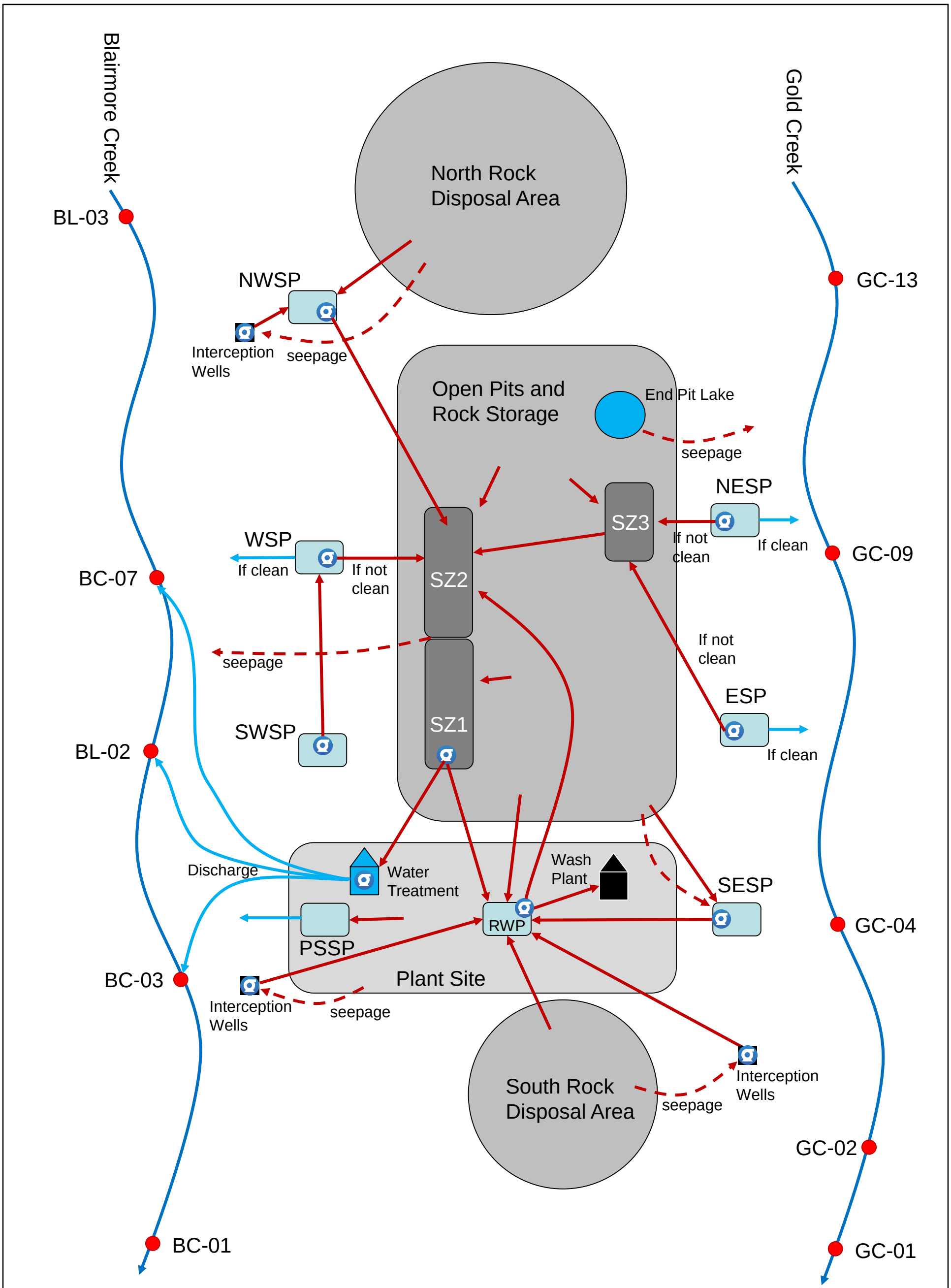
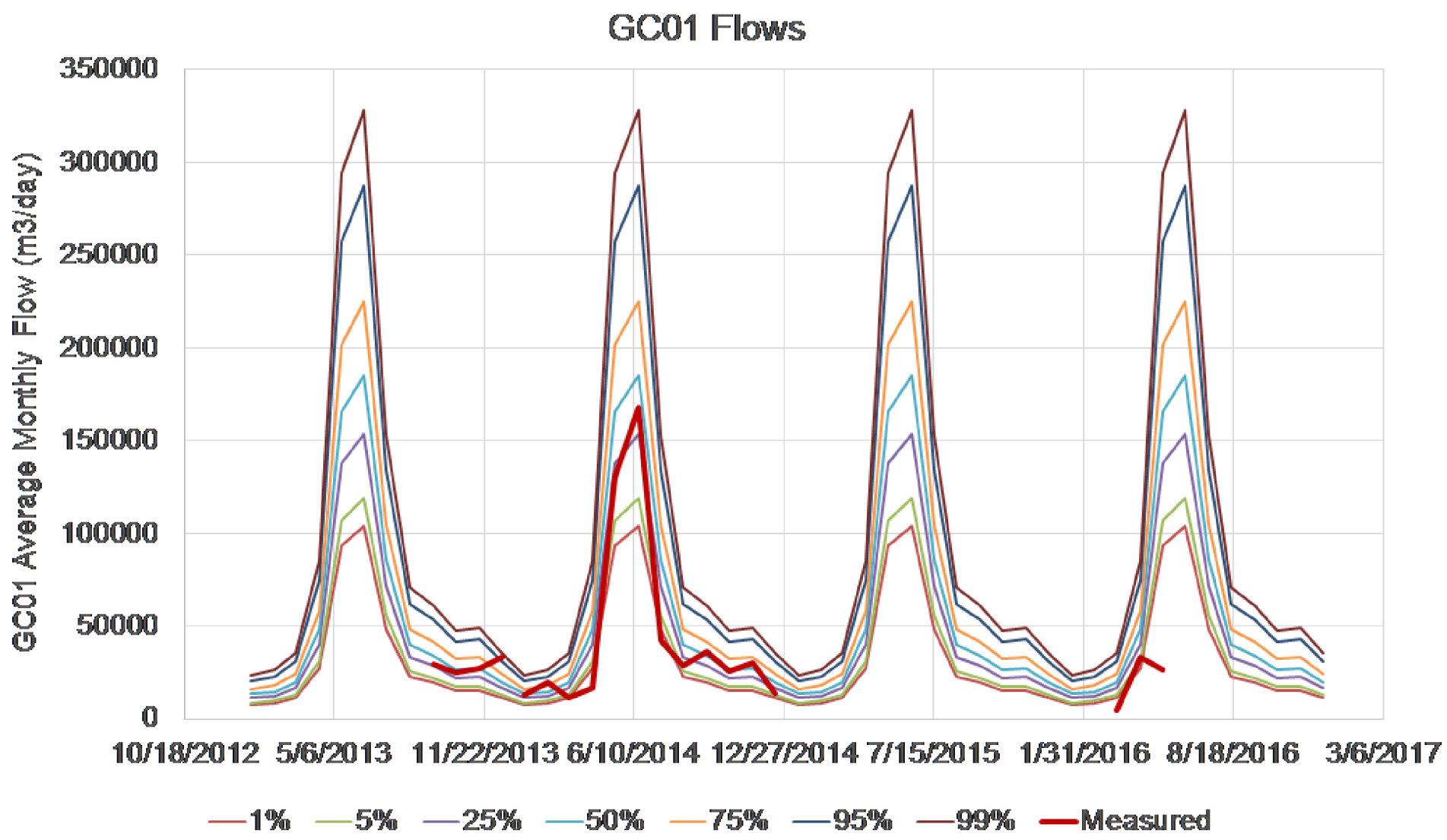


srk consulting	RIVERSDALE RESOURCES	Water Quality Prediction Model
		Grassy Mountain Water Management Schematic (IR# 31)
Job No: 1CB033.000 Filename: Grassy Schematic 20180404.pptx	Grassy Mountain Coal Project	Date: 4 April 2018 / Approved: SRJ / Figure: **IR-31-1**



RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

MEASURED AND MODELLED FLOWS AT GC01

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 27, 2018
FIGURE	33-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIRDFOFig 33-1 Measured Modelled Flow GC01 14-00201.mxd

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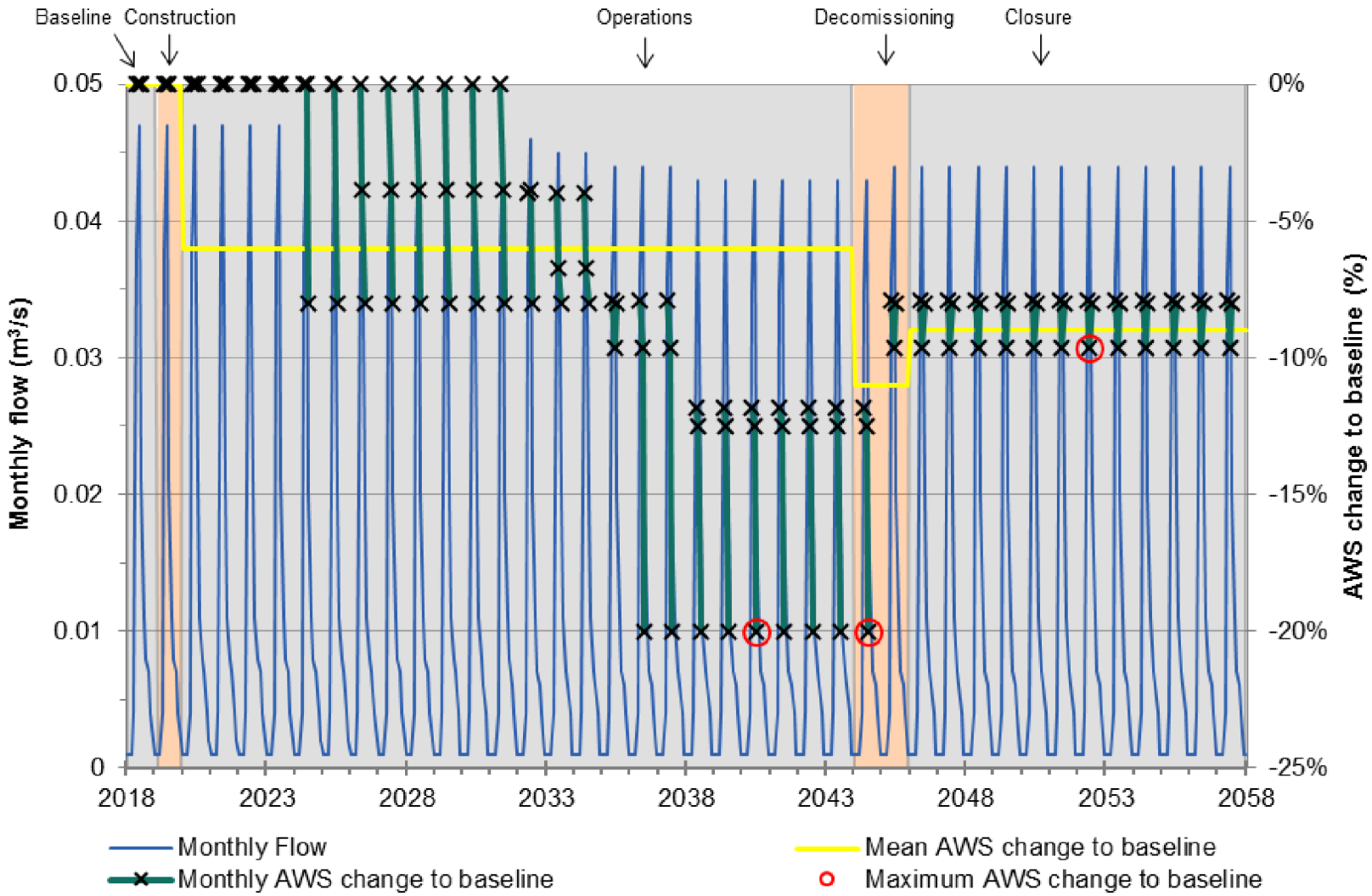

Note: Spawning habitat results are only calculated during May-July each year, although year-round flows are shown for reference. For clarity, closure phase results are abbreviated to 2057 but results are virtually identical between 2046-2058 (shown) and 2058-2100 (not shown). A median year was selected for displaying maximum AWS changes to baseline, during late operations and closure when the same value occurred in multiple years.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

MONTHLY TIME-SERIES OF FLOWS AND LOSSES OF WSCT SPAWNING HABITAT ESTIMATED AT REACH 9 OF GOLD CREEK DURING 1-IN-20 YEAR DROUGHT CONDITIONS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
37-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFOF\Fig 37-1 WSCT Spawning Habitat 14-00201.mxd

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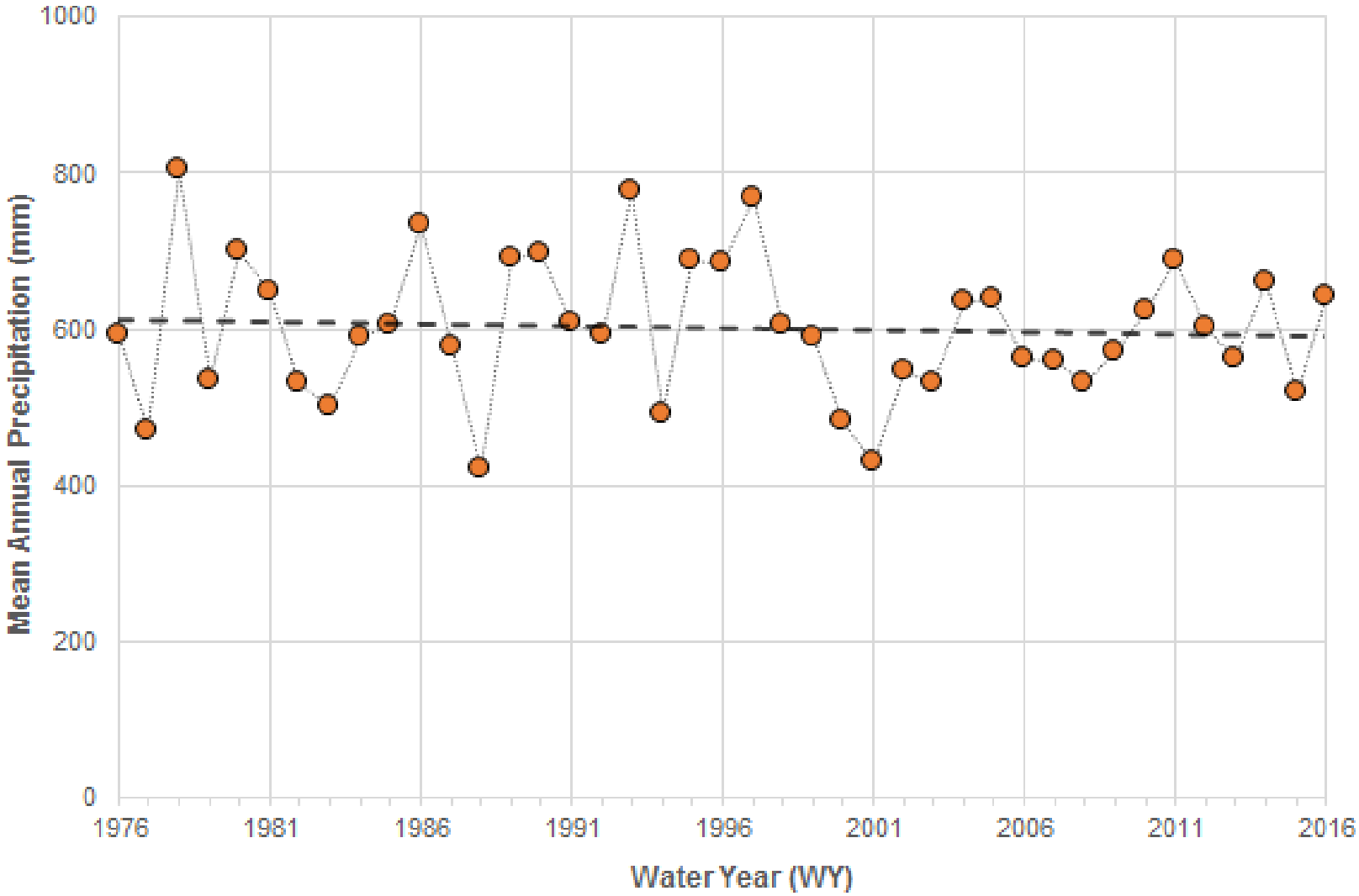

Note: Monthly MAP values obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude), then summed annually on a Water Year timeframe (i.e., 1976 WY = Nov 1975-Oct 1976).

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

ESTIMATED PROJECT AREA MEAN ANNUAL PRECIPITATION, 1976-2016 WY

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 28, 2018

FIGURE
39-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFODFO-39-1 Est Mean Annual Precip 14-00201.mxd

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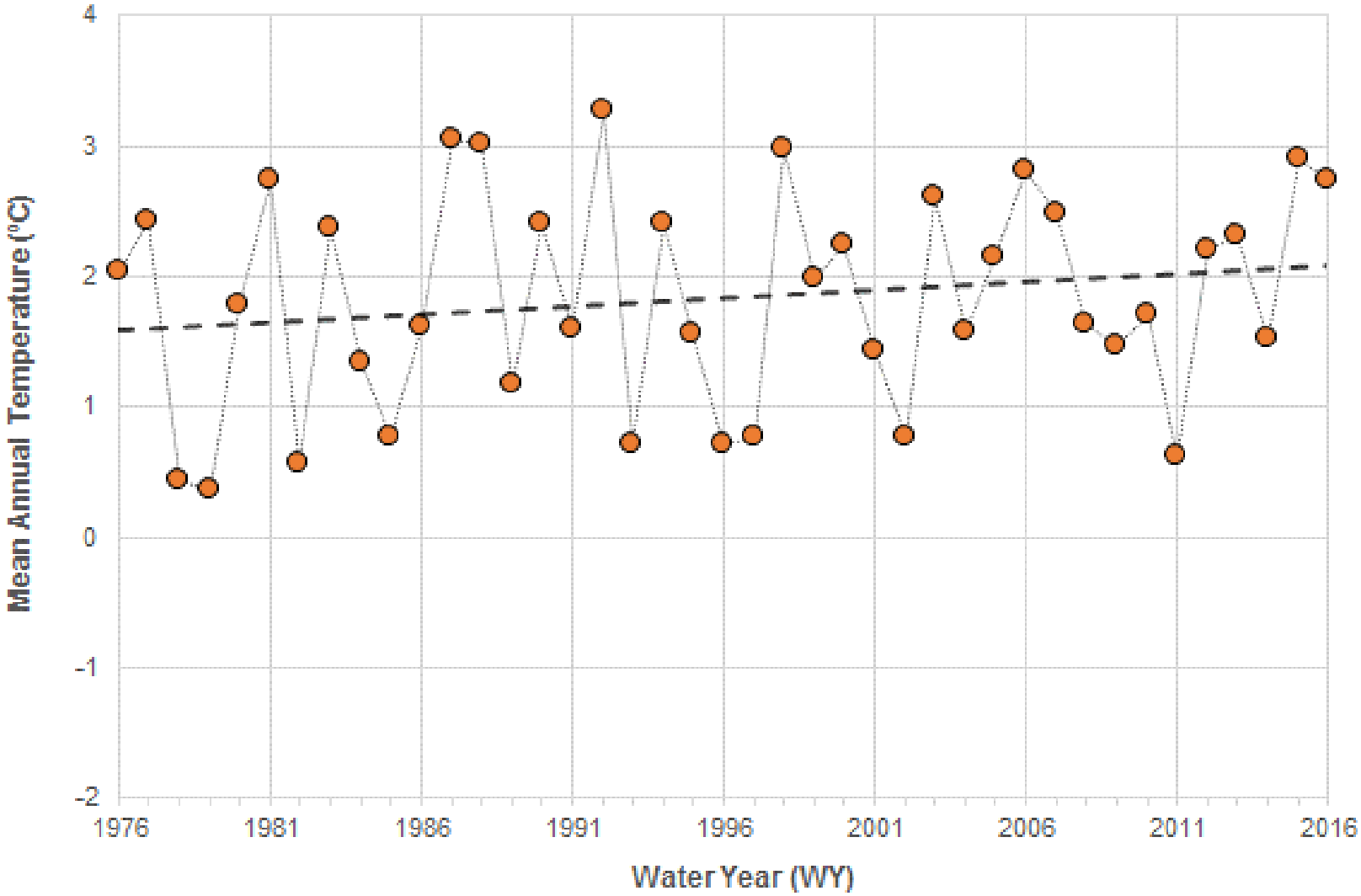

Note: Monthly MAT values obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude), then averaged annually on a Water Year timeframe (i.e., 1976 WY = Nov 1975-Oct 1976).

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

ESTIMATED PROJECT AREA MEAN ANNUAL TEMPERATURE, 1976-2016 WY

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018
FIGURE	39-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFOIDFO-39-2 Est Mean Annual Temp 14-00201.mxd

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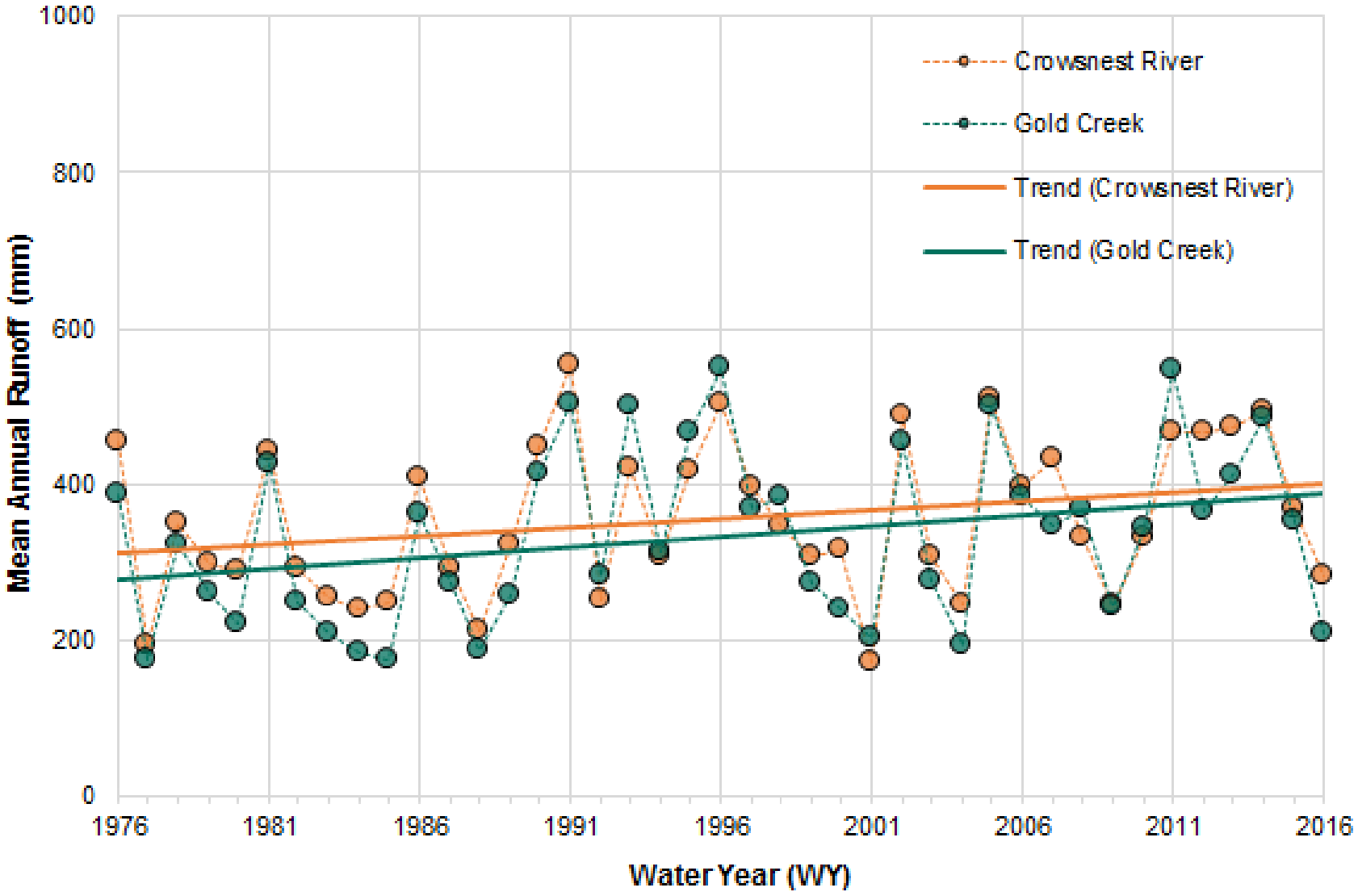

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

ANNUAL RUNOFF AT REGIONAL HYDROMETRIC GAUGES, 1976-2016 WY

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018
FIGURE	39-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\DFODFO-39-3 Annual Runoff 14-00201.mxd

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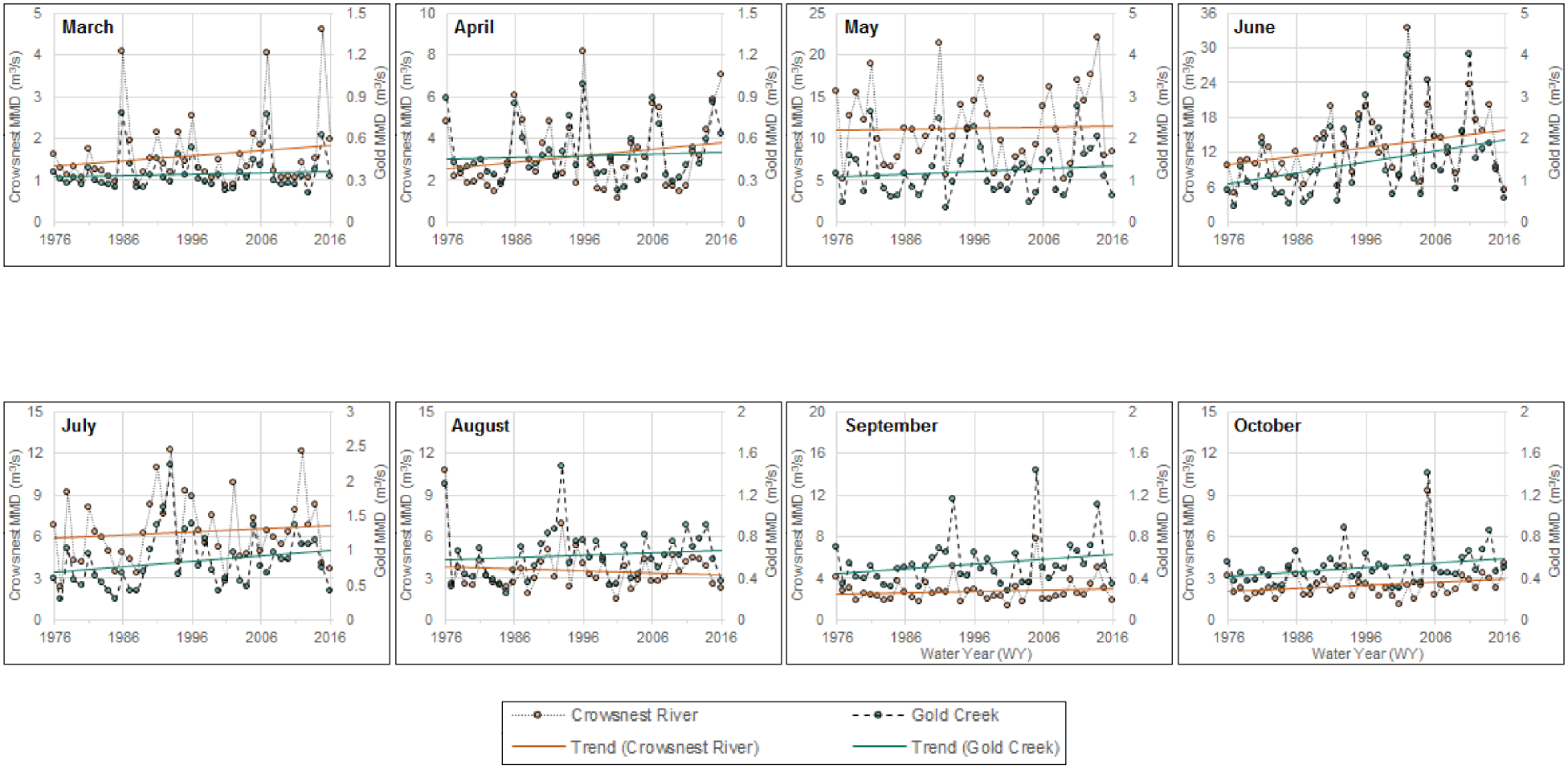

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

MONTHLY MEAN DISCHARGE AT REGIONAL HYDROMETRIC GAUGES, 1976-2016 WY

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018
FIGURE	39-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\DFO\DFO-39-4 Monthly Mean Discharge 14-00201.mxd

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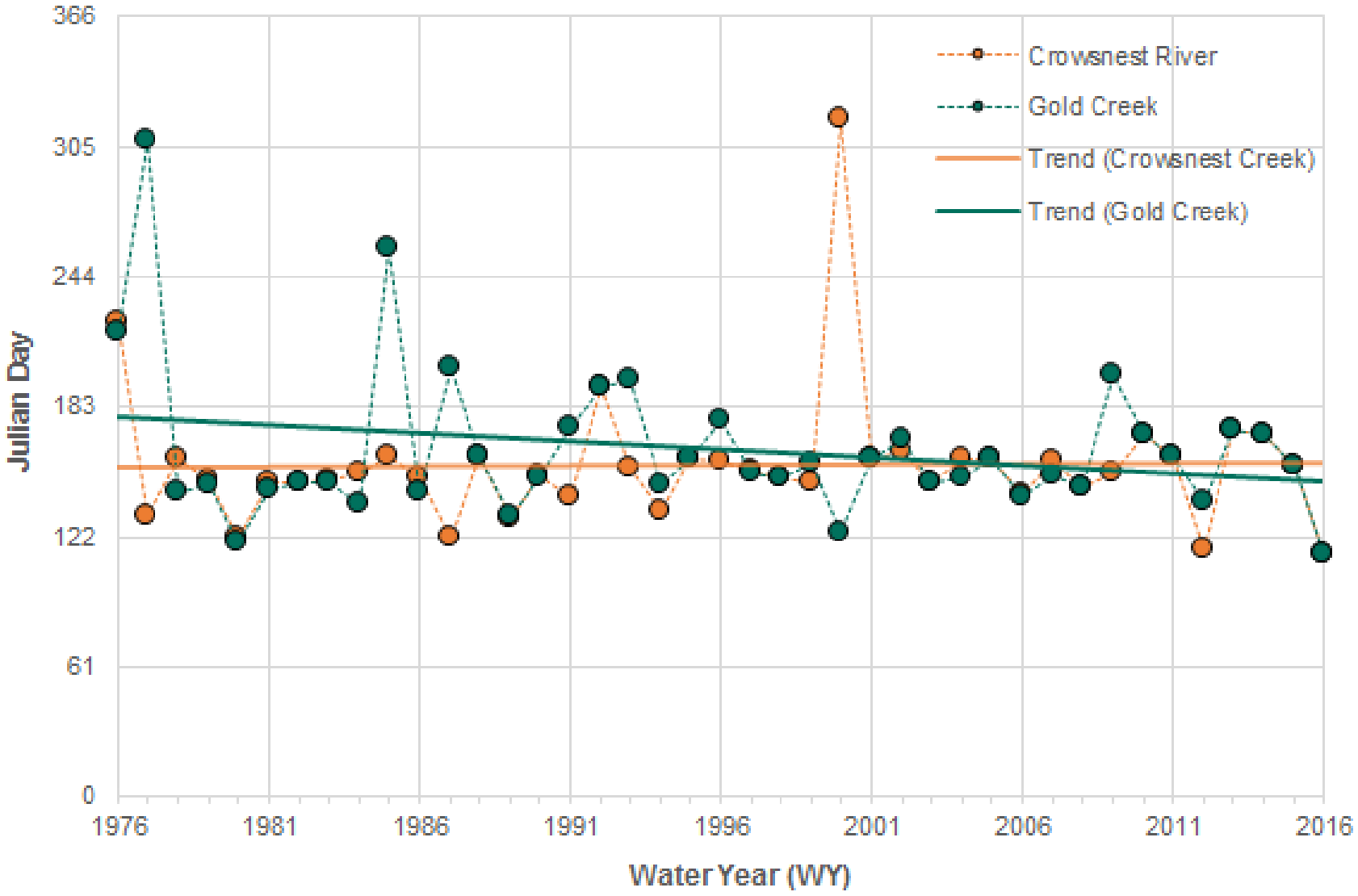

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TIMING OF MAXIMUM DAILY FLOW AT REGIONAL HYDROMETRIC GAUGES, 1976-2016 WY

MEMS, 2018

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018
FIGURE	39-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFODFO-39-5 Timing Max Daily Flow 14-00201.mxd

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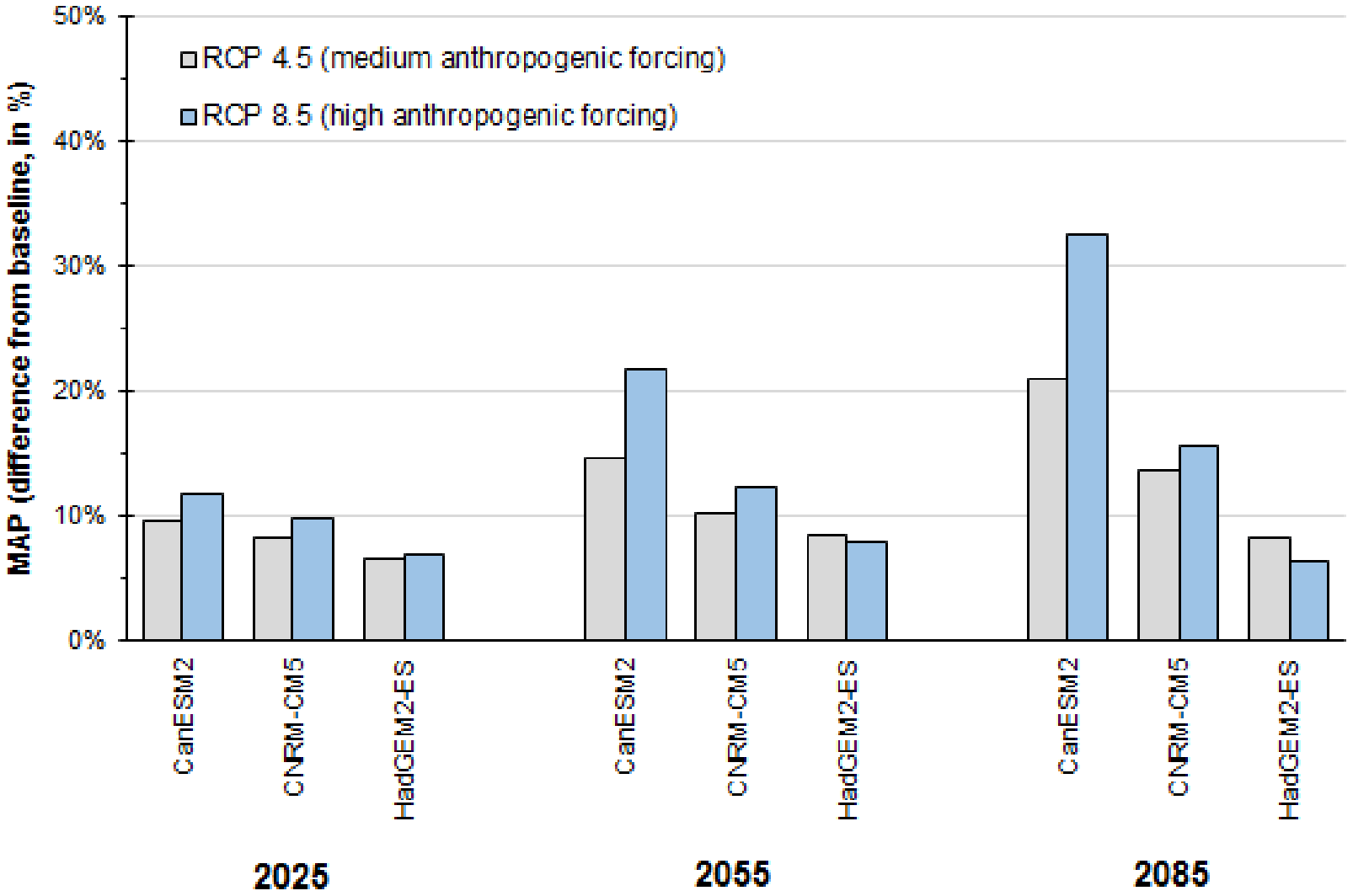

Note: data obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude). Differences shown are relative to the MAP during the 1981-2010 period.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MEAN ANNUAL PRECIPITATION DIFFERENCE FROM BASELINE, MODELLED FOR PROJECT AREA IN 2025, 2055 AND 2085

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018

FIGURE

39-6

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIRDFODFO-39-6 Mean Annual Precip Diff 14-00201.mxd

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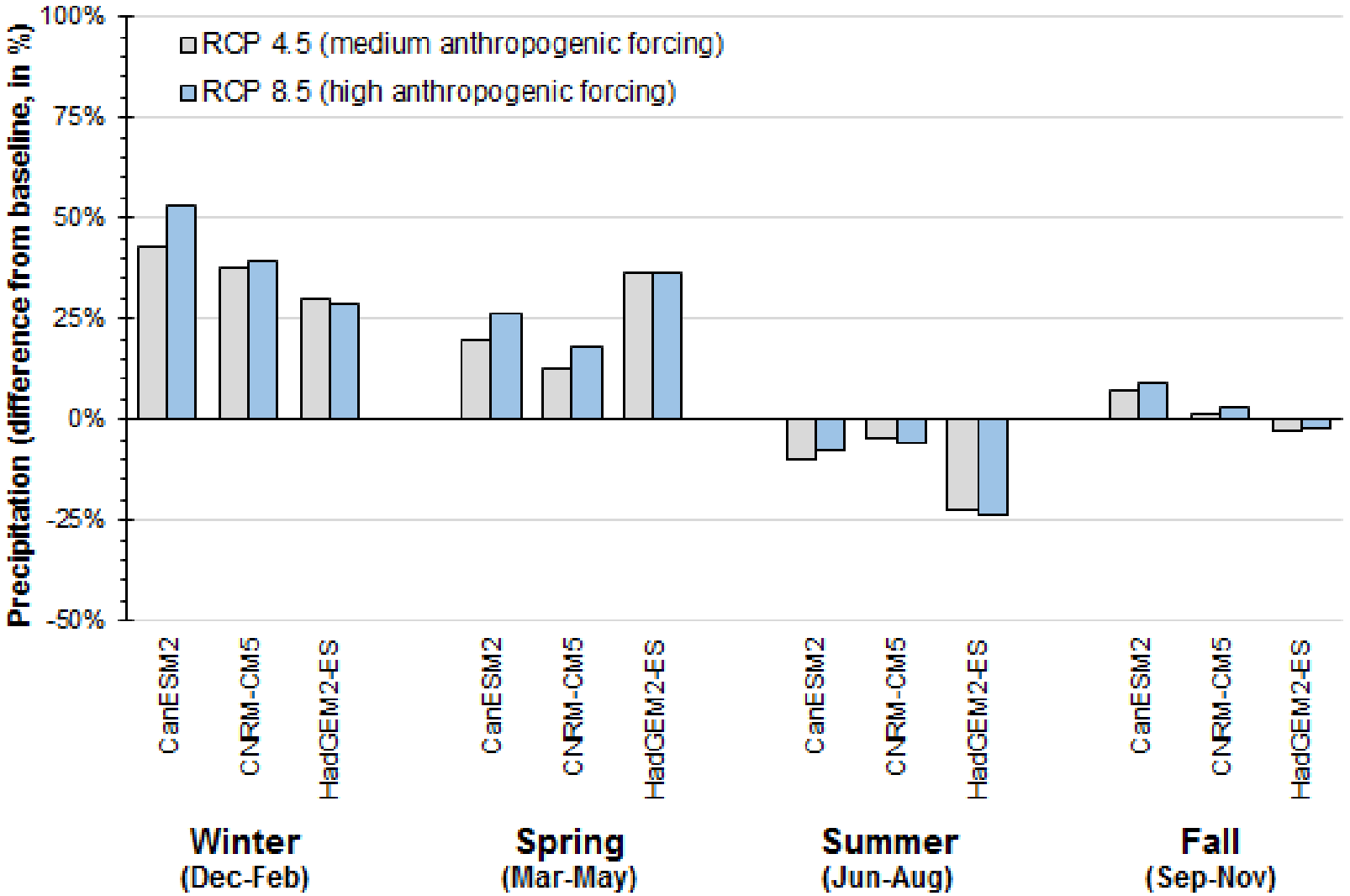

Note: data obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude). Differences shown are relative to the MAP during the 1981-2010 period and averaged for 2025 and 2055 results.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

SEASONAL PRECIPITATION DIFFERENCE FROM BASELINE, MODELLED FOR PROJECT AREA IN 2040

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 28, 2018

FIGURE
39-7

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFODFO-39-7 Seasonal Precip Diff 14-00201.mxd

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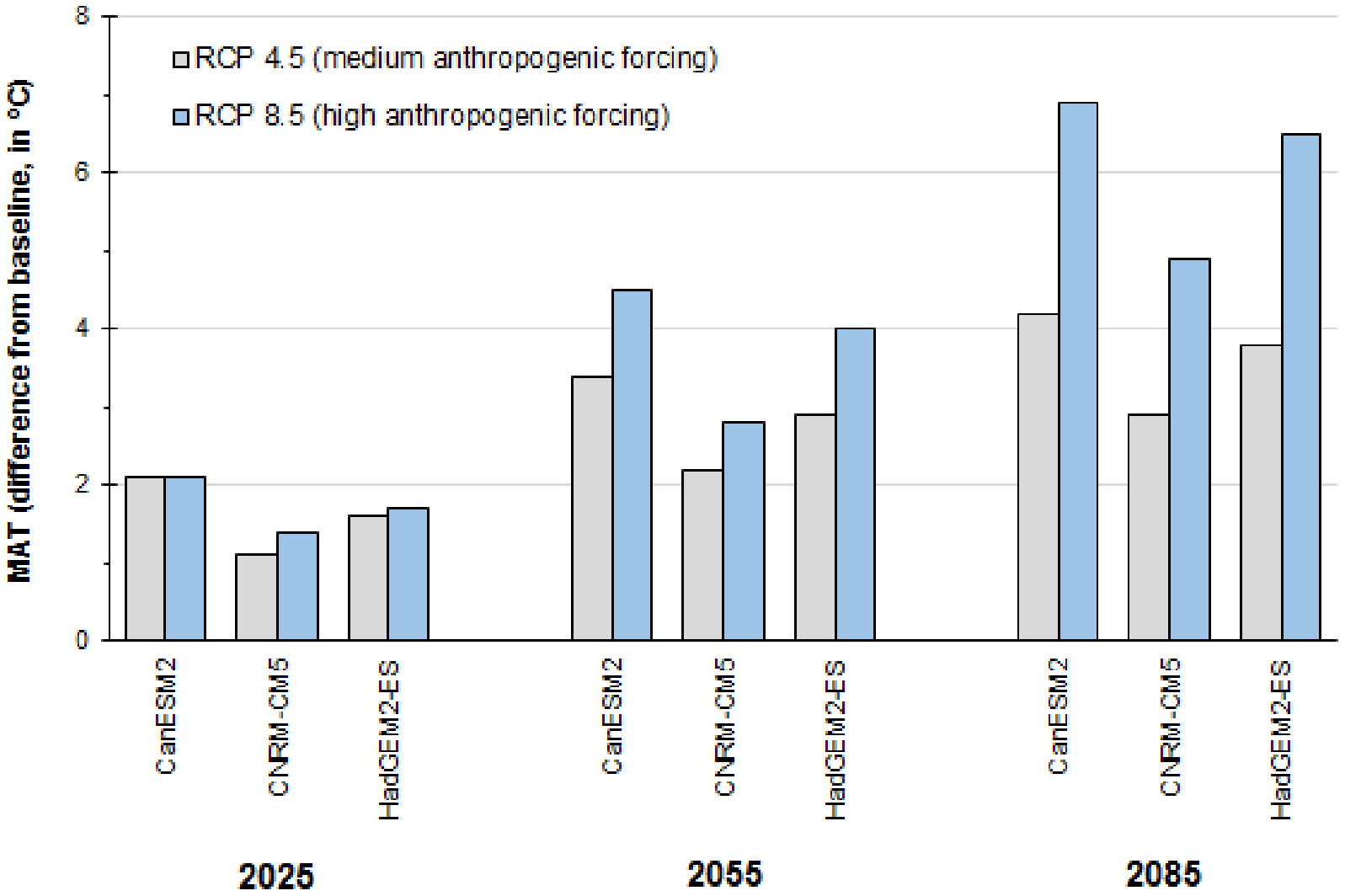

Note:data obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude). Differences shown are relative to the MAP during the 1981-2010 period.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MEAN ANNUAL TEMPERATURE DIFFERENCE FROM BASELINE, MODELLED FOR PROJECT AREA IN 2025, 2055 AND 2085

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 28, 2018
FIGURE	39-8

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIRSDFODFO-39-8 Mean Annual Temp Diff 14-00201.mxd

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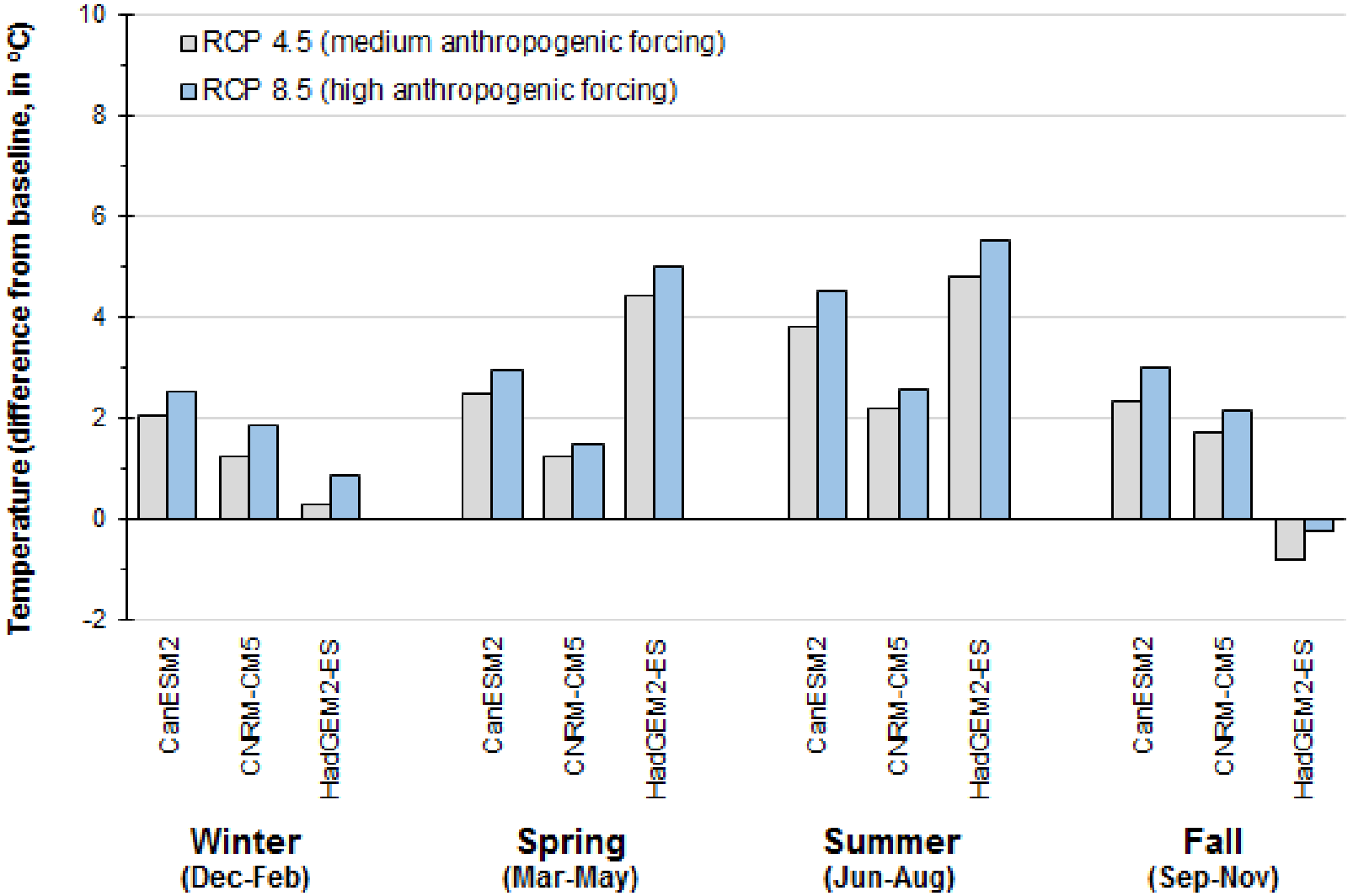

Note: data obtained from ClimateWNA (http://www.climatewna.com/), at the input location of 49.681ºN (latitude), 114.395ºW (longitude). Differences shown are relative to the MAP during the 1981-2010 period and averaged for 2025 and 2055 results.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

SEASONAL TEMPERATURE DIFFERENCE FROM BASELINE, MODELLED FOR PROJECT AREA IN 2040

MEMS, 2018

PROJECT: 14-00201
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CHECKED BY: MB
DATE: APRIL 28, 2018

FIGURE
39-9

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SDFO\DFO-39-9 Seasonal Temp Diff 14-00201.mxd

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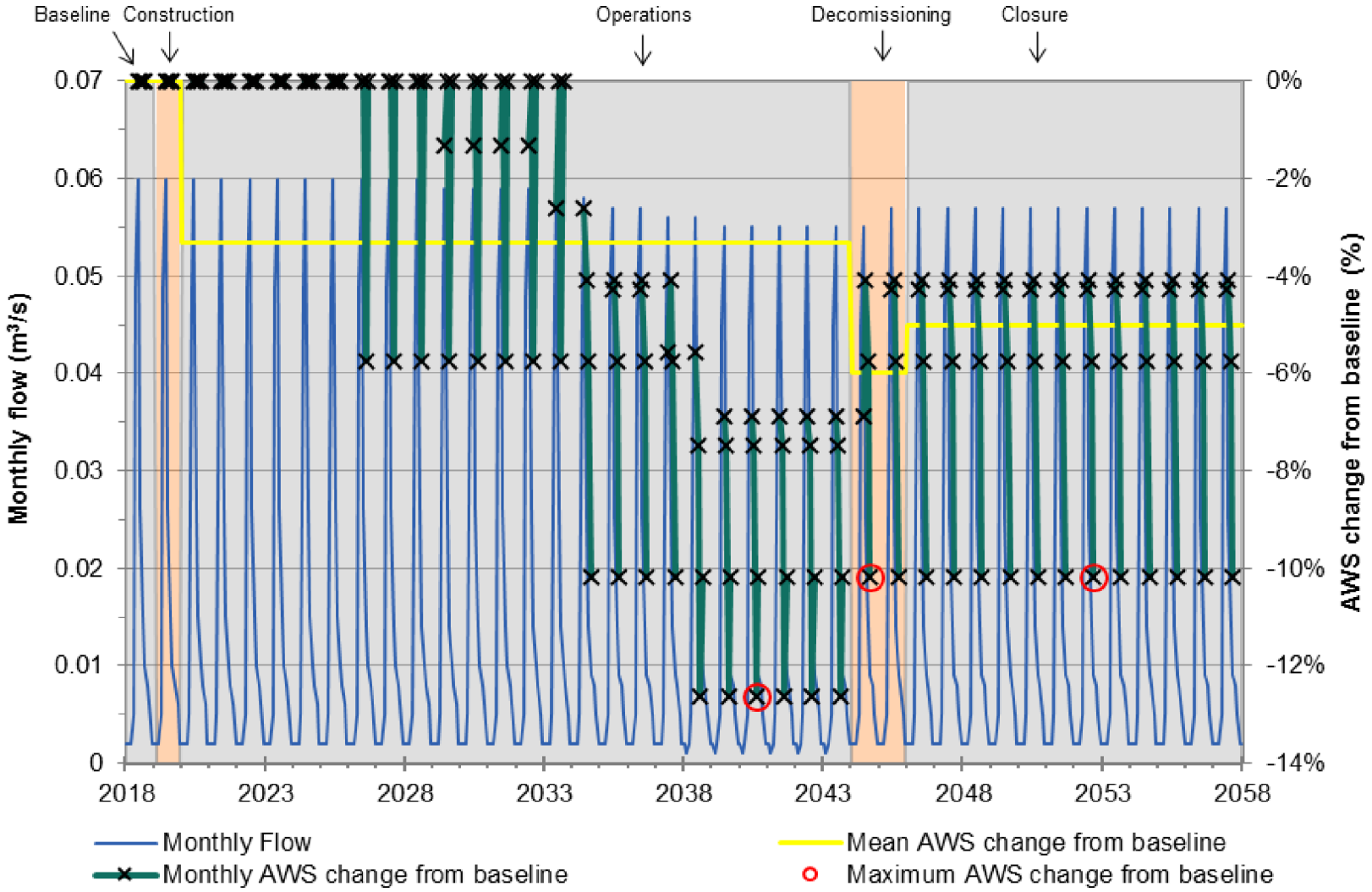

Note: Benthic invertebrate habitat results are only calculated during July-September each year, although year-round flows are shown for reference. For clarity, closure phase results are abbreviated to 2058 but results are virtually identical between 2046-2058 (shown) and 2058-2100 (not shown). A median year was selected for displaying maximum AWS changes to baseline, during late operations and closure when the same value occurred in multiple years.

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

MONTHLY TIME-SERIES OF FLOWS AND LOSSES OF BENTHIC INVERTEBRATE HABITAT ESTIMATED AT REACH 9 OF GOLD CREEK DURING 1-IN-10 YEAR DROUGHT CONDITIONS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
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DATE: APRIL 27, 2018

FIGURE
40-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SIDFOIFig 40-1 Benthic Invertebrate Habitat 14-00201.mxd

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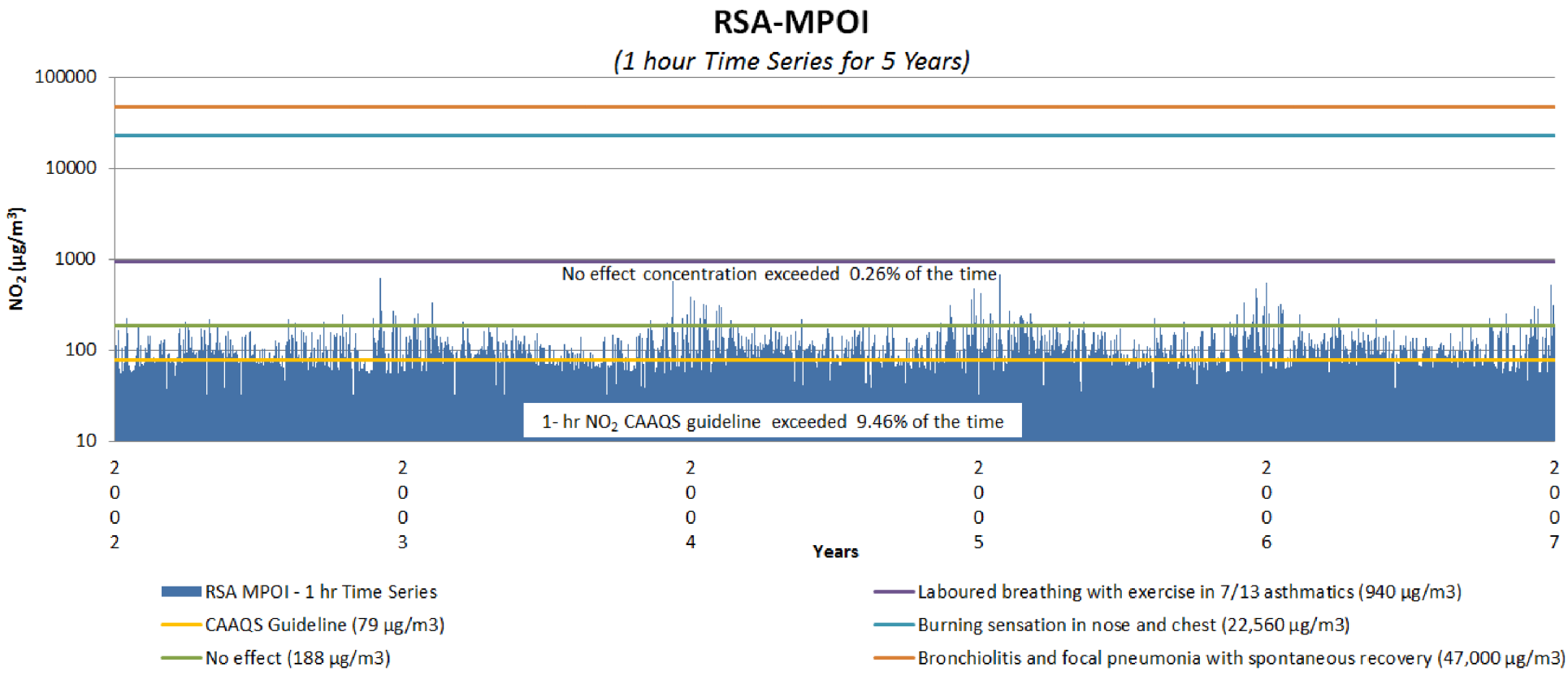
HEALTH CANADA



RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT THE RSA-MPOI FOR 5 YEARS

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	MM
CHECKED BY:	MB
DATE:	APRIL 27, 2018
FIGURE	3-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\Health Canada\Fig 3-1 NO2 RSA-MPOI 14-00201.mxd

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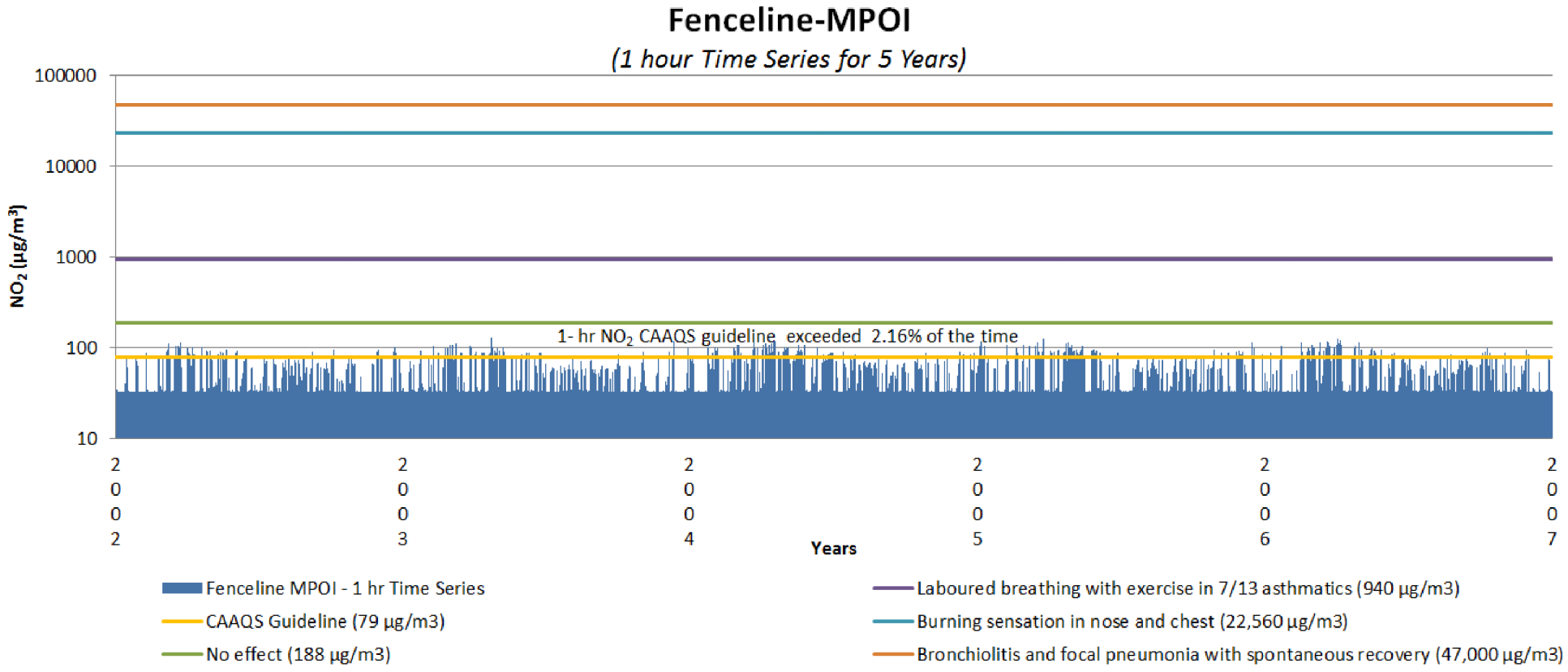

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT THE FENCELINE-MPOI FOR 5 YEARS

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201
DRAWN BY: MM
CHECKED BY: MB
DATE: APRIL 27, 2018

FIGURE
3-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\Health Canada\Fig 3-2 NO2 Fenceline-MPOI 14-00201.mxd

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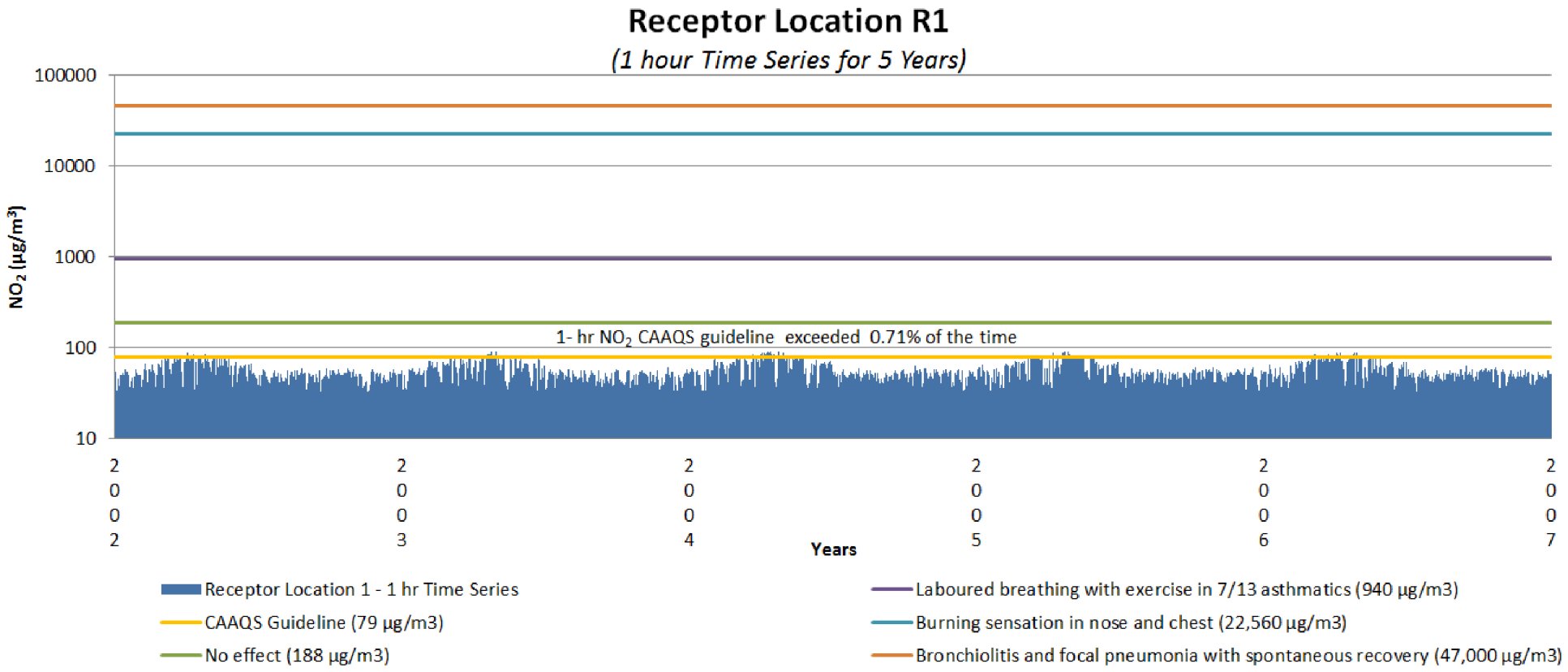

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 1 FOR 5 YEARS

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
DRAWN BY:	MM
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DATE:	APRIL 27, 2018

FIGURE

3-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\Health Canada\Fig 3-3 NO2 Receptor Location 1 14-00201.mxd

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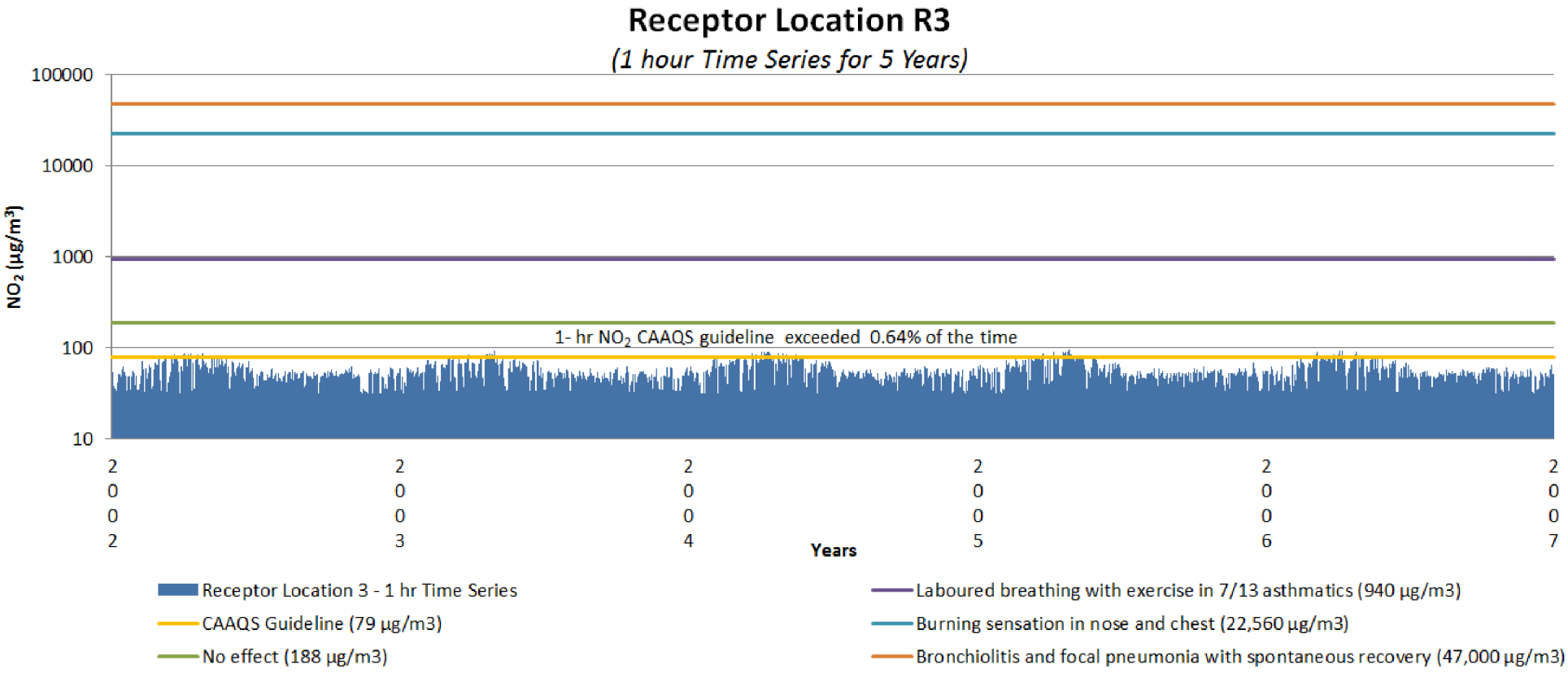

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 3 FOR 5 YEARS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
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DATE: APRIL 27, 2018

FIGURE
3-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\Health Canada\Fig 3-3 NO2 Receptor Location 3 14-00201.mxd

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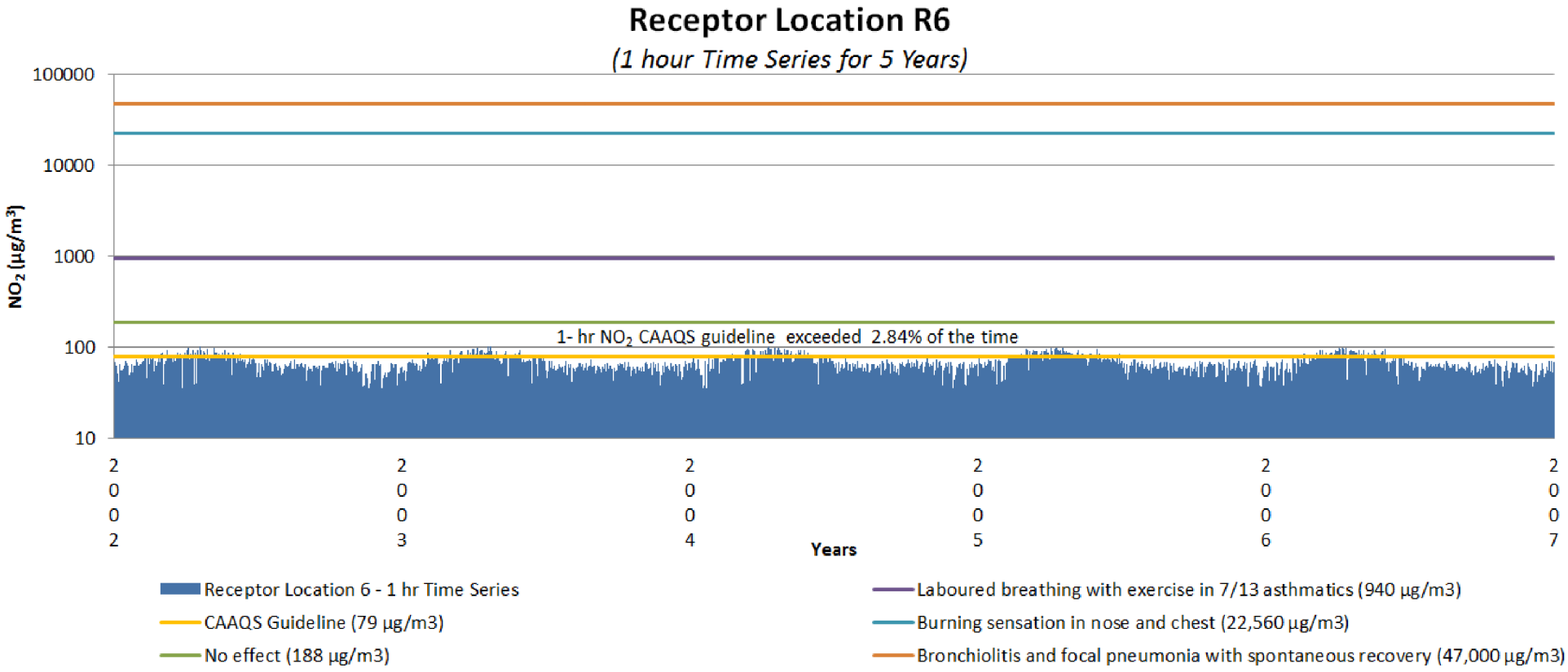

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 6 FOR 5 YEARS

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201
DRAWN BY: MM
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DATE: APRIL 27, 2018

FIGURE
3-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIRS\Health Canada\Fig 3-5 NO2 Receptor Location 6 14-00201.mxd

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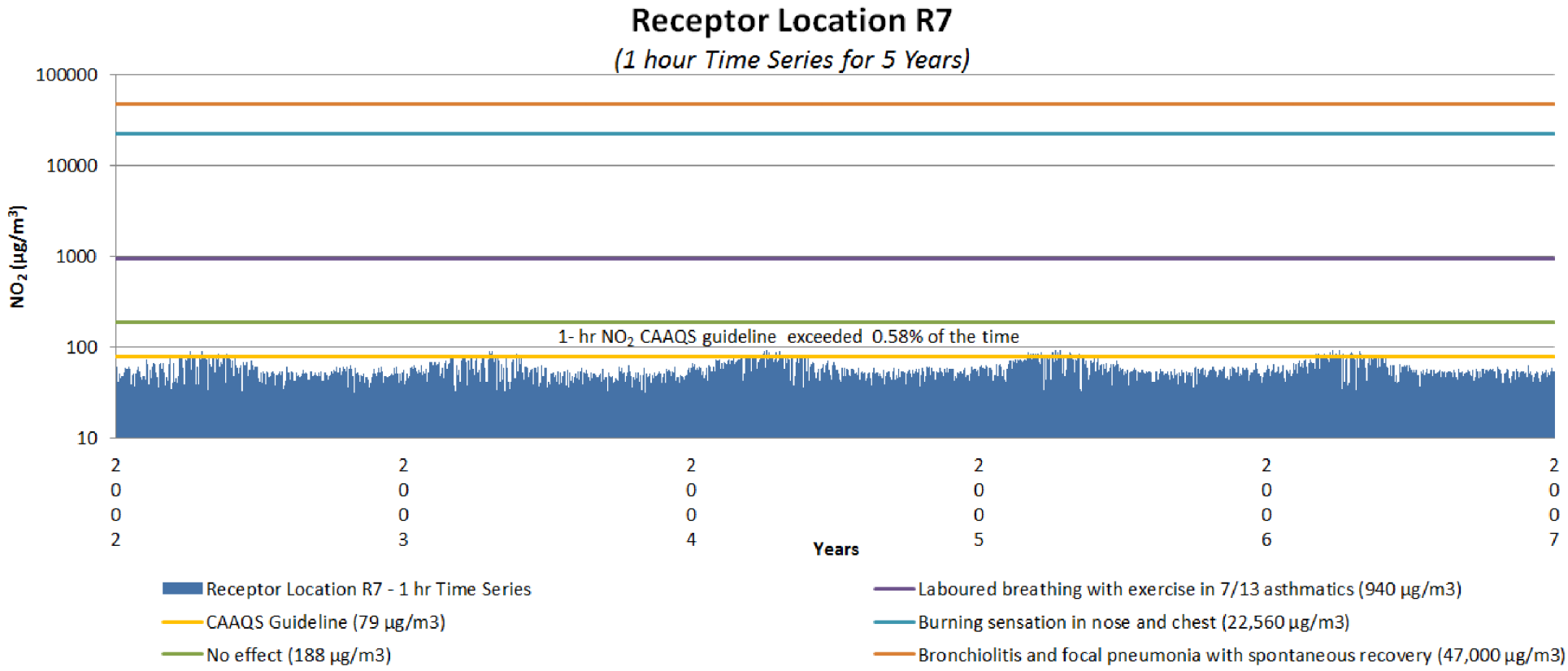

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 7 FOR 5 YEARS

MEMS, 2018

PROJECT: 14-00201
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FIGURE
3-6

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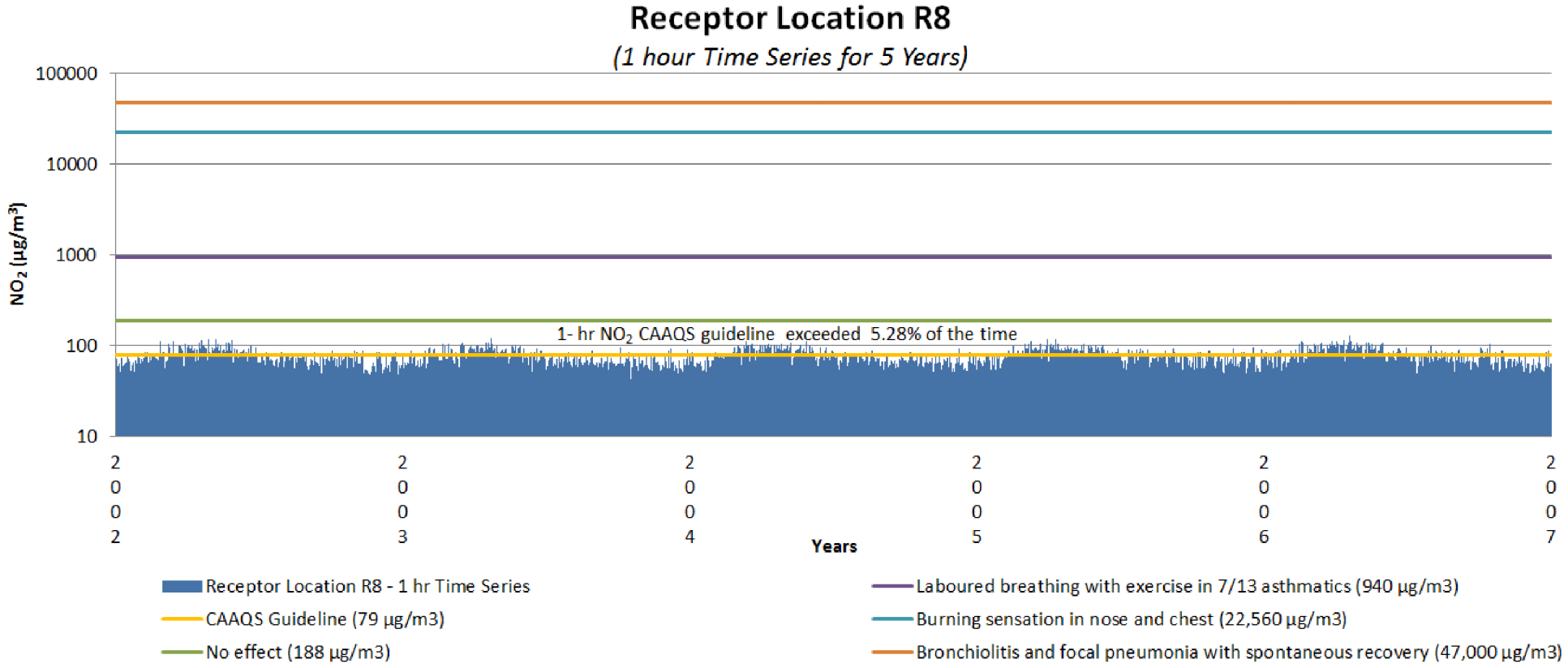

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 8 FOR 5 YEARS

MEMS, 2018

PROJECT:	14-00201
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DATE:	APRIL 27, 2018
FIGURE	3-7

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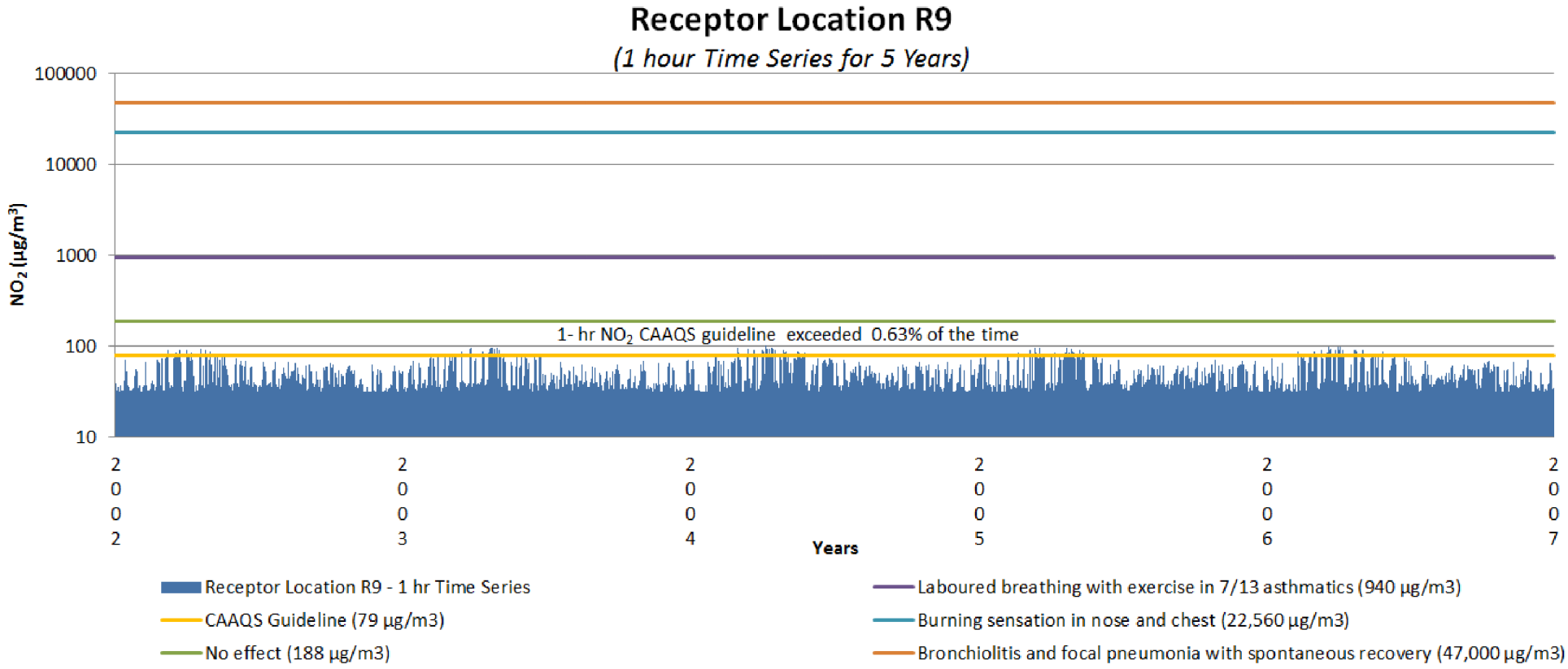

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 9 FOR 5 YEARS

MEMS, 2018

PROJECT:	14-00201
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FIGURE	3-8

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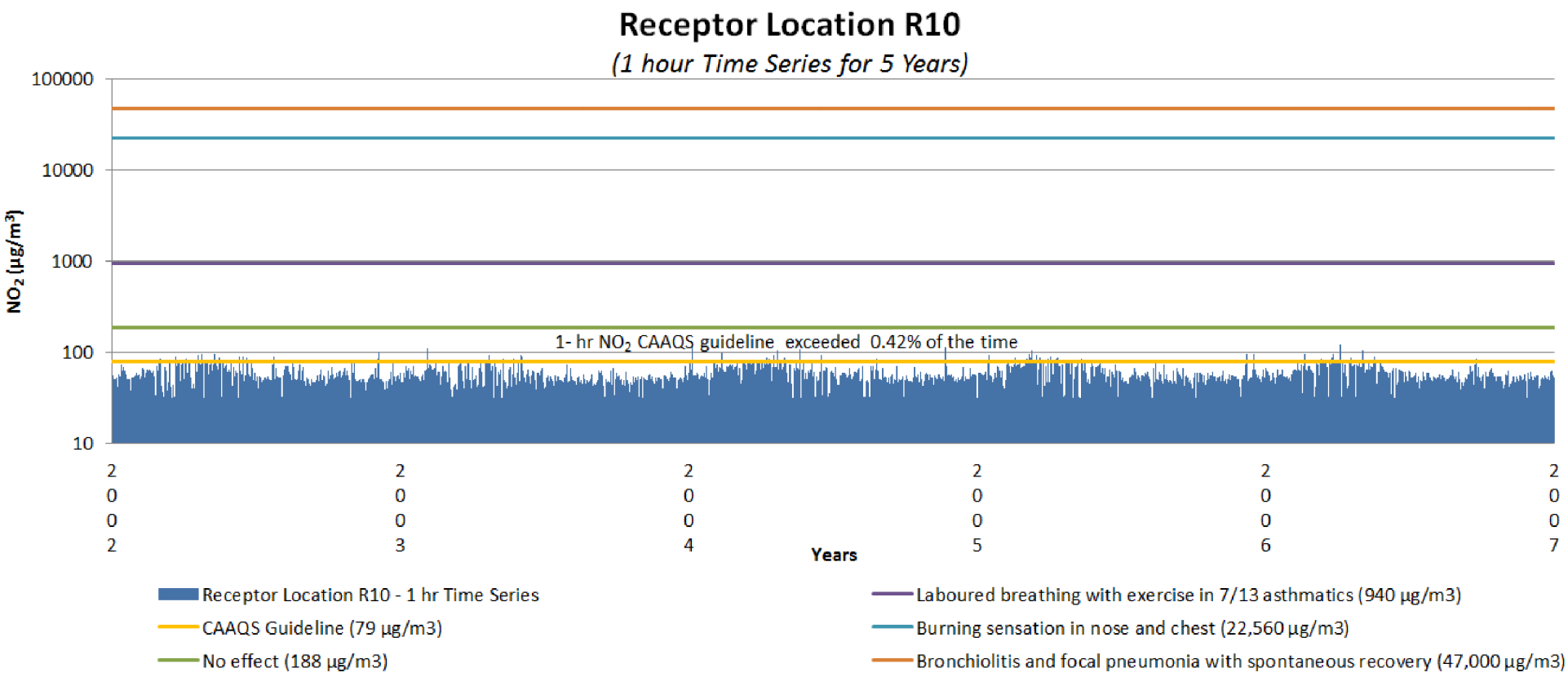

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 10 FOR 5 YEARS

MEMS, 2018

MILLENNIUM EMS Solutions Ltd.

PROJECT:	14-00201
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DATE:	APRIL 27, 2018
FIGURE	3-9

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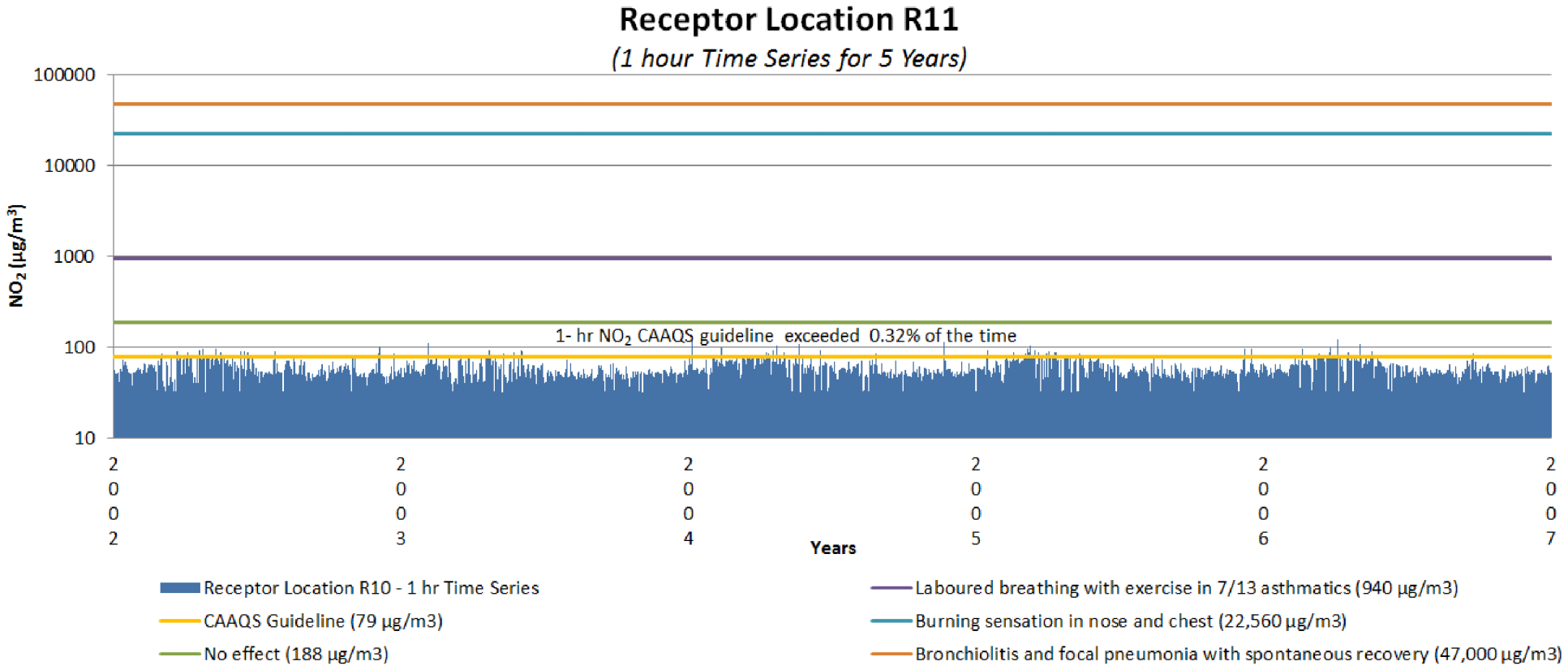

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 11 FOR 5 YEARS

MEMS, 2018

PROJECT:	14-00201
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DATE:	APRIL 27, 2018
FIGURE	3-10

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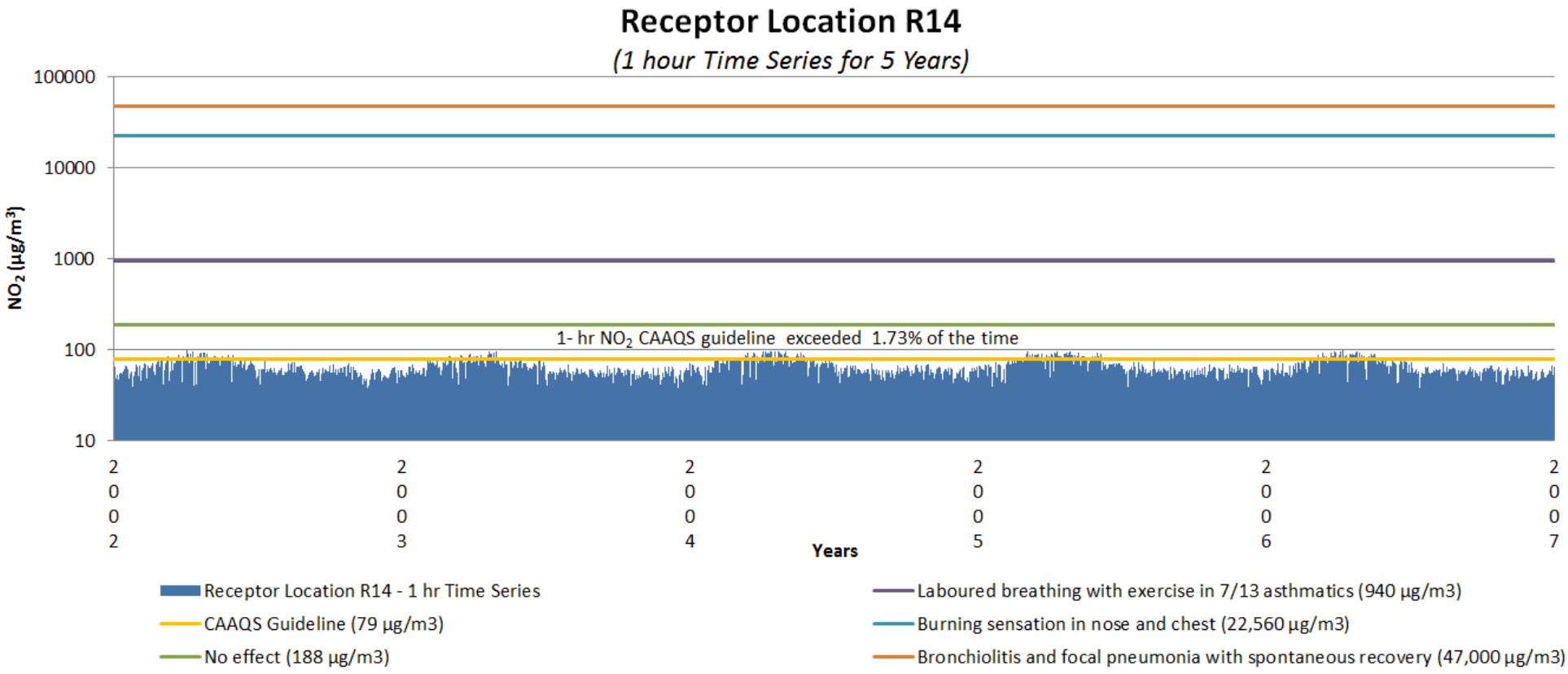

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

1-HOUR NO_2 (µG/M^3) TIME SERIES DATA AT RECEPTOR LOCATION 14 FOR 5 YEARS

MEMS, 2018

PROJECT: 14-00201
DRAWN BY: MM
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DATE: APRIL 27, 2018

FIGURE
3-11

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APPENDIX A-1: BAT HIBERNACULA REPORT

Grassy Mountain Coal Project

CEAA Additional Information Request - Bat Hibernacula

14-00201-06
February 2018

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1.0 INTRODUCTION

A discussion of the bat species community along with an impact assessment for little brown myotis (*Myotis lucifugus*) was provided as part of the Grassy Mountain Coal Project's (the Project) Environmental Impact Assessment (EIA), submitted to the Alberta Energy Regulator (AER) and the Canadian Environmental Assessment Agency (CEAA) on August 12, 2016 and in an Addendum 1 to the EIA submitted to AER and CEAA on January 31, 2017.

In response to additional information requests from CEAA (December 05, 2016 and May 16, 2017; AIR #'s 13 and 5, respectively), in June 2017, Benga Mining Ltd (Benga) initiated a wildlife field program to identify potential areas within the Project's proposed Mine Permit Boundary (MPB) that may provide suitable areas for *M. lucifugus* hibernacula. This program was initiated in part during a teleconference between Environment and Climate Change Canada (ECCC), Benga, and Millennium EMS Solutions Ltd. (MEMS) on April 27, 2017, during which it was agreed that Benga would conduct fall swarming surveys for *M. lucifugus* to determine whether potential hibernacula sites are identified in the MPB. The purpose of this report is to provide the methods and results of this swarming program.

2.0 RECONNAISSANCE SURVEYS

Prior to conducting swarming surveys, a desktop review of *M. lucifugus* hibernacula requirements was completed, locations with potential to have suitable hibernaculum conditions were identified, and reconnaissance field-verification of potentially suitable hibernaculum locations was conducted.

2.1 Desktop Review

The desktop review was conducted to:

- determine the requirements for *M. lucifugus* hibernacula relevant to the Project; and,
- determine the locations within or immediately adjacent to the Project's MPB that may provide suitable hibernation conditions for *M. lucifugus*.

Publicly available resources were reviewed to establish benchmarks for characteristics required for *M. lucifugus* hibernacula in southwestern Alberta. Locations with the following characteristics are the most suitable for *M. lucifugus* hibernacula in the region of the Project:

- stable temperature within the range of 2°C to 10°C and relative humidity of >80% during the winter hibernation period (OMNR 1984, Environment Canada 2015);
- sheltered from extreme weather (OMNR 1984); and
- minimal/no human presence and protected from predators (WDNR 2013).

The MPB occurs on often-steep mountainous terrain with large areas previously disturbed by mining, and without known karstic formations. The types of locations that would best provide the above-mentioned hibernacula requirements include (OMNR 1984, Johnson *et al.* 2006, WDNR 2013, Environment Canada 2015, ACA 2016, Brigham 2017 (pers.comm.):

- abandoned underground mine infrastructure (*e.g.*, shafts, tunnels);
- caves on rock faces; and
- deep cracks or crevices on rock faces.

The presence of hibernacula at 1,890 masl (Cadomin Cave opening) and up to 2,438 masl (in nearby Montana, MNHP 2013) indicate that there are unlikely to be elevation limitations to hibernacula on Grassy Mountain (~2,040 masl at its current peak).

Locations in or adjacent to the MPB that may provide suitable conditions for *M. lucifugus* hibernacula were initially determined using aerial imagery and knowledge of the landscape, geological features, and locations of historical mining.

2.2 Reconnaissance Field Investigations

The reconnaissance field survey was conducted to ground-verify potentially suitable hibernaculum locations to determine whether the required conditions may occur at the locations identified from the desktop review.

The 43 locations indicated on Figure 1 were visited by a qualified wildlife/bat biologist to discern the likelihood of each to be a potential *M. lucifugus* hibernaculum. The results of the ground-verification survey are summarized in Figure 1 and Table 1. The actual potential for a site to be a hibernaculum is not possible to determine during the summer months; therefore, relative potential (relative to other areas surveyed) was determined.

Of the 43 sites visited, eight sites and four sites were deemed to have high and high-moderate potential, respectively, for providing suitable conditions for *M. lucifugus* hibernation (Figure 1, Table 1). These sites are associated with abandoned legacy mine infrastructure that may have exposed pipes or tunnels, and rock faces with tunnels/cracks/crevices large enough for *M. lucifugus* to fly into.

Twenty sites were deemed to have moderate relative potential for providing suitable conditions for *M. lucifugus* hibernation (Figure 1, Table 1). These sites were not characterized as having high potential due to either being too narrow for *M. lucifugus* to fly into, consisting of crumbly rock unlikely to provide a stable high-quality environment, or having insufficient depths to protect

hibernating bats from exposure to cold temperatures. All moderate sites are large enough for *M. lucifugus* to easily crawl into.

Ten sites were rated as having low relative potential and one site as having moderate-low potential for providing suitable conditions for hibernating *M. lucifugus* (Figure 1, Table 1). These sites either did not contain cracks or other required features, provide features deep enough for hibernacula, or have locations thought to protect hibernacula from winter conditions.

Due to the nature of the mountainous landscape with an abundance of exposed rock faces and high cliffs, it is not possible to observe or assess every crack or rock opening within or adjacent to the MPB. Benga believes that the preliminary desktop and ground verification surveys were of a sufficient effort to identify all abandoned mine sites and the most probable rock features (*i.e.*, opening, cracks, crevices) for *M. lucifugus* hibernacula within or adjacent to the MPB.

Table 1 Summary of Ground Verification Survey Results		
Site	**Relative Hibernaculum Potential**	**Characteristics**
Mine Sites		
M1	High	Old mine infrastructure with 20-cm pipe (unobstructed opening is about 12 cm) entering/exiting closed off mine portal at ground level. Unknown depth.
M2-1	High	Abandoned, rotting wooden mine structure with a tunnel (5 cm x 20 cm; unknown depth) at the back.
M2-2	High	30 cm x 30 cm shaft going downwards at 45°. Close to the opening for the legacy mine. Cool air observed to flow out.
M2-3	High	A deep diagonal crack (20 cm x 120 cm) in the rock about 3 meters above M2-2. Moss growing inside; unknown depth.
M2-4	High	8 cm x 12 cm opening in the rock near an abandoned, closed off mine portal; unknown depth.
M3	High	180 cm x 180 cm opening to an abandoned mine portal; steep shaft goes down to an unknown depth.
Mountain Ridge Sites		
R1-1	Moderate	Opening located under a rock overhang, 3 cm x 6 cm tunnel curves down beyond view. Unknown depth.
R1	Moderate	Hole in the rock about 15 cm across, with 5 cm x 5 cm tunnel going up. Located under the overhang of a horizontal crack; unknown depth.
R1-3	High-Moderate	8 cm x 30 cm diagonal crack behind a tree near ground level; unknown depth
R1-4	Low	5 cm x 15 cm cave in horizontal crack; 80 cm depth.
R1-5	Moderate	20 cm x 5 cm horizontal crack under boulder angling upwards in a steep slope; unknown depth.
R1-6	Moderate	Vertical crack 6 cm wide x 100 cm high; unknown depth.
R1-7	High-Moderate	Deep crack (8 cm x 15 cm); unknown depth.
R2	Low	Rock faces are crumbly and unstable; no potentially suitable cracks, crevices, or openings were observed.
R3	Moderate	20 cm x 200 cm vertical crack in crumbly rock; unknown depth.
R4-1	Moderate	25 cm x 10 cm crack near the very top of the ridge; 300 cm deep.

Table 1 Summary of Ground Verification Survey Results

Site	Relative Hibernaculum Potential	Characteristics
R4-2	High	Diagonal crack with 20 cm x 20 cm tunnel inside; unknown depth.
R5a-1	Moderate	3 cm x 6 cm horizontal tunnel; unknown depth.
R5a-2	Moderate	3 cm x 20 m vertical crack that angles down to unknown depth.
R5a-3	High	Small opening 50 cm x 25 cm. At the back of the opening there is a 10 cm x 25 cm vertical crack of unknown depth. There is a vertical crack above this opening that cannot be accessed.
R5a-4	Moderate-Low	Shallow opening with two cracks (3 cm to 5 cm wide); unknown depth.
R5a-5	High-Moderate	Horizontal crack (20 cm high) of unknown depth.
R5b-1	Moderate	Triangular-shaped hole (15 cm x 5 cm) going up in the rock at a 45° angle; unknown depth.
R5b-2	Moderate	3-metre vertical crack (5 cm wide) with overhang. Many fissures inside the crack.
R5b-3	Low	Four bats found inside 2 cm x 10 cm crack (summer roost), located 20 cm above small ledge, the ledge is 2 metres off the ground. This roost is too shallow to offer potential for hibernation.
R5b-4	Moderate	Horizontal crack 1.5 m above summer roost (R5b-3). 5 cm high with protective overhang.
R5b-5	Moderate	Two openings 1.5 meters apart. One is a 5 cm x 5 cm tunnel going up beyond view; unknown depth. The other is a 3 cm x 200 cm vertical crack that goes deep in the rock in some places; unknown depth
R5b-6	Low	Hole 30 cm across with 3 cm x 3 cm crack inside that goes up; unknown depth. Position at the top of the cliff would make this feature unsuitable for hibernation due to exposure from the top.
R6-1	Moderate	3 cm x 3 cm hole going down at a 45° angle; unknown depth.
R6-2	Moderate	4 cm x 5 cm horizontal “tunnel” with moss growing deep inside; unknown depth.
R6-3	Moderate	10 cm x 6 cm hole at ground level under the rock face, angling down and left. Some moss growing inside; unknown depth.

Table 1 Summary of Ground Verification Survey Results		
Site	**Relative Hibernaculum Potential**	**Characteristics**
R7	Low	Weathered sandstone cliff with surface cracks. No potential hibernacula features observed.
R8-1	Moderate	Hole in the rock, about 30 cm across, with 2 cm x 7 cm crack at the back, turning at right angle; unknown depth.
R8-2	Moderate	Shallow opening facing east, 50 cm across, with 2 cm x 5 cm crack inside; unknown depth.
R8-3	Low	Diagonal 3-cm wide crack with slab on top; unknown depth but unlikely to go very deep.
Sandstone Cliffs along Blairmore Creek		
BC1-1	Low	Network of cracks, up to 4 cm x 10 cm. Unknown depth but likely not deep based on rock characteristics.
BC1	Moderate	5 cm x 15 cm vertical crack; unknown depth.
BC2	High-Moderate	15 cm x 15 cm tunnel going horizontal into the rock then turns left out of view, unknown depth.
BC3	Low	Crumbly mudstone cliffs. No suitable hibernaculum features observed.
BC4	Low	Rock outcroppings with superficial cracks.
BC5	Low	Sandstone with superficial cracks.
BC6-1	Moderate	4 cm x 10 cm vertical crack under an overhang; unknown depth.
BC6-2	Moderate	5 cm x 10 cm vertical crack with a lot off moss around the entrance; unknown depth.

3.0 SWARMING SURVEYS – METHODS

Bats, including *M. lucifugus*, may swarm prior to or during the fall migration period at locations at or near hibernacula. For this reason, Environment Canada (2015) has indicated that swarms may be an indicator of locations where hibernacula occur. Swarming surveys were conducted at ground-verified sites rated as having high (n=8 sites) or high-moderate (n=3 sites) relative potential for providing suitable conditions for hibernating *M. lucifugus* (Appendix A Photos 1 to 12). Although located just outside of the MPB, M2, which contains a cluster of four high relative potential sites, was included in the survey due to it being thought to be a very good potential location for hibernacula

near the Project. Note that BC2 was not included in the study because it will not be affected by the Project.

3.1 Field Work

Swarming surveys consisted of:

- acoustic monitoring, with analysis focussing on identifying the presence of multiple *M. lucifugus* present at the same time;
- visual observations for swarming activity; and,
- mist netting to identify species present in the area.

The swarming survey methods used at each of the sites are summarized in Table 2. Wherever vehicle access was possible to allow for night time safety and quick egress, the full suite of three surveys was conducted at sites rated as having high relative potential for providing suitable hibernaculum conditions (*i.e.*, M1, M2-1, and M3). At high relative potential sites where access was possible only by foot or where it would be difficult to observe bats or conducting netting, only acoustic monitoring was conducted. Acoustic monitoring only was conducted at high-moderate relative potential sites in the MPB (*i.e.*, R1-3, R1-7, R5a-5).

Table 2 Swarming Survey Methods and Dates

Site	Methods	Dates - Planned	Dates – Actual 1
M1	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 4; September 21 – October 12
	Swarm visual observation	Every second week in August and September 2017, starting first week of August. N=5 surveys.	August 2, 16, 30; September 4, 26 (N = 5 surveys)
	Mist netting	Every second week in August and September 2017, starting first week of August. N=5 surveys.	August 2, 16, 30; September 4, 26 (N = 5 surveys)
M2-1	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 10; September 21 – October 12
	Swarm visual observation	Every second week in August and September 2017, starting first week of August. N=5 surveys.	August 1, 15, 29; September 25 (N = 4 surveys)
	Mist netting	Every second week in August and September 2017, starting first week of August. N=5 surveys.	August 1, 15, 29; September 25 (N = 4 surveys)

Table 2 Swarming Survey Methods and Dates

Site	Methods	Dates - Planned	Dates – Actual 1
M2-2 and M2	Acoustic monitoring (treated as one site due to proximity)	July 28 – September 30, 2017	July 28 – September 9; September 21 – October 12
M2-4	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 4; September 21 – October 12
M3	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 6; September 21 – October 12
	Swarm visual observation	Every second week in August and September 2017, starting first week of August. N=5 surveys.	July 31; August 14, 28; September 24 (N = 4 surveys)
	Mist netting	Every second week in August and September 2017, starting first week of August. N=5 surveys.	July 31; August 14, 28; September 24 (N = 4 surveys)
R1-3	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 3; September 21 – October 12
R1-7	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 5; September 21 – October 12
R4-2	Acoustic monitoring	July 29 – September 30, 2017	July 29 – September 9; September 21 – October 12
R5a-3	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 10; September 21 – October 12
R5a-5	Acoustic monitoring	July 28 – September 30, 2017	July 28 – September 8; September 21 – October 12

[1] Due to extreme fire risk in the region, the mine project area and all swarming survey locations were closed to access by the provincial government from September 4 to September 21, 2017. This resulted in missing a scheduled monitor battery replacement in early September, consequently leading to monitors not recording continuously through September, and the final visual swarming and mistnetting session planned for mid-September was missed.

Acoustic monitoring was anticipated to provide the most conclusive evidence of swarming activity because it was planned to be continuous for nine weeks at each location. Not including netting/visual observations at all locations was not anticipated to negatively effect the overall results of the swarming survey.

Swarming surveys commenced July 28, 2017, and were originally planned to end September 30, 2017, based on the anticipated migration and swarming season of *M. lucifugus* (and other bats) through and

within the MPB. However, due to extreme forest fire risk throughout British Columbia and Southern Alberta in 2017, resulted in the closure of the forest in which the Project is located, as a result the actual survey dates changed (Table 2).

A total of 10 acoustic monitors (Song Meter™ SM4Bat-FS™ ultrasonic recorders) were deployed in late July 2017. Monitors were programmed to start 30 minutes prior to sunset and end 30 minutes after sunrise every night. Benga had planned to leave the monitors in place, monitoring continuously until October 1; however, due to the regional forest closure that prevented access to all monitor locations (see footnote and actual dates in Table 2), there was an unplanned break in monitoring in September, with monitors remaining in place until October 13.

During each netting session, mist netting was conducted for one night at each of the three netting/visual observation locations. All nets were 38-mm mesh, 75/2 black polyester bat mist nets, were 2.6 m tall with four shelves, and were either 6 m, 9 m, or 12 m in length. At each survey station, nets were assembled in configurations that followed Vonhof (2002). Mist nets were constantly monitored to ensure captured bats were removed soon after capture to minimize potential injuries and to limit the number of escapes. Data collected from captured bats included sex, reproductive condition, age class, and forearm length. Trapping and handling were conducted under Alberta Environment and Parks Research Permit #17-177 (Appendix B), and procedures followed recommendations from Vonhof (2002) and directives contained in Class Protocol 004: Bat Handling, Capture and Release (AESRD 2012).

Visual observations for swarming bats were made continuously throughout the netting periods, aside from when the biologists were checking nets or handling bats that were captured in the nets.

3.2 Data Analysis

3.2.1 Bat Visual Observations

Mist netting effort at each site was standardized to account for the use of different lengths of nets. Sampling effort was calculated by dividing the actual length of each net by 3 m to determine its length in terms of 3-m net equivalents (*e.g.*, a 9-m net is three 3-m equivalents) and multiplying by the number of hours the net was in use. When more than one net was in use at a site on a given night, sampling effort was summed across all nets in use, to yield a sampling effort of net-hours (*e.g.*, if one 9-m was set up for 6 hours and one 6-m net was set up for 5 hours, the total effort would be 3*6 + 2*5 = 28 net-hours).

Due to the small sample sized of captured bats and flying bat observations, these data are simply reported but not analysed in any way.

3.2.2 Acoustic Monitoring

All sound files were recorded in full spectrum format and filtered using Kaleidoscope Pro™ from Wildlife Acoustics, Inc. Resulting sound files were analyzed using Kaleidoscope Pro™. Because of similarities in call characteristics, it was not always possible to confidently distinguish between small myotis species with high-frequency calls (*i.e.*, *M. lucifugus* and long-legged myotis (*Myotis volans*)). In these cases, the calls were labelled Unidentified *Myotis* > 35 kHz.

Calls of other species (*i.e.*, *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and *Myotis evotis*) were identified, but because they were not the focus of this study they were collectively labelled Other.

To discern if swarming by *M. lucifugus* may have occurred, the following steps were completed:

1. Tallied all bat passes attributed to *M. lucifugus* and potentially attributed to *M. lucifugus* (*i.e.* passes of unidentified *Myotis* with low frequency >35 kHz) per monitor hour per night per site.
    - Total activity levels over the duration of the study will illustrate which sites are used by *M. lucifugus*, and the relative use/importance of each site to this species.
2. Calculated descriptive statistics of nightly *M. lucifugus* acoustic activity per site to gain an understanding of 'typical' and 'extreme' levels of activity at each site, which would be helpful in determining which extreme levels may be indicative of season-specific activities such as emergence of young of the year, migration stopovers, and swarming activity.
    - Due to the believed key function of swarming (*i.e.*, for bats migrating from different summer locations to meet and mate while repeatedly circling around and into a potential hibernaculum), very high levels of activity (*e.g.*, ≥95th percentile of nightly activity), relative to typical commuting and foraging activity, would be expected if bats were swarming.
    - The use of 95th percentiles was anticipated to exclude nights characterized by only high levels of feeding activity arising from the most favourable environmental conditions.
3. Discerned on which nights at each site peak *M. lucifugus* acoustic activity occurred, which may be indicative of when swarms (or other seasonal activities such as emergence of young of the year or migration stopovers) occurred.
    - Peaks occurring in late July or early August are most likely attributed to emergence of young of the year but may also be indicative of swarming or migration stopover activity. Sites with peaks occurring only in July or early August are unlikely (but possibly) experiencing swarming activity.

- Peak activity occurring mid-August to into September would most likely be attributed to migration stopover or swarming activity.
- August 1 was used as a conservative threshold for potential swarming activity.

4. Calculated descriptive statistics of hourly *M. lucifugus* acoustic activity per site to gain an understanding of 'typical' and 'extreme' levels of activity at each site, which would be helpful in determining which extreme levels may be indicative of swarming activity.
5. Discerned the times at each site that peak (≥95th percentile) *M. lucifugus* acoustic activity occurred, which may be indicative of swarming activity.
   - When peak activity is a result of high levels of foraging activity – which may occur because of high levels of prey abundance and other favourable environmental conditions, individuals at a migration stopover location foraging at the beginning of a night prior to night-time migration, or individuals foraging after arriving at a migration stopover location – acoustic activity is likely to follow a bimodal distribution, with the most activity occurring shortly after sunset and just before sunrise.
   - The timing of swarming activity within a night is an unknown, not well-studied, and likely dependent on the distance that all participating individuals of the swarm migrated or locally travelled from during the night. Because swarming activity is a way for individuals residing in different summer locations over a potentially large area to meet and mate, swarming should occur with a unimodal temporal distribution (*i.e.*, during one potentially extended period of the night when all swarming individuals are present), rather than at multiple distinct times of the night. Such a unimodal pattern was found for *M. lucifugus* when swarming at the Renfrew mine in Ontario (Adams *et al.* 2015), with acoustic activity peaking at 4 hours after sunset.
6. Qualitatively determined whether swarming had likely occurred at each study site, based on nights and hours of peak acoustic activity and the absolute level of activity.
   - There is little known about activity level in the scientific literature for swarming at anything other than large known hibernacula consisting of hundreds or more bats. No such hibernacula are known in or near the Grassy Mountain area.
   - Acoustic activity of fewer than 25 passes/hr was used as a threshold for swarming, based on an assumption that during swarming, 10 bats would feasibly make five passes each (*i.e.*, total of 50 passes) over a course of 2 hr of swarming activity. This is a conservative estimate given the nature of swarming activity described at known swarming sites (*e.g.*, >5,000 *M. lucifugus* calls per hour of swarming at Renfrew mine in Ontario (Adams *et al.* 2015)) or used as an activity threshold for swarming (*e.g.*, >6 bats captured/hr at underground mine locations in Nova Scotia (Randall and Broders 2014)).

- Following Adams *et al*. (2015), peak activity would be expected to occur around 4 hr after sunset, or at approximately 01:00 in early-mid August to approximately midnight in early September at the Grassy Mountain area. Allowing for potential variation in swarming activity between Grassy Mountain and Adams *et al*.'s (2015) Renfrew mine location in Ontario, we conservatively expanded the expected peak timing to 23:00 – 03:59, which would still exclude the peak feeding times at dusk and dawn.

4.0 SWARMING SURVEYS - RESULTS

4.1 Swarming Observations

Swarming observation surveys were conducted a total of four nights at each of M2-1 and M3 and five nights at M1 (Table 2) during August and September 2017. Unidentified bats were observed flying at M1 on all nights but the final date (September 26), with the most individuals observed the night of September 4 (Table 3, Appendix C Table C1). Unidentified bats were also observed flying at M2-1 on the nights of August 1 and August 29, and no bats were observed flying on any night at M3. Given these results, swarming of very small numbers of unidentified bats may have occurred at M1.

Table 3 Summary of Swarm Visual Observations

Site	Time			Temperature (°C)		Observations	
	Start	End	Total (hr)	Start	End	Bats	Swarming
July 31 – August 2							
M1	21:15	04:30	7.25	12	6	3 observation events between 3:10 and 3:40; 1 individuals per event; all hunting; not identified	Unlikely
M2-1	21:15	04:00	6.75	16	10	1 observation event; 2 individuals hunting; not identified	Unlikely
M3	20:45	3:00	6.25	18	12.5	0	No
August 14 - 16							
M1	20:15	05:00	8.75	21	12	6 observation events; 1 to 10 individuals per event; flying but not hunting; not identified	Possible, with group of 10 (species not identified)
M2-1	20:30	04:15	7.75	15	10	0	No

Table 3 Summary of Swarm Visual Observations

Site	Time			Temperature (°C)		Observations	
	Start	End	Total (hr)	Start	End	Bats	Swarming
M3	21:15	03:30	6.25	7	3	0	No
August 28 – August 30							
M1	20:15	04:30	8.25	27	13	2 observation events between 20:50 and 21:41; 1 to 2 individuals per event; flying but not hunting; not identified	Possibly a very small swarm
M2-1	20:15	03:50	7.58	22	14	1 observation event of 3 individuals; hunting over nearby pond; not identified	Unlikely
M3	20:15	03:20	7.08	19	12	0	No
September 4							
M1	20:00	03:10	7.17	17	6	6 observation events between 20:35 and 21:20; 1 to 2 individuals per event; flying, with one individual observed hunting; not identified	Possibly a very small swarm
September 24 - 26							
M1	19:15	02:05	6.83	14	4	0	No
M2-1	19:15	02:15	7.00	11	7	0	No
M3	19:15	01:15	6.00	9	4	0	No

4.2 Mist Netting

Mist netting was conducted a total of four nights at each of M2-1 and M3 and five nights at M1 (Tables 2 and 4) during August and September 2017. Netting effort was 197.1 3-m net equivalent-hours at M1 and 199.7 and 171.2 3-m net equivalents at M2-1 and M3, respectively (Table 4).

Twenty bats were captured in mist nets in August and September 2017 (Table 5). All individuals were in good condition with no obvious signs of white nose syndrome. Of these 20, 18 were captured at M1, including 11 *M. lucifugus*, two *M. volans*, one *M. evotis*, one *L. noctivagans*, and three individuals

that escaped from the nets before they were identified. Of the 11 captured *M. lucifugus*, four were captured the night of August 2, one on the night of August 16, and six on the night of September 4.

One *M. lucifugus* was captured at M2-1, and one *L. noctivagans* was captured at M3 (Table 5).

Similar to the results from the visual observations (Section 4.1), these capture results indicate that swarming of very small numbers *M. lucifugus* may have occurred at M1, particularly on the night of September 4.

Table 4 Bat Mist Net Surveys – Sampling Details

Site	Nets Used	Time			Effort (net-hr) [1]	Ambient Temperature (°C)		Capture
		Nets Opened	Nets Closed	Total (hr)		Nets Opened	Nets Closed	
July 31 – August 2								
M1	6 m x 2.6 m 9 m x 2.6 m 12 m x 2.6 m	21:25 21:45 21:35	04:30 03:00 04:00	7.08 5.25 6.41	55.6	12	6	Yes
M2-1	6 m x 2.6 m 12 m x 2.6 m	22:00 22:25	03:55 03:30	5.91 5.08	32.2	16	10	Yes
M3	6 m x 2.6 m 9 m x 2.6 m 9 m x 2.6 m	21:30 21:00 21:00	02:40 03:00 02:50	5.17 6.00 5.83	45.8	18	12.5	No
August 14 - 16								
M1	6 m x 2.6 m 9 m x 2.6 m 9 m x 2.6 m	20:30 20:15 21:00	05:00 03:00 03:15	8.50 6.75 6.25	56	21	12	Yes
M2-1	6 m x 2.6 m 6 m x 2.6 m 12 m x 2.6 m	20:40 20:50 21:00	03:45 04:00 04:15	7.08 7.17 7.25	57.5	15	10	No
M3	6 m x 2.6 m 6 m x 2.6 m 9 m x 2.6 m	21:20 21:40 21:30	03:30 03:00 03:15	6.17 5.33 5.75	40.3	7	3	No

Table 4 Bat Mist Net Surveys – Sampling Details

Site	Nets Used	Time			Effort (net-hr) [1]	Ambient Temperature (°C)		Capture
		Nets Opened	Nets Closed	Total (hr)		Nets Opened	Nets Closed	
August 28 – August 30								
M1	6 m x 2.6 m 6 m x 2.6 m	20:20 20:45	04:30 04:25	8.17 7.67	31.7	27	13	Yes
M2-1	6 m x 2.6 m 6 m x 2.6 m 12 m x 2.6 m	20:25 20:45 20:35	03:50 03:30 03:40	7.42 6.75 7.08	56.7	22	14	No
M3	9 m x 2.6 m 9 m x 2.6 m	20:35 20:45	03:10 03:00	6.58 6.25	38.5	19	12	Yes
September 4								
M1	6 m x 2.6 m 6 m x 2.6 m	20:10 20:15	03:10 03:00	7.00 6.75	27.5	17	6	Yes
September 24 - 26								
M1	6 m x 2.6 m 6 m x 2.6 m	19:25 19:30	02:00 02:05	6.58 6.58	26.3	14	4	No
M2-1	6 m x 2.6 m 6 m x 2.6 m 12 m x 2.6 m	19:25 19:35 19:30	02:15 02:05 02:10	6.83 6.50 6.67	53.3	11	7	No
M3	6 m x 2.6 m 9 m x 2.6 m 9 m x 2.6 m	19:35 19:20 19:25	01:15 01:15 01:15	5.67 5.92 5.83	46.6	9	4	No

[1] Effort: equivalent of 3-m net for 1 hr (*e.g.,* one 6-m net in place for 2 hr would equate to an effort of 4 net-hr).

Table 5 Bat Mist Net Surveys – Capture Results					
Site	**Night**	**Capture Time**	**Species**	**Sex**	**Age**
M1	August 2	01:30	*M. lucifugus*	Male	Adult
		02:45	*M. lucifugus*	Male	Adult
		03:00	*M. lucifugus*	Male	Adult
		03:15	Unknown - escaped		
		03:40	*M. lucifugus*	Female	Adult
M1	August 16	21:20	*M. lucifugus*	Male	Adult
		21:22	*L. noctivagans*	Male	Adult
		21:23	Unknown - escaped		
M1	August 30	23:45	*M. evotis*	Male	Adult
M1	September 4	20:40	*M. lucifugus*	Male	Juvenile
		20:55	*M. lucifugus*	Female	Adult
		21:00	*M. volans*	Male	Juvenile
		21:00	*M. lucifugus*	Male	Adult
		22:20	*M. volans*	Male	Adult
		22:35	*M. lucifugus*	Female	Adult
		22:35	*M. lucifugus*	Female	Adult
		00:05	*M. lucifugus*	Male	Adult
		01:00	Unknown - escaped		
M2-1	August 1	03:00	*M. lucifugus*	Male	Adult
M3	August 28	02:00	*L. noctivagans*	Female	Adult

4.3 Acoustic Monitoring

The ten acoustic monitors operated for a total of 7,369 hrs from the nights of July 29 to October 12, 2017 (Table 6). Due to closure of the study area because of extreme fire risk from September 4 to September 20, 2017, and the resulting inability to change monitor batteries, data from all or part of this period are missing from each location.

A key assumption in this study is that higher levels of acoustic activity correlate with higher abundance of individuals. It is not possible to translate number of passes to number of individuals, and therefore the number of individuals at each location cannot be determined. However, sites with

more acoustic activity are assumed to have greater relative importance to the bat populations located within the Grassy Mountain MPB.

Table 6 Summary of Overall Acoustic Monitoring Effort and Results

Site	Monitor Hours	Total Bat Passes	Bat Passes/ Monitor Hour
M1	706.0	45,839	64.9
M2-1	775.5	1,786	2.3
M2-2 and M2-3	760.4	5,807	7.6
M2-4	700.5	8,117	11.6
M3	725.0	6,972	9.6
R1-3	696.1	4,636	6.7
R1-7	718.2	6,585	9.2
R4-2	746.7	1,227	1.6
R5a-3	783.9	5,765	7.4
R5a-5	756.9	4,287	5.7
Total	***7,369***	***91,021***	***12.4***

4.3.1 Bat Community

Bats were present at all monitored sites (Table 6). The least amount of acoustic activity occurred at sites R4-2, M2-1, R5a-5, and R1-3 (site details provided in Table 1).

The number of passes of each species or species group at each monitoring location, along with relative frequencies of each species or species, are summarized in Table 7. The greatest numbers of passes were detected at sites M1 (45,839, or 50.4% of all passes; 64.9 passes/hour), M2-4 (8,117; 8.9%; 11.6), M3 (6,972; 7.7%; 9.6), and R1-7 (6,585; 7.2%; 9.2). Sites M1, M2-4, and M3 are all abandoned mine infrastructure, while site R1-7 is a deep crack along a mountain ridge (Table 1, Figure 1, Appendix A). The least amount of bat activity was detected at sites R4-2 (1,227 passes; 1.3% of all passes; 1.6 passes/hour), M2-1 (1,786; 2.0%; 2.3), R5a-5 (4,287; 4.7%; 5.7), and R1-3 (4,636; 6.7%; 6.7).

Of the total 91,021 passes identified over the duration of the study, the greatest proportion belonged to *M. lucifugus* and unidentified high frequency *Myotis* species (*i.e.*, calls with low frequency >35 kHz; *M. lucifugus* and/or *M. volans*) (Table 7). Bats characterized by lower-frequency calls (*i.e.*, *E. fuscus*, *L. noctivagans*, *L. cinereus*, and *M. evotis*) comprised a total of 31.4% of all identified bat passes.

For further details on the overall bat community, activity per night and per hour each night at each site for each species or species group are provided in Appendix D Tables D1 to D10 and Appendix E Tables E1 to E10, respectively.

Table 7 Bat Passes Detected During the Acoustic Survey

Location	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
Number of Passes						
M1	22,328	18,453	1,865	3,193	45,839	40,781
M2-1	285	29	33	1,439	1,786	314
M2-2 and M2	1,242	4,207	102	256	5,807	5,449
M2-4	1,457	249	44	6,367	8,117	1,706
M3	881	99	23	5,969	6,972	980
R1-3	1,286	172	35	3,143	4,636	1,458
R1-7	4,399	23	1	2,162	6,585	4,422
R4-2	336	42	39	810	1,227	378
R5a-3	2,320	511	213	2,721	5,765	2,831
R5a-5	1,437	194	129	2,527	4,287	1,631
Total	***35,971***	***23,979***	***2,484***	***28,587***	***91,021***	***59,950***
Relative Frequency of Passes per Species						
M1	48.7	40.3	4.1	7.0	100	89.0
M2-1	16.0	1.6	1.8	80.6	100	17.6
M2-2 and M2	21.4	72.4	1.8	4.4	100	93.8
M2-4	17.9	3.1	0.5	78.4	100	21.0
M3	12.6	1.4	0.3	85.6	100	14.1
R1-3	27.7	3.7	0.8	67.8	100	31.4
R1-7	66.8	0.3	0.0	32.8	100	67.2
R4-2	27.4	3.4	3.2	66.0	100	30.8
R5a-3	40.2	8.9	3.7	47.2	100	49.1
R5a-5	33.5	4.5	3.0	58.9	100	38.0
Total	***39.5***	***26.3***	***2.7***	***31.4***	***100***	***65.9***

1 *Myotis lucifugus*
2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz.
3 *Myotis volans*
4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*
5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

4.3.2 Little Brown Myotis (*M. lucifugus*)

4.3.2.1 Overall Activity

M. lucifugus echolocation activity was identified at all 10 acoustic monitoring sites (Table 7, MYLU). *M. volans* (MYVO) was also identified at all sites, albeit at much lower abundances. Additionally, at each location, there was the presence of echolocation calls that could be attributed to either *M. lucifugus* or *M. volans* (UNMY >35 kHz). Because the focus of this study was to discern whether *M. lucifugus* was swarming at any of the identified potential hibernacula sites, a conservative assumption was made that for *M. lucifugus* activity to include activity identified as *M. lucifugus* plus activity that was potentially attributed to *M. lucifugus* (Table 7, MYLU + UNMY >35 kHz). Henceforth in this report, *M. lucifugus* activity refers to this combined activity level.

M. lucifugus activity was by far most frequent at site M1 (40,781 passes; 68% of all *M. lucifugus* passes) (Table 8). The next highest levels of activity occurred at sites M2-2&3 (5,449; 9.1%), R1-7 (4,422; 7.4%), and R5a-3 (2,831; 4.7%). This information reveals the study sites with the most overall *M. lucifugus* activity during the study, which may be indicative of areas important for summer roosts, maternity roosts, and/or foraging. Sites M1 and M2-2&3 include abandoned mine infrastructure, while sites R1-7 and R5a-3 are located on a mountain ridge (Table 1).

Sites with higher levels of activity may be indicative of locations containing or near day roosts, maternity colonies, good foraging habitat, and/or nightly commute corridors, or locations where *M. lucifugus* stops over during migration or exhibits fall swarming behaviour near potential hibernacula.

Table 8 *M. lucifugus* Passes Detected During Acoustic Survey

Location	# Passes[1]	Relative Frequency
M1	40,781	68.0
M2-1	314	0.5
M2-2 and M2-3	5,449	9.1
M2-4	1,706	2.8
M3	980	1.6
R1-3	1,458	2.4
R1-7	4,422	7.4
R4-2	378	0.6
R5a-3	2,831	4.7
R5a-5	1,631	2.7
Total	***59,950***	**100.0**

1 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

4.3.2.2 Nightly Activity

The inter-site variation in *M. lucifugus* acoustic activity is further illustrated in Table 9. Typical nightly activity at each site would likely fall within the range of the 25th to 75th percentiles; this level of activity is not expected to include more than typical nightly commuting and feeding during this time of the year. Nights with maximum activity notably greater than the 75th percentile level of activity at each site, may be indicative of seasonal-specific activity such as emergence of young of the year from maternity roosts in July or early August, migration stopovers (with no swarming) in August or September, or swarming in August or September.

Notable levels of *M. lucifugus* acoustic activity did not occur at sites M2-1, M3, and R4-2 (Table 9); therefore, it is highly unlikely that swarming activity occurred at these locations.

Table 9 Descriptive Statistics of *M. lucifugus* Nightly Activity

Site[1]	Maximum	95th Percentile	75th Percentile	Median	25th Percentile
M1	2,778	2,290.4	1,153	664	382
M2-1	19	18.3	11	4	0
M2-2 and M2-3	287	243	158	94	41
M2-4	138	97.8	54	27.5	5.8
M3	63	49.3	29	18	7
R1-3	152	101.6	45.5	18	4.5
R1-7	506	242.8	115	69	4
R4-2	39	22.5	9.5	5	0.8
R5a-3	264	171.5	65.5	29	3
R5a-5	104	91	50	24	5

The timing of peak activity on a nightly basis varied among the 10 sites (Table 10). Maximum nightly activity was highest at site M1 (2,778 passes on the night of August 19), followed by R1-7 (506 passes on the night of August 13), M2-2&3 (287 passes on the night of July 28), and R5a-3 (264 passes on the night of August 22). Activity levels ≥95th percentiles within each site also exhibited a variety of patterns, with peak activity nights closely clumped at some sites (*e.g.*, sites M1, M3, R1-3) and widely spread at others (*e.g.*, sites M2-1, M2-2&3, R5a-3).

The range of nights on which activity levels equal to or greater than the 95th percentile occurred at each site cannot rule out peak activity being attributed to either emergence of young of the year,

migration stopover, or swarming at many of the sites. However, with all peak activity occurring July 29 to August 2 at site R1-3, swarming is unlikely to be responsible for peak activity at this site.

Due to the regional forest closure arising from extreme fire risk, no acoustic data were collected during the period of early September (ranging from September 4 to September 10, depending on site) to September 20, 2017; it is possible that swarming may have occurred during this time.

Table 10 Nights with Peak Detection Levels of *M. lucifugus*

Site[1]	Maximum		≥95th percentile		Potential Cause of Peak Activity Based on Timing
	# Passes	Night	# Passes	Nights	
M1	2,778	Aug 19	2,778 2,406 2,421	Aug 19 Aug 20 Aug 25	Migration stopover, swarming
M2-1	19	Aug 3, 21, 25	19 19 19	Aug 3 Aug 21 Aug 25	Emergence of young of year, migration stopover, swarming
M2-2 and M2-3	287	July 28	287 252 259	July 28 Aug 6 Aug 25	Emergence of young of year, migration stopover, swarming
M2-4	138	Aug 19	137 138 102	Aug 11 Aug 19 Aug 20	Migration stopover, swarming
M3	63	Aug 16	53 63 52	Aug 13 Aug 16 Aug 19	Migration stopover, swarming
R1-3	152	July 30	104 152 109	July 29 July 30 Aug 2	Emergence of young of year
R1-7	506	Aug 13	319 506 252	Aug 1 Aug 13 Aug 17	Emergence of young of year, migration stopover, swarming
R4-2	39	Aug 2	39 32 23	Aug 2 Aug 9 Aug 22	Emergence of young of year, migration stopover, swarming
R5a-3	264	Aug 22	203 209 264	July 28 Aug 12 Aug 22	Emergence of young of year, migration stopover, swarming
R5a-5	104	Aug 12	94 101 104	July 28 Aug 11 Aug 12	Emergence of young of year, migration stopover, swarming

1 As *M. lucifugus* activity was extremely rare after September 30, October nights are not included.

4.3.2.3 Hourly Activity

To further evaluate potential *M. lucifugus* swarming activity, acoustic activity on an hourly basis was assessed (Tables 11 and 12). At this temporal resolution, it is possible to discern the level of peak activity within 1-hr increments and at which times of night peak activity occurred. Although activity levels are site-specific, being dependent on environmental conditions, distance of site from foraging locations, distance of site from where individuals may have migrated from during the night, and how many bats reside in or otherwise use the area, temporal patterns in relative activity levels may be useful for determining the likelihood of bats having swarmed at a location.

Peak hourly activity was greatest at site M1 (maximum of 929 passes in a single hour), followed by sites R1-7 (250 passes), R5a-3 (100 passes), and R1-3 (88 passes) (Table 11). Hourly maxima at sites M2-1 (8 passes), M2-2&3 (37 passes), M3 (32 passes), and R4-2 (19 passes) are indicative of no swarming activity detected at these sites.

Table 11 Descriptive Statistics of *M. lucifugus* Hourly Activity

Site	Maximum	95th Percentile	75th Percentile	Median	25th Percentile
M1	929	302.6	118	61.5	17.8
M2-1	8	4	2	0	0
M2-2 and M2-3	37	13.2	5	2	0
M2-4	63	17	6	2	0
M3	32	10	4	1	0
R1-3	88	20.5	4	1	0
R1-7	250	54	14	5	1
R4-2	19	7	2	0	0
R5a-3	100	31.5	8	2	0
R5a-5	46	16	6	2	0

When peak activity is a result of high levels of foraging activity (attributed to emergence of young of the year or migration stopovers), acoustic activity is expected to follow a bimodal distribution, with the most activity occurring shortly after sunset and just before sunrise. Peak activity at these times is less likely to be a result of swarming activity than high levels of foraging activity. Peak activity attributed to swarming should occur with a unimodal temporal distribution, with one extended period of high levels of activity during the middle of the night (Adams *et al*. 2015).

Based on assumptions that swarming activity would: 1) occur between the hours of 23:00 and 03:59, 2) on nights in August and September, and 3) would involve a minimum of 25 passes/hour during the middle of the night at times when foraging activity is not typically at its peak (Table 12). Given these criteria, swarming possibly occurred at seven of the sites:

- M2-2 and M2-3 (August 11 and 12; 26 passes/hour);
- M2-4 (August 6, 11, 17, 19, and 23; 26 to 37 passes/hour);
- M3 (August 16; 32 passes/hour);
- R1-3 (August 2 and 14; 29 to 88 passes/hour);
- R1-7 (August 1, 9, 13, 14; 76 to 250 passes/hour);
- R5a-3 (August 3, 9, 12, 15, 16, 18, 22 and September 3; 32 to 100 passes/hour); and
- R5a-5 (August 9; 28 passes/hour).

Peak call density for each of these potential swarming locations indicates that the potential swarming events contained relatively few individuals.

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
M1	929	Aug 24	5	Unlikely	392	Aug 7	5	Unlikely
					448	Aug 13	21	Unlikely
					484	Aug 18	5	Unlikely
					605; 411; 451	Aug 19	21; 22; 5	Unlikely
					508; 746	Aug 20	21; 5	Unlikely
					333; 552	Aug 21	21; 5	Unlikely
					313; 596;560	Aug 22	21; 5; 6	Unlikely
					315; 929	Aug 24	4; 5	Unlikely
					378; 357; 437	Aug 25	21; 22; 5	Unlikely
					436; 408	Aug 26	21; 5	Unlikely
					548	Aug 27	21	Unlikely
					426	Aug 28	21	Unlikely
					303	Aug 29	22	Unlikely
M2-1	8	July 28	5	Unlikely	8	July 28	5	Unlikely

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
	8	Aug 3	22; 5	Unlikely	5	Aug 1	4	Unlikely
	8	Aug 25	***1***	Unlikely	8; 8	Aug 3	22; 5	Unlikely
					4; 4; 6	Aug 6	22; **23**; **2**	Unlikely
					4; 4	Aug 8	**1**; 5	Unlikely
					4; 4	Aug 9	**0; 2**	Unlikely
					4; 5	Aug 10	**2**; 5	Unlikely
					5	Aug 11	**23**	Unlikely
					7	Aug 12	**0**	Unlikely
					4	Aug 13	22	Unlikely
					4	Aug 16	21	Unlikely
					4	Aug 17	22	Unlikely
					5	Aug 18	**1**	Unlikely
					4	Aug 19	**2**	Unlikely
					4	Aug 20	**3**	Unlikely
					7; 4	Aug 21	**0**; 6	Unlikely
					5; 8; 5	Aug 25	**23; 1; 2**	Unlikely
					5	Aug 27	21	Unlikely
					4	Aug 29	**23**	Unlikely
M2-2 and M2-3	37	July 28	4	Unlikely	37; 19	July 28	4; 5	Unlikely
					32; 16	July 29	**2**; 4	Unlikely
					22	July 30	22	Unlikely
					15	Aug 4	22	Unlikely
					19	Aug 5	**2**	Unlikely
					13	Aug 6	**23**	Unlikely
					28	Aug 8	**23**	Unlikely
					13	Aug 9	**0**	Unlikely
					26	Aug 11	**3**	**Possibly**
					25; 13; 26; 19	Aug 12	22; **23; 1**; 5	**Possibly**

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
					21; 17	Aug 13	**0**; 5	Unlikely
					22; 14	Aug 15	**23; 0**	Unlikely
					13; 18; 15	Aug 16	**0; 1; 2**	Unlikely
					15	Aug 17	**0**	Unlikely
					17; 14	Aug 22	**0**; 4	Unlikely
M2-4	63	Aug 19	4	Unlikely	18	July 28	4	Unlikely
					18	July 29	**1**	Unlikely
					25	July 30	22	Unlikely
					17	Aug 5	22	Unlikely
					29	Aug 6	**0**	**Possibly**
					18	Aug 9	4	Unlikely
					34; 26; 41	Aug 11	**23; 3**; 4	**Possibly**
					21	Aug 12	**3**	Unlikely
					18	Aug 16	21	Unlikely
					37	Aug 17	**0**	**Possibly**
					30; 63	Aug 19	**3**; 4	**Possibly**
					36; 20	Aug 20	21; **3**	Unlikely
					24	Aug 22	6	Unlikely
					29; 21	Aug 23	**0; 1**	**Possibly**
					17	Aug 25	**23**	Unlikely
M3	32	Aug 16	***23***	**Possibly**	13	July 31	**1**	Unlikely
					15; 19	Aug 2	**0; 1**	Unlikely
					10	Aug 5	4	Unlikely
					11	Aug 10	4	Unlikely
					12; 15	Aug 11	22; **23**	Unlikely
					15; 28	Aug 13	**1**; 5	Unlikely
					13; 32	Aug 16	22; **23**	**Possibly**
					10; 12; 11	Aug 19	**23; 0**; 5	Unlikely

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
					15	Aug 22	21	Unlikely
					15	Aug 25	21	Unlikely
					11	Aug 26	22	Unlikely
					12	Sep 5	21	Unlikely
R1-3	88	Aug 14	***23***	**Possibly**	63	July 29	4	Unlikely
					33; 82	July 30	**3**; 5	Unlikely
					22	July 31	4	Unlikely
					26	Aug 1	5	Unlikely
					29; 23; 39	Aug 2	**3**; 4; 5	**Possibly**
					26	Aug 3	5	Unlikely
					30	Aug 4	5	Unlikely
					30	Aug 6	5	Unlikely
					40	Aug 9	5	Unlikely
					22; 26	Aug 13	21; 5	Unlikely
					88	Aug 14	**23**	**Possibly**
					22	Aug 15	**2**	Unlikely
					21; 44	Aug 19	**1**; 5	Unlikely
R1-7	250	Aug 13	21	Unlikely	161	July 29	5	Unlikely
					219	Aug 1	**23**	**Possibly**
					63; 123	Aug 7	22; 5	Unlikely
					76	Aug 9	**23**	**Possibly**
					250; 142	Aug 13	21; **23**	**Possibly**
					78	Aug 14	**23**	**Possibly**
					59	Aug 15	22	Unlikely
					54	Aug 16	22	Unlikely
					124; 58	Aug 17	21; 22	Unlikely
					105; 54	Aug 18	21; 4	Unlikely
					63	Aug 21	21	Unlikely

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
					54	Aug 24	21	Unlikely
					114	Aug 25	21	Unlikely
					67	Sep 2	20	Unlikely
R4-2	19	Aug 9	***3***	Unlikely	8	July 29	22	Unlikely
					9; 12; 7	Aug 2	**0**; 4; 5	Unlikely
					7	Aug 4	**1**	Unlikely
					10	Aug 5	5	Unlikely
					10	Aug 7	**23**	Unlikely
					8	Aug 8	4	Unlikely
					19	Aug 9	**3**	Unlikely
					7	Aug 12	**1**	Unlikely
					8	Aug 15	21	Unlikely
					10	Aug 22	**23**	Unlikely
					10	Aug 27	**2**	Unlikely
					7	Sep 7	**2**	Unlikely
R5a-3	100	Aug 22	***1***	**Possibly**	47; 59	July 28	**23; 0**	Unlikely
					34	July 29	**0**	Unlikely
					40; 33	Aug 3	**1; 2**	**Possibly**
					40; 35	Aug 9	22; **23**	**Possibly**
					50	Aug 11	22	Unlikely
					45; 65	Aug 12	**1; 2**	**Possibly**
					34; 37	Aug 15	21; **23**	**Possibly**
					38	Aug 16	**0**	**Possibly**
					32	Aug 18	**2**	**Possibly**
					55	Aug 20	21	Unlikely
					100; 76; 37	Aug 22	**1; 2;** 5	**Possibly**
					41	Aug 23	6	Unlikely
					62; 45	Sep 3	**0**; 4	**Possibly**

Table 12 Hours with Peak Detection Levels of *M. lucifugus*

Site	Maximum			Potential Swarming?[2]	≥95th percentile			Potential Swarming?[2]
	# Passes	Night	Hour[1]		# Passes	Night	Hour[1]	
R5a-5	46	Aug 8	4	Unlikely	37	July 28	**3**	Unlikely
	46	Aug 22	5	Unlikely	18	Aug 3	**2**	Unlikely
					17; 18	Aug 6	4; 5	Unlikely
					46	Aug 8	4	Unlikely
					28	Aug 9	**2**	**Possibly**
					17; 18	Aug 10	**2**3; 5	Unlikely
					16; 20; 21	Aug 11	4; 5; 6	Unlikely
					20; 16; 19	Aug 12	**0; 1**; 5	Unlikely
					18; 16	Aug 14	**1; 2**	Unlikely
					16	Aug 15	21	Unlikely
					16	Aug 16	5	Unlikely
					17	Aug 18	**2**	Unlikely
					26; 22	Aug 19	22; 5	Unlikely
					46	Aug 22	5	Unlikely

1 Hours are based on a 24-hour clock. *e.g.*, 23 = 23:01 – 23:59, 0 = midnight – 00:59

2 Potential swarming activity is based on night and night-hour of peak activity and the number of passes constituting that peak activity. A date threshold of August 8 was chosen, and times between 23:00 and 03:59 were chosen. Acoustic activity of fewer than 25 passes/hr was used as a threshold, based on an assumption that during swarming, five bats would make 10 passes each during a two-hour period of swarming.

4.3.2.4 Further Investigation of Site M1

To rule out swarming at Site M1, which was the most heavily used site yet did not exhibit swarming activity using the criteria established for hourly activity, further investigation was done. It is clear from the data that the site likely contained a maternity colony and/or summer roost and was likely a migration stopover location for *M. lucifugus*. It is possible that intensive foraging activity of individuals during a migration stopover masked potential swarming events when using a 95th percentile threshold for identifying swarming activity. For this reason, an hourly activity using a 90th percentile threshold was assessed.

Based on this reduced threshold, swarming events possibly occurred on the nights of August 19, 20, 25, 27, and 29, and September 3, with activity levels ranging from 211 to 300 passes/hour during the middle of the night when foraging activity is usually not at its peak (Table 13).

Table 13 Hours with 90th to <95th Percentile Detection Levels of *M. lucifugus* at Site M1

# Passes	Night	Hour[1]	Potential Swarming?[2]
225	Aug 1	5	Unlikely
216	Aug 3	5	Unlikely
208	Aug 7	22	Unlikely
220	Aug 9	5	Unlikely
264	Aug 12	21	Unlikely
216	Aug 14	22	Unlikely
249	Aug 15	21	Unlikely
223	Aug 18	21	Unlikely
256; 235	Aug 19	**23**; 4	**Possibly**
213	Aug 20	**1**	**Possibly**
213	Aug 21	6	Unlikely
265	Aug 23	21	Unlikely
238; 223	Aug 25	**23**; 4	**Possibly**
256	Aug 26	6	Unlikely
300; 292	Aug 27	**23**; 5	**Possibly**
256	Aug 28	5	Unlikely
241; 275	Aug 29	**2**; 6	**Possibly**
211	Sep 3	**0**	**Possibly**

1 Hours are based on a 24-hour clock. *e.g.*, 23 = 23:01 – 23:59, 0 = midnight – 00:59

2 Potential swarming activity is based on night and night-hour of peak activity and the number of passes constituting that peak activity. A date threshold of August 8 was chosen, and times between 23:00 and 03:59 were chosen. Acoustic activity of fewer than 25 passes/hr was used as a threshold, based on an assumption that during swarming, five bats would make 10 passes each during a two-hour period of swarming.

5.0 SWARMING SURVEYS - CONCLUSIONS

A summary of mist netting, visual observation, and acoustic monitoring results is provided in Table 14. Based on the intensive swarming survey completed in 2017, there is no conclusive evidence either to support or refute the possibility of *M. lucifugus* swarming events in the Grassy Mountain MPB. Small and very small swarming events may have occurred at sites M1, M2-2 and M2-3, M2-4, M3, R1-3, R1-7, R5a-3, and R5a-5; swarming was very unlikely at sites M2-1 and R4-2.

Although the presence of swarming cannot be confirmed, there was no evidence to suggest that large swarming events occurred at any of the monitored sites (Tables 12 and 13). Large swarming events are expected to involve thousands of *M. lucifugus* passes/hour (*e.g.*, Adams *et al.* 2015, Renfrew mine), whereas at Grassy Mountain acoustic activity never surpasses 300 passes/hour (site M1, Table 13) during middle of the night hours when swarming would be expected to occur.

The lack of large swarming events is not unexpected, given that no large underground caverns, caves, or abandoned mine shafts occur in the Grassy Mountain MPB or are known in the areas adjacent to the MPB. These types of formations and structures would be required to support large hibernacula. There are no sites comparable to, for example, the Renfrew mine in Ontario, which is a known large hibernaculum for *M. lucifugus*.

At the sites with possible swarming events, it is not possible to discern:

- whether swarming did occur;
- the number of individuals associated with each potential swarming event (other than to say that the groups would have likely been no more than up to 10 or 15 individuals); and
- whether potential or actual hibernacula are located at or near any of the locations where possible swarming events did occur.

Despite the lack of confident swarming evidence, site M1 is clearly important to the *M. lucifugus* population in the Grassy Mountain project area during late July to early September. The high levels of acoustic activity (relative to what was observed at the other locations) at this site throughout the study period indicate that a relatively large population of *M. lucifugus* resides near M1 during the summer and uses the area during the migration period in August and September.

It is possible that swarming occurred at any monitored location during the forest closure period in September when data were not collected (*i.e.*, starting September 4 to 10, depending on site, and ending September 20). However, given the information that was collected in early September along with the fact that mid September would be late for migration in this part of the country or province, there is no reason to suggest large groups of swarming bats should be expected to have occurred during the forest closure period.

Table 14 Summary of Potential Swarming Activity of *M. lucifugus*

Site	Data Supports Potential Swarming of *M. lucifugus*?						Conclusion
	Acoustic Data				Mist Netting	Visual	
	Peak Nights (August – early September)	>50 Passes/Peak Night	Peak Hours (23:00 – 03:59)	>25 Passes/Peak Hour	Multiple Captures/ Night (23:00 – 03:59)	Observed Group(s) Flying (23:00 – 03:59)	
M1	Yes	Yes	Yes (using 90th percentile threshold)	Yes	Yes (Aug 2)	No	**Swarming – Possible** This is the highest-use area of all 10 sites studied. Likely nearby *M. lucifugus* maternity/day roost. Likely used as migration stopover location.
M2-1	Yes	No	Yes	No	No	No	**Swarming – Unlikely** Maximum of 19 passes/night indicates this is a very low-use area for *M. lucifugus*
M2-2 and M2-3	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	**Swarming – Possible (very small group)** In terms of total detected passes, this is the second most consistently used site. Maximum of 287 passes/night and 37 passes/hr indicate this site is not heavily used by *M. lucifugus*
M2-4	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	**Swarming – Possible (very small group)** Maximum of 138 passes/night and 63 passes/hr indicate this site is not heavily used by *M. lucifugus*
M3	Yes	No	Yes	Yes	No	No	**Swarming – Possible (very small group)** Maximum of 63 passes/night and 32 passes/hr indicate this is a low-use area for *M. lucifugus*

Table 14 Summary of Potential Swarming Activity of *M. lucifugus*

Site	Data Supports Potential Swarming of *M. lucifugus*?						Conclusion
	Acoustic Data				Mist Netting	Visual	
	Peak Nights (August – early September)	>50 Passes/Peak Night	Peak Hours (23:00 – 03:59)	>25 Passes/Peak Hour	Multiple Captures/ Night (23:00 – 03:59)	Observed Group(s) Flying (23:00 – 03:59)	
R1-3	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	**Swarming – Possible (small group)** Maximum of 152 passes/night and 88 passes/hr indicate this site is not heavily used by *M. lucifugus*
R1-7	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	**Swarming – Possible** With a maximum of 506 passes/night and 250 maximum passes/hr, this site was the second highest in peak activity.
R4-2	Yes	No	No	No	Not Applicable	Not Applicable	Swarming – Very Unlikely Maximum of 39 passes/night and 19 passes/hr indicate this is a low-use area for *M. lucifugus*
R5a-3	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	**Swarming – Possible (small group)** Maximum of 264 passes/night and 100 passes/hr indicate this is a relatively moderately site in the Grassy Mountain project area.
R5a-5	Yes	Yes	Yes	Yes	Not Applicable	Not Applicable	Swarming – Possible (small group) Maximum of 104 passes/night and 46 passes/hr indicate this area is not heavily used by *M. lucifugus*

6.0 *M. LUCIFUGUS* HIBERNACULA MITIGATION AND MONITORING

There is no conclusive evidence about the presence of swarming by migrating *M. lucifugus* or potential hibernacula, despite an extensive swarming survey. Therefore, without confirmation of suspected or known hibernacula in the Grassy Mountain area, no site-specific mitigations can be planned. Also, without the presence of underground caverns, caves, and large abandoned mine shafts, site-specific mitigations for these types of features, which are the most likely features for housing large hibernacula, cannot be planned.

The federal conservation objective for *M. lucifugus* in areas where white-nose syndrome does not yet occur is to maintain current population levels (Environment Canada 2015). Until the federal recovery strategy for this species is finalized, critical habitat is fully defined, and standardized survey or monitoring protocols are developed, Benga proposes to continue monitoring *M. lucifugus* (and other bats) using the field and acoustic analysis procedures described in this report. EC (2015) recommends that the North American Bat Monitoring Program (NABat, Loeb *et al*. 2015) be used to the extent possible for long-term monitoring of *M. lucifugus*; Benga's current protocol will be adapted as necessary to ensure consistency with the NABat protocol where possible and logical. This methodology is anticipated to monitor *M. lucifugus* (and other bats) populations at spatial and temporal scales that will allow Benga to discern whether the general mitigations in place for wildlife (Consultant Report #9 Wildlife Assessment, Section 7), particularly species at risk, are minimizing or preventing any Project impacts on these populations.

Specifically, Benga will:

- work in consultation with ECCC to develop species-specific mitigation and monitoring plans for *M. lucifugus* in the Wildlife Local Study Area (as defined in Consultant Report #9 Wildlife Assessment, Section 1.2);
- work in consultation with ECCC to adapt mitigation and monitoring plans in such ways as to meet any additional conservation objectives that may be included in ECCC's final recovery strategy for *M. lucifugus*;
- continue monitoring the *M. lucifugus* population, ensuring intensive swarming surveys occur in areas with features that have high potential for hibernacula. This includes, at a minimum, all sites from this study that showed possible swarming events. This intensive monitoring will be phased, in sync with the phased mine development plan, ensuring that each site is monitored at least one full year prior to development, with sufficient time to conduct all necessary surveys, analyse all acoustic data, and develop any required site-specific or feature-specific mitigation plans. Should Benga observe any suspected fall swarming activity during operations, they will develop a site-specific mitigation plan in consultation with ECCC;

- conduct summer roost and maternity roost surveys at site M1, where summer male or maternity roosts may be located nearby. Should roosts be located, ECCC will be informed immediately and site-specific mitigation plans will be developed. These roost surveys will consist of:
  - ground surveys to look for roosts or trees/structures with high potential for housing roosts;
  - mist-netting at known/potential roost locations, to identify species, sex, age, and health, including white-nose syndrome; and
  - acoustic surveys in June and July to identify activity levels that would correlate with the presence of summer roost for males or maternity roost.
- conduct summer roost and maternity roost surveys at any other locations where such roosts become suspected or are observed;
- follow all wildlife mitigations stated in Consultant Report #9 Wildlife Assessment, Section 7.1; and
- follow the preliminary wildlife monitoring program that was provided in Consultant Report #9 Wildlife Assessment, Section 7.2. This initial wildlife monitoring approach will enable Benga to evaluate the effectiveness of their wildlife protection, mitigation, and reclamation procedures and to minimize Project effects on wildlife. A detailed wildlife mitigation and monitoring plan based on provincial and federal Approval Conditions will be developed following Project approval.

Benga is committed to monitoring the bat community at the Grassy Mountain Coal Project, as well as developing any further mitigations that may become necessary to ensure the Project does not negatively affect *M. lucifugus* populations and hibernacula.

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FIGURES

R4 W5M

R3 W5M

T9

T8

T7

Proposed Mine Permit Boundary

Ultimate Pit Extent

North Rock Disposal Area

Central Rock Disposal Area

Coal Handling Processing Plant and Infrastructure

Topsoil Stockpiles

Proposed Water Pipeline/ Service Road

Covered Conveyor, Access Road and Powerline ROW

South Rock Disposal Area

Construction Camp

Proposed Golf Course

Proposed Rail Loadout

Proposed Rail Loop

Proposed Helipad Access

Road Access

R7 R6-2 R6-1 R6-3 R8-3 R8-2 R8-1 R5a-3 R5a-2 R4-2 R5b-2 R5a-5 R4-1 R5a-1 R5b-1 R5b-4 R5b-6 R5a-4 R5b-5 BC6-1 BC6-2 R5b-3 BC5 R1-7 R1-6 R1-5 R1-3 R1-4 R1-2 R1-1 BC4 R3 R2 M3 BC3 M2-4 M2-3 M2-2 M2-1 BC2 BC1-2 BC1-1 M1

Forestry Trunk Road

Coleman

Blairmore

Crowsnest River

Gold Creek

Green Creek

Lyons Creek

Morin Creek

Nez Perce Creek

York Creek

LEGEND

Survey Location Rating

- Low
- Moderate-Low
- Moderate
- High-Moderate
- High

- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Railway Loop
- Proposed Helipad Access
- Access Road
- Rail Loadout
- Proposed Haul Road

- 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

SURVEY LOCATIONS

AltaLIS, 2017; MEMS, 2017; Riverside, 2016

Projection/Datum: UTM 11 Nad 83

0 1 2 Kilometres

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201

DRAWN BY: JL

CHECKED BY: RM

DATE: JULY 5, 2017

FIGURE 1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Wildlife\Addendum\Fig 1 Ground Verification Survey Locations 14-00201.mxd

Disclaimer: This figure was derived from multiple data sources and while we make every effort to assure its accuracy, Millennium EMS Solutions Ltd. disclaims any representation or warranty and assumes no liability either for any errors, omission or inaccuracies that may occur.

APPENDIX A: PHOTOS

Photo 1: Site M1

Photo 2: Site M1

Photo 3: Site M2-1 (wooden structure)

Photo 4: Site M2-1 (close-up of tunnel inside wooden structure)

Photo 5: Sites M2-2 (yellow) and M2-3 (red)

Photo 6: Site M2-4

Photo 7: Site M3

Photo 8: Site R1-3

Photo 9: Site R1-7

Photo 10: Site R4-2

Photo 11: Site R5a-3 (small cave – yellow; crack – red)

Photo 12: Site R5a-5

APPENDIX B: RESEARCH PERMIT

Alberta

Alberta Environment and Parks
Policy and Planning Division
Fish and Wildlife Policy Branch

#17-177

General Permit - GP

Region: South Saskatchewan

RESEARCH PERMIT

FEE $ NIL

PERMITTEE: Robin Mackey, Millennium EMS Solutions Ltd

ADDRESS: Suite 325, 1925 - 18th Avenue NE, Calgary, AB T2E 7T8

IS AUTHORIZED TO: Conduct fall bat surveys (mist net and acoustic) on the Riversdale Resources Grassy Mountain Project, Crowsnest Pass

DATE OF ISSUE: July 04, 2017
<Original signed by>

DATE OF EXPIRY: December 31, 2017

Signature of Permittee

<Original signed by>

Maria Didkowsky, Wildlife Biologist
South Saskatchewan Region

IN ACCORDANCE WITH: The approved research plan (application # 12266662) and Class Protocol(s) #004

Class Protocols are reviewed by the Alberta Wildlife Animal Care Committee and approved by the Director of Fish and Wildlife Policy.Class Protocols are available at http://aep.alberta.ca/fish-wildlife/wildlife-research-collection/default.aspx.

Conditions:

1. The Permit is subject to all conditions listed in the attached Appendix 1.

Alberta

Alberta Environment and Parks
Policy and Planning Division
Fish and Wildlife Policy Branch

#17-177

Licence - CN

COLLECTION LICENCE

FEE $ NIL

Region: South Saskatchewan

NAME: Robin Mackey, Millennium EMS Solutions Ltd

ADDRESS: Suite 325, 1925 - 18th Avenue NE, Calgary, AB T2E 7T8

Is authorized, subject to the conditions of this licence, and in accordance with the approved research plan # 12266662, to hunt* or collect, the following wildlife species: All bats species.

This Licence authorizes the use of the following equipment and methods: mist nets

This Licence is valid (location): South Saskatchewan

EFFECTIVE DATE: August 01, 2017

DATE OF EXPIRY: December 31, 2017

Hunting and/or collection is to be conducted by: Robin Mackey, Emilie Brien, Ryan Hrywkiw, Domenico Santomauro, Bryan Koentges, Zandra Ocholi

Date of issue: July 04, 2017

Signature of Licencee (not valid until signed by the Licencee)

Licence must be carried while hunting or collecting.

<Original signed by>

Maria Didkowsky, Wildlife Biologist
South Saskatchewan Region

**The meaning of the word "hunt" is inclusive of activities within the definition of "hunt" in the Wildlife Act except that the activity authorized by this licence is limited to what is expressly stated in it and, to be lawful, that activity must occur in accordance with the approved research plan and licence conditions.*

Appendix 1: Research Permit General Permit Conditions
Addendum to Research Permit #17-177

1. All research must be conducted according to the approved Research Plan (the approved application).
2. It is the responsibility of the Permittee to contact the appropriate Regional Wildlife Biologist and District Fish and Wildlife Officer and the appropriate landowner prior to the commencement of any permitted activities. Contact information for Wildlife Management staff is available at: http://aep.alberta.ca/about-us/contact-us/fisheries-wildlife-management-area-contacts.aspx or by calling 310-0000 and asking for the appropriate Wildlife Management office.
3. The permit is valid only for research and collection activities in the specific area and for the dates identified on the permit.
4. For activities in any Provincial Park, Ecological Reserve, Wildland Provincial Park, Natural Area, or Wilderness Area, additional approvals for access may be required. Please contact your local Alberta Environment and Parks, Parks Division authority.
5. The Permittee is responsible for ensuring that public safety is not endangered by activities associated with the project.
6. The Permittee shall be held accountable for damages to resources or property arising directly or indirectly from the project.
7. The issuance of this Permit does not exempt the holder from any other Canadian Laws that might otherwise apply.
8. All captured animals must be handled in a humane manner and according to the approved Research Plan (the approved application) as well as any additional approvals or instructions provided by the Wildlife Animal Care Committee.
9. Animals captured using immobilization drugs must follow the Chemical Immobilization of Wildlife: Drug Volume Calculation Tables: http://aep.alberta.ca/fish-wildlife/wildlife-research-collection/documents/WR-ChemicalImmobilizationWildlife-DrugVolumeCalculation-2016.pdf
10. If radio telemetry is a component of the research, the Permittee is responsible for providing up-to-date information on frequency deployment including date, general location, species, transmitter type, manufacturer, and expected transmitter life.
11. A report of the past year's activities (which can be part of the renewal application), including any issues such as accidental mortality/oversampling exceeding 10%, is required before permits will be renewed or new permits will be issued. If the project has finished and the permit will not be renewed, the report is due within 30 days of the expiry of the permit.
12. All observations made during your project are to be provided within either:
    a) A FWMIS Load Form, or
    b) Where USFWS bands are used in the project, a "Band Manager" or "BANDIT" digital export. Note: Banding data locations are to be provided as Latitude/Longitude in Degrees-Minutes-Seconds.

    FWMIS.xls digital files can be accessed at the following web site:
    http://aep.alberta.ca/fish-wildlife/fwmis/wildlife-load-forms.aspx

    Instructions for submitting banding data are available at:
    http://aep.alberta.ca/fish-wildlife/wildlife-research-collection/default.aspx

    This completed data file, including the permit number, is to be attached to your annual or final progress report, upon completion of the project (no later than December 1st annually).

APPENDIX C: DETAILED RESULTS OF VISUAL OBSERVATION SURVEYS

Table C1 Visual Observation Details of Flying Bats

Site	Night	Temperature (°C)		Bat Observation		
		Start	End	Time	# Individuals	Behaviour
M3	31-Jul-17	18	12.5	--	0	--
M2-1	1-Aug-17	16	10	1:35	2	hunting over pond
M1	2-Aug-17	12	6	3:10	1	hunting
	2-Aug-17	12	6	3:15	2	hunting
	2-Aug-17	12	6	3:40	1	hunting
M3	14-Aug-17	7	3	--	0	--
M2-1	15-Aug-17	15	10	--	0	--
M1	16-Aug-17	21	12	21:15	1	flying overhead (not hunting)
	16-Aug-17	21	12	21:17	1	flying into mine portal
	16-Aug-17	21	12	21:30	10	flying in and out of mine portal
	16-Aug-17	21	12	21:50	2	flying in straight line
	16-Aug-17	21	12	3:30	2	flying in straight line
	16-Aug-17	21	12	4:10	1	flying in straight line
M3	28-Aug-17	19	12	--	0	--
M2-1	29-Aug-17	22	14	4:00	3	hunting over pond near M2-1, but no bats observed at M2-1
M1	30-Aug-17	27	13	20:50	2	flying high in the trees

Table C1 Visual Observation Details of Flying Bats

Site	Night	Temperature (°C)		Bat Observation		
		Start	End	Time	# Individuals	Behaviour
	30-Aug-17	27	13	21:41	1	flew out of portal, avoided nets which were blowing in the wind
M1	4-Sep-17	17	6	20:35	1	flying low
	4-Sep-17	17	6	20:45	1	zig zagging above nets
	4-Sep-17	17	6	20:50	1	hunting near nets
	4-Sep-17	17	6	21:00	1	flying around portal
	4-Sep-17	17	6	21:10	2	flying around portal, dodging nets
	4-Sep-17	17	6	21:20	1	flying straight
M3	24-Sep-17	9	4	--	0	--
M2-1	25-Sep-17	11	7	--	0	--
M1	26-Sep-17	14	4	--	0	--

APPENDIX D: DETAILED ACOUSTIC RESULTS - NIGHTLY

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Table D1 Number of Bat Passes Detected at Site M1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	165	371	144	12	692	536
July 29	167	367	97	13	644	534
July 30	335	256	83	13	687	591
July 31	280	309	84	25	698	589
August 1	268	306	27	103	704	574
August 2	4	12	1	0	17	16
August 3	450	231	128	27	836	681
August 4	265	315	41	105	726	580
August 5	195	282	24	77	578	477
August 6	294	301	65	81	741	595
August 7	809	172	4	54	1,039	981
August 8	322	162	12	62	558	484
August 9	545	188	16	52	801	733
August 10	519	253	22	139	933	772
August 11	556	265	17	40	878	821
August 12	1,111	257	11	34	1,413	1,368
August 13	877	276	22	44	1,219	1,153
August 14	352	124	6	13	495	476
August 15	551	118	14	11	694	669
August 16	140	22	5	13	180	162
August 17	332	50	33	40	455	382
August 18	440	460	16	33	949	900
August 19	1,263	1,515	117	130	3,025	2,778
August 20	1,279	1,127	96	149	2,651	2,406
August 21	979	627	44	145	1,795	1,606
August 22	847	1,270	98	77	2,292	2,117
August 23	785	438	3	55	1,281	1,223
August 24	728	1,356	202	107	2,393	2,084
August 25	1,148	1,273	100	135	2,656	2,421

Table D1 Number of Bat Passes Detected at Site M1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	1,110	787	37	57	1,991	1,897
August 27	1,340	594	7	59	2,000	1,934
August 28	1,052	677	4	94	1,827	1,729
August 29	1,155	670	7	121	1,953	1,825
August 30	519	174	7	49	749	693
August 31	246	500	26	201	973	746
September 1	194	470	52	336	1,052	664
September 2	216	606	57	267	1,146	822
September 3	229	809	88	136	1,262	1,038
September 4	60	367	37	29	493	427
September 5	-	-	-	-	-	-
September 6	-	-	-	-	-	-
September 7	-	-	-	-	-	-
September 8	-	-	-	-	-	-
September 9	-	-	-	-	-	-
September 10	-	-	-	-	-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	17	0	0	1	18	17
September 22	58	8	0	1	67	66
September 23	9	7	0	10	26	16

Table D1 Number of Bat Passes Detected at Site M1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	41	2	0	26	69	43
September 25	14	21	6	5	46	35
September 26	17	16	0	1	34	33
September 27	5	16	0	1	22	21
September 28	12	12	2	2	28	24
September 29	21	14	0	0	35	35
September 30	0	0	3	5	8	0
October 1	7	0	0	0	7	7
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	2	2	0
October 5	0	0	0	0	0	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	1	1	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	*22,328*	*18,453*	*1,865*	*3,193*	*45,839*	*40,781*

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D2 Number of Bat Passes Detected at Site M2-1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	11	0	0	2	13	11
July 29	1	0	0	2	3	1
July 30	0	0	0	1	1	0
July 31	2	0	0	1	3	2
August 1	5	0	0	6	11	5
August 2	4	0	0	13	17	4
August 3	19	0	0	21	40	19
August 4	3	0	0	19	22	3
August 5	6	0	0	14	20	6
August 6	17	0	0	14	31	17
August 7	7	0	0	31	38	7
August 8	13	0	1	16	30	13
August 9	11	1	0	29	41	12
August 10	13	0	5	54	72	13
August 11	5	3	19	27	54	8
August 12	18	0	2	18	38	18
August 13	13	0	0	16	29	13
August 14	0	0	0	7	7	0
August 15	3	0	0	4	7	3
August 16	7	5	0	22	34	12
August 17	7	0	0	35	42	7
August 18	11	0	0	52	63	11
August 19	12	0	0	53	65	12
August 20	11	3	0	102	116	14
August 21	12	7	0	35	54	19
August 22	3	2	2	37	44	5
August 23	0	0	2	37	39	0
August 24	8	0	0	49	57	8
August 25	16	3	0	190	209	19

Table D2 Number of Bat Passes Detected at Site M2-1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	7	0	0	67	74	7
August 27	7	0	0	25	32	7
August 28	10	3	2	25	40	13
August 29	6	2	0	29	37	8
August 30	5	0	0	23	28	5
August 31	2	0	0	48	50	2
September 1	3	0	0	26	29	3
September 2	1	0	0	107	108	1
September 3	4	0	0	26	30	4
September 4	1	0	0	14	15	1
September 5	0	0	0	7	7	0
September 6	1	0	0	23	24	1
September 7	0	0	0	7	7	0
September 8	0	0	0	15	15	0
September 9	0	0	0	0	0	0
September 10	0	0	0	38	38	0
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	0	0	0
September 22	0	0	0	0	0	0
September 23	0	0	0	9	9	0

Table D2 Number of Bat Passes Detected at Site M2-1

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	8	8	0
September 25	0	0	0	14	14	0
September 26	0	0	0	5	5	0
September 27	0	0	0	6	6	0
September 28	0	0	0	0	0	0
September 29	0	0	0	4	4	0
September 30	0	0	0	0	0	0
October 1	0	0	0	0	0	0
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	1	1	0
October 5	0	0	0	5	5	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	285	29	33	1,439	1,786	314

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D3 Number of Bat Passes Detected at Site M2-2&3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	79	208	22	11	320	287
July 29	66	121	0	6	193	187
July 30	41	151	2	1	195	192
July 31	17	80	0	0	97	97
August 1	17	74	3	3	97	91
August 2	12	73	1	0	86	85
August 3	38	139	11	5	193	177
August 4	27	68	2	7	104	95
August 5	41	52	1	8	102	93
August 6	48	204	1	7	260	252
August 7	4	59	1	2	66	63
August 8	49	99	2	1	151	148
August 9	38	100	0	0	138	138
August 10	37	134	4	0	175	171
August 11	64	161	24	2	251	225
August 12	78	112	1	42	233	190
August 13	56	76	3	22	157	132
August 14	28	22	0	2	52	50
August 15	54	58	0	14	126	112
August 16	67	77	3	12	159	144
August 17	57	76	4	8	145	133
August 18	29	65	2	10	106	94
August 19	41	196	6	4	247	237
August 20	30	161	0	9	200	191
August 21	26	62	4	6	98	88
August 22	36	96	5	22	159	132
August 23	9	89	0	5	103	98
August 24	19	100	0	7	126	119
August 25	38	221	0	13	272	259

Table D3 Number of Bat Passes Detected at Site M2-2&3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	22	146	0	8	176	168
August 27	3	61	0	3	67	64
August 28	19	152	0	7	178	171
August 29	14	58	0	6	78	72
August 30	10	65	0	0	75	75
August 31	9	77	0	0	86	86
September 1	0	97	0	3	100	97
September 2	3	155	0	0	158	158
September 3	5	67	0	0	72	72
September 4	6	43	0	0	49	49
September 5	5	16	0	0	21	21
September 6	0	7	0	0	7	7
September 7	0	5	0	0	5	5
September 8	0	5	0	0	5	5
September 9	-	-	-	-	-	-
September 10	-	-	-	-	-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	0	0	0
September 22	0	4	0	0	4	4
September 23	0	28	0	0	28	28

Table D3 Number of Bat Passes Detected at Site M2-2&3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	41	0	0	41	41
September 25	0	16	0	0	16	16
September 26	0	11	0	0	11	11
September 27	0	3	0	0	3	3
September 28	0	3	0	0	3	3
September 29	0	13	0	0	13	13
September 30	0	0	0	0	0	0
October 1	0	0	0	0	0	0
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	0	0	0
October 5	0	0	0	0	0	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	1,242	4,207	102	256	5,807	5,449

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D4 Number of Bat Passes Detected at Site M2-4

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	36	21	6	196	259	57
July 29	45	17	5	175	242	62
July 30	38	0	0	95	133	38
July 31	6	0	3	78	87	6
August 1	16	3	1	121	141	19
August 2	11	1	0	93	105	12
August 3	44	2	0	76	122	46
August 4	26	2	0	43	71	28
August 5	34	1	0	95	130	35
August 6	75	13	0	244	332	88
August 7	37	6	0	163	206	43
August 8	20	0	1	208	229	20
August 9	43	0	1	112	156	43
August 10	52	1	0	278	331	53
August 11	113	24	21	207	365	137
August 12	78	12	0	254	344	90
August 13	22	5	0	78	105	27
August 14	13	1	0	111	125	14
August 15	30	7	3	107	147	37
August 16	48	18	0	84	150	66
August 17	53	15	0	148	216	68
August 18	21	3	0	154	178	24
August 19	122	16	0	473	611	138
August 20	82	20	0	285	387	102
August 21	57	1	0	164	222	58
August 22	75	3	0	492	570	78
August 23	61	17	0	156	234	78
August 24	40	4	0	166	210	44
August 25	43	7	0	337	387	50

Table D4 Number of Bat Passes Detected at Site M2-4

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	25	23	0	184	232	48
August 27	22	6	3	199	230	28
August 28	11	0	0	94	105	11
August 29	14	0	0	212	226	14
August 30	20	0	0	41	61	20
August 31	5	0	0	104	109	5
September 1	2	0	0	104	106	2
September 2	7	0	0	122	129	7
September 3	10	0	0	23	33	10
September 4	-	-	-	-	-	-
September 5	-	-	-	-	-	-
September 6	-	-	-	-	-	-
September 7	-	-	-	-	-	-
September 8	-	-	-	-	-	-
September 9	-	-	-	-	-	-
September 10	-	-	-	-	-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	3	3	0
September 22	0	0	0	6	6	0
September 23	0	0	0	20	20	0

Table D4 Number of Bat Passes Detected at Site M2-4

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	16	16	0
September 25	0	0	0	16	16	0
September 26	0	0	0	4	4	0
September 27	0	0	0	7	7	0
September 28	0	0	0	11	11	0
September 29	0	0	0	2	2	0
September 30	0	0	0	0	0	0
October 1	0	0	0	4	4	0
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	2	2	0
October 5	0	0	0	0	0	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	1,457	249	44	6,367	8,117	1,706

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D5 Number of Bat Passes Detected at Site M3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	7	3	0	26	36	10
July 29	12	0	0	24	36	12
July 30	17	1	0	34	52	18
July 31	35	0	0	43	78	35
August 1	22	0	0	59	81	22
August 2	44	1	1	54	100	45
August 3	28	0	0	121	149	28
August 4	29	1	0	106	136	30
August 5	35	1	5	172	213	36
August 6	18	0	2	117	137	18
August 7	10	1	0	87	98	11
August 8	16	0	0	56	72	16
August 9	11	0	0	49	60	11
August 10	27	0	5	68	100	27
August 11	46	0	5	158	209	46
August 12	26	3	0	89	118	29
August 13	37	16	1	146	200	53
August 14	0	0	0	2	2	0
August 15	10	6	0	31	47	16
August 16	49	14	0	132	195	63
August 17	26	0	0	154	180	26
August 18	10	2	0	278	290	12
August 19	47	5	0	163	215	52
August 20	13	5	0	151	169	18
August 21	14	0	0	152	166	14
August 22	38	1	0	137	176	39
August 23	20	4	0	205	229	24
August 24	20	3	1	270	294	23
August 25	35	2	3	143	183	37

Table D5 Number of Bat Passes Detected at Site M3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	22	13	0	100	135	35
August 27	21	0	0	99	120	21
August 28	21	2	0	168	191	23
August 29	16	4	0	133	153	20
August 30	14	3	0	144	161	17
August 31	11	0	0	138	149	11
September 1	22	0	0	542	564	22
September 2	31	6	0	1,325	1,362	37
September 3	6	0	0	44	50	6
September 4	3	1	0	12	16	4
September 5	12	1	0	9	22	13
September 6	-	-	-	-	-	-
September 7	-	-	-	-	-	-
September 8	-	-	-	-	-	-
September 9	-	-	-	-	-	-
September 10	-	-	-	-	-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	2	2	0
September 22	0	0	0	0	0	0
September 23	0	0	0	4	4	0

Table D5 Number of Bat Passes Detected at Site M3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	12	12	0
September 25	0	0	0	8	8	0
September 26	0	0	0	0	0	0
September 27	0	0	0	0	0	0
September 28	0	0	0	0	0	0
September 29	0	0	0	0	0	0
September 30	0	0	0	1	1	0
October 1	0	0	0	0	0	0
October 2	0	0	0	1	1	0
October 3	0	0	0	0	0	0
October 4	0	0	0	0	0	0
October 5	0	0	0	0	0	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	881	99	23	5,969	6,972	980

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D6 Number of Bat Passes Detected at Site R1-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	49	14	0	59	122	63
July 29	83	21	8	44	156	104
July 30	121	31	0	40	192	152
July 31	44	1	0	90	135	45
August 1	36	11	0	11	58	47
August 2	90	19	8	92	209	109
August 3	43	7	0	70	120	50
August 4	62	8	2	13	85	70
August 5	22	3	1	14	40	25
August 6	21	18	0	51	90	39
August 7	33	4	0	20	57	37
August 8	25	3	5	10	43	28
August 9	54	0	7	48	109	54
August 10	18	8	1	44	71	26
August 11	9	8	3	40	60	17
August 12	36	0	0	64	100	36
August 13	82	4	0	42	128	86
August 14	92	5	0	27	124	97
August 15	41	0	0	41	82	41
August 16	24	0	0	149	173	24
August 17	12	0	0	54	66	12
August 18	7	0	0	110	117	7
August 19	80	0	0	109	189	80
August 20	55	0	0	98	153	55
August 21	4	2	0	27	33	6
August 22	30	0	0	55	85	30
August 23	27	0	0	18	45	27
August 24	3	0	0	88	91	3
August 25	19	0	0	73	92	19

Table D6 Number of Bat Passes Detected at Site R1-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	8	0	0	30	38	8
August 27	3	0	0	96	99	3
August 28	6	2	0	46	54	8
August 29	5	0	0	23	28	5
August 30	12	2	0	57	71	14
August 31	5	0	0	294	299	5
September 1	9	0	0	322	331	9
September 2	5	0	0	529	534	5
September 3	9	0	0	5	14	9
September 4	-	-	-		-	-
September 5	-	-	-		-	-
September 6	-	-	-		-	-
September 7	-	-	-		-	-
September 8	-	-	-		-	-
September 9	-	-	-		-	-
September 10	-	-	-		-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	0	0	0
September 22	0	0	0	2	2	0
September 23	0	0	0	1	1	0

Table D6 Number of Bat Passes Detected at Site R1-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	6	6	0
September 25	2	0	0	53	55	2
September 26	0	0	0	13	13	0
September 27	0	0	0	18	18	0
September 28	0	0	0	5	5	0
September 29	0	0	0	29	29	0
September 30	0	0	0	0	0	0
October 1	0	0	0	0	0	0
October 2	0	1	0	0	1	1
October 3	0	0	0	0	0	0
October 4	0	0	0	0	0	0
October 5	0	0	0	10	10	0
October 6	0	0	0	2	2	0
October 7	0	0	0	1	1	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	1,286	172	35	3,143	4,636	1,458

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D7 Number of Bat Passes Detected at Site R1-7

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	49	0	0	49	98	49
July 29	191	0	0	69	260	191
July 30	87	4	0	62	153	91
July 31	93	0	0	20	113	93
August 1	317	2	0	46	365	319
August 2	103	0	0	52	155	103
August 3	98	0	0	37	135	98
August 4	79	0	0	39	118	79
August 5	83	0	0	14	97	83
August 6	55	0	1	19	75	55
August 7	229	0	0	13	242	229
August 8	115	0	0	27	142	115
August 9	187	0	0	79	266	187
August 10	53	0	0	60	113	53
August 11	40	1	0	16	57	41
August 12	69	0	0	51	120	69
August 13	499	7	0	91	597	506
August 14	183	0	0	28	211	183
August 15	191	0	0	203	394	191
August 16	130	2	0	135	267	132
August 17	252	0	0	163	415	252
August 18	226	0	0	187	413	226
August 19	113	0	0	55	168	113
August 20	57	1	0	23	81	58
August 21	87	1	0	22	110	88
August 22	111	4	0	59	174	115
August 23	158	0	0	22	180	158
August 24	113	1	0	53	167	114
August 25	166	0	0	77	243	166

Table D7 Number of Bat Passes Detected at Site R1-7

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	18	0	0	9	27	18
August 27	13	0	0	37	50	13
August 28	18	0	0	6	24	18
August 29	4	0	0	5	9	4
August 30	61	0	0	55	116	61
August 31	44	0	0	18	62	44
September 1	25	0	0	116	141	25
September 2	78	0	0	112	190	78
September 3	0	0	0	12	12	0
September 4	4	0	0	13	17	4
September 5	-	-	-		-	-
September 6	-	-	-		-	-
September 7	-	-	-		-	-
September 8	-	-	-		-	-
September 9	-	-	-		-	-
September 10	-	-	-		-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	0	0	0
September 22	0	0	0	1	1	0
September 23	0	0	0	0	0	0

Table D7 Number of Bat Passes Detected at Site R1-7

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	0	0	0
September 25	0	0	0	3	3	0
September 26	0	0	0	0	0	0
September 27	0	0	0	0	0	0
September 28	0	0	0	0	0	0
September 29	0	0	0	0	0	0
September 30	0	0	0	0	0	0
October 1	0	0	0	0	0	0
October 2	0	0	0	0	0	0
October 3	0	0	0	2	2	0
October 4	0	0	0	0	0	0
October 5	0	0	0	0	0	0
October 6	0	0	0	2	2	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	4,399	23	1	2,162	6,585	4,422

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D8 Number of Bat Passes Detected at Site R4-2

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	18	1	0	38	57	19
July 29	8	0	0	30	38	8
July 30	10	1	0	19	30	11
July 31	3	0	1	0	4	3
August 1	35	4	2	56	97	39
August 2	7	0	0	14	21	7
August 3	13	0	2	10	25	13
August 4	19	3	7	9	38	22
August 5	7	2	7	25	41	9
August 6	18	0	1	17	36	18
August 7	10	2	0	14	26	12
August 8	32	0	2	57	91	32
August 9	7	1	0	31	39	8
August 10	7	0	15	30	52	7
August 11	13	1	0	30	44	14
August 12	8	0	0	11	19	8
August 13	4	0	0	5	9	4
August 14	20	0	0	22	42	20
August 15	1	5	0	14	20	6
August 16	3	0	2	13	18	3
August 17	1	0	0	13	14	1
August 18	3	3	0	24	30	6
August 19	11	0	0	35	46	11
August 20	6	1	0	30	37	7
August 21	20	3	0	59	82	23
August 22	0	0	0	8	8	0
August 23	0	0	0	15	15	0
August 24	3	0	0	21	24	3
August 25	1	0	0	0	1	1

Table D8 Number of Bat Passes Detected at Site R4-2

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	18	1	0	35	54	19
August 27	7	1	0	5	13	8
August 28	2	0	0	4	6	2
August 29	0	0	0	5	5	0
August 30	1	0	0	9	10	1
August 31	1	0	0	21	22	1
September 1	2	0	0	17	19	2
September 2	2	1	0	6	9	3
September 3	3	3	0	3	9	6
September 4	5	4	0	0	9	9
September 5	2	2	0	18	22	4
September 6	5	2	0	18	25	7
September 7	0	1	0	10	11	1
September 8	-	-	-	-	-	-
September 9	-	-	-	-	-	-
September 10	-	-	-	-	-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	0	0	0	0	-	0
September 21	0	0	0	0	0	0
September 22	0	0	0	0	0	0
September 23	0	0	0	1	1	0

Table D8 Number of Bat Passes Detected at Site R4-2

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	0	0	0
September 25	0	0	0	2	2	0
September 26	0	0	0	0	0	0
September 27	0	0	0	6	6	0
September 28	0	0	0	0	0	0
September 29	0	0	0	0	0	0
September 30	0	0	0	0	0	0
October 1	0	0	0	0	0	0
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	0	0	0
October 5	0	0	0	0	0	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	336	42	39	810	1,227	378
Total	18	1	0	38	57	19

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D9 Number of Bat Passes Detected at Site R5a-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	174	29	24	153	380	203
July 29	106	19	20	27	172	125
July 30	54	7	1	32	94	61
July 31	54	9	26	76	165	63
August 1	8	5	0	7	20	13
August 2	7	2	1	15	25	9
August 3	135	9	10	48	202	144
August 4	35	3	6	12	56	38
August 5	9	0	1	9	19	9
August 6	43	6	0	38	87	49
August 7	52	12	3	83	150	64
August 8	34	7	5	64	110	41
August 9	156	2	4	28	190	158
August 10	36	4	12	61	113	40
August 11	106	4	12	98	220	110
August 12	180	29	9	71	289	209
August 13	25	5	4	32	66	30
August 14	17	3	7	53	80	20
August 15	107	48	14	29	198	155
August 16	88	15	8	134	245	103
August 17	55	7	4	41	107	62
August 18	46	0	0	8	54	46
August 19	50	17	18	68	153	67
August 20	73	10	5	36	124	83
August 21	51	10	2	17	80	61
August 22	190	74	1	149	414	264
August 23	140	10	2	47	199	150
August 24	27	0	0	82	109	27
August 25	5	2	0	93	100	7

Table D9 Number of Bat Passes Detected at Site R5a-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	25	4	0	124	153	29
August 27	47	5	0	115	167	52
August 28	52	43	2	105	202	95
August 29	21	4	0	70	95	25
August 30	4	4	0	59	67	8
August 31	0	2	0	159	161	2
September 1	8	3	0	91	102	11
September 2	8	4	0	76	88	12
September 3	36	91	10	20	157	127
September 4	8	0	0	20	28	8
September 5	35	1	0	30	66	36
September 6	7	0	0	33	40	7
September 7	4	0	0	22	26	4
September 8	2	0	0	7	9	2
September 9	0	0	0	0	0	0
September 10	0	2	2	24	28	2
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	0	0	0
September 22	0	0	0	2	2	0
September 23	0	0	0	11	11	0

Table D9 Number of Bat Passes Detected at Site R5a-3

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	18	18	0
September 25	0	0	0	34	34	0
September 26	0	0	0	31	31	0
September 27	0	0	0	19	19	0
September 28	0	0	0	27	27	0
September 29	0	0	0	5	5	0
September 30	0	0	0	1	1	0
October 1	0	0	0	0	0	0
October 2	0	0	0	0	0	0
October 3	0	0	0	0	0	0
October 4	0	0	0	2	2	0
October 5	0	0	0	5	5	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	0	0	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	0	0	0
October 12	0	0	0	0	0	0
Total	2,320	511	213	2,721	5,765	2,831

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table D10 Number of Bat Passes Detected at Site R5a-5

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
July 28	90	4	5	29	128	94
July 29	49	2	2	100	153	51
July 30	31	4	1	210	246	35
July 31	24	3	0	51	78	27
August 1	20	7	1	20	48	27
August 2	13	0	0	13	26	13
August 3	47	3	1	12	63	50
August 4	12	0	1	16	29	12
August 5	10	1	0	14	25	11
August 6	60	9	0	40	109	69
August 7	42	0	10	74	126	42
August 8	80	1	6	28	115	81
August 9	52	9	7	74	142	61
August 10	58	10	9	132	209	68
August 11	74	27	56	415	572	101
August 12	96	8	1	139	244	104
August 13	22	4	0	13	39	26
August 14	51	12	5	24	92	63
August 15	54	18	6	24	102	72
August 16	35	2	2	23	62	37
August 17	33	5	0	32	70	38
August 18	39	9	0	10	58	48
August 19	86	3	0	60	149	89
August 20	29	5	4	24	62	34
August 21	36	16	0	40	92	52
August 22	64	0	0	28	92	64
August 23	40	5	0	113	158	45
August 24	7	3	7	44	61	10
August 25	15	5	0	49	69	20

Table D10 Number of Bat Passes Detected at Site R5a-5

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
August 26	9	6	1	30	46	15
August 27	28	0	0	28	56	28
August 28	19	4	4	96	123	23
August 29	23	1	0	76	100	24
August 30	9	0	0	27	36	9
August 31	26	8	0	17	51	34
September 1	16	0	0	34	50	16
September 2	4	0	0	19	23	4
September 3	13	0	0	9	22	13
September 4	8	0	0	31	39	8
September 5	1	0	0	53	54	1
September 6	7	0	0	29	36	7
September 7	5	0	0	40	45	5
September 8	0	0	0	5	5	0
September 9	-	-	-		-	-
September 10	-	-	-		-	-
September 11	-	-	-	-	-	-
September 12	-	-	-	-	-	-
September 13	-	-	-	-	-	-
September 14	-	-	-	-	-	-
September 15	-	-	-	-	-	-
September 16	-	-	-	-	-	-
September 17	-	-	-	-	-	-
September 18	-	-	-	-	-	-
September 19	-	-	-	-	-	-
September 20	-	-	-	-	-	-
September 21	0	0	0	6	6	0
September 22	0	0	0	15	15	0
September 23	0	0	0	21	21	0

Table D10 Number of Bat Passes Detected at Site R5a-5

Night (all 2017)	MYLU[1]	UNMY >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNMY >35 kHz[5]
September 24	0	0	0	12	12	0
September 25	0	0	0	22	22	0
September 26	0	0	0	10	10	0
September 27	0	0	0	12	12	0
September 28	0	0	0	24	24	0
September 29	0	0	0	3	3	0
September 30	0	0	0	0	0	0
October 1	0	0	0	3	3	0
October 2	0	0	0	2	2	0
October 3	0	0	0	0	0	0
October 4	0	0	0	17	17	0
October 5	0	0	0	32	32	0
October 6	0	0	0	0	0	0
October 7	0	0	0	0	0	0
October 8	0	0	0	1	1	0
October 9	0	0	0	0	0	0
October 10	0	0	0	0	0	0
October 11	0	0	0	2	2	0
October 12	0	0	0	0	0	0
Total	1,437	194	129	2,527	4,287	1,631

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

APPENDIX E: DETAILED ACOUSTIC RESULTS - HOURLY

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Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
July 28	21	21	72	17	2	112	93
	22	25	102	26	0	153	127
	23	34	35	17	0	86	69
	0	19	14	26	1	60	33
	1	15	11	0	1	27	26
	2	8	23	7	1	39	31
	3	9	23	3	2	37	32
	4	21	67	18	5	111	88
	5	13	24	30	0	67	37
	Total	*165*	*371*	*144*	*12*	*692*	*536*
July 29	21	51	75	29	1	156	126
	22	33	59	14	2	108	92
	23	1	8	0	0	9	9
	0	12	35	0	3	50	47
	1	25	40	3	0	68	65
	2	4	11	0	1	16	15
	3	11	31	24	2	68	42
	4	19	51	10	4	84	70
	5	11	57	17	0	85	68
	Total	*167*	*367*	*97*	*13*	*644*	*534*
July 30	21	51	21	0	0	72	72
	22	50	43	14	1	108	93
	23	12	7	1	2	22	19
	0	25	39	0	1	65	64
	1	37	8	9	3	57	45
	2	2	8	0	0	10	10
	3	11	16	1	2	30	27
	4	46	32	16	2	96	78
	5	101	82	42	2	227	183
July 31	*Total*	*335*	*256*	*83*	*13*	*687*	*591*
	21	31	15	2	0	48	46
	22	39	30	19	4	92	69
	23	13	23	2	1	39	36
	0	51	51	17	1	120	102
	1	25	6	0	0	31	31
	2	20	26	0	1	47	46

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	3	13	20	0	9	42	33
	4	40	73	5	7	125	113
	5	48	65	39	2	154	113
	Total	*280*	*309*	*84*	*25*	*698*	*589*
August 1	21	46	30	2	1	79	76
	22	28	18	0	14	60	46
	23	8	5	3	3	19	13
	0	27	13	0	10	50	40
	1	22	8	0	19	49	30
	2	16	16	1	4	37	32
	3	6	23	3	13	45	29
	4	27	56	18	36	137	83
	5	88	137	0	3	228	225
	Total	*268*	*306*	*27*	*103*	*704*	*574*
August 2	21	--	--	--	--	--	--
	22	--	--	--	--	--	--
	23	--	--	--	--	--	--
	0	--	--	--	--	--	--
	1	--	--	--	--	--	--
	2	--	--	--	--	--	--
	3	--	--	--	--	--	--
	4	3	7	1	0	11	10
	5	1	5	0	0	6	6
	Total	*4*	*12*	*1*	*0*	*17*	*16*
August 3	21	133	52	4	1	190	185
	22	45	17	3	1	66	62
	23	32	33	7	1	73	65
	0	16	47	1	1	65	63
	1	13	8	3	0	24	21
	2	14	3	0	4	21	17
	3	3	2	0	1	6	5
	4	32	15	0	12	59	47
	5	162	54	110	6	332	216
	Total	*450*	*231*	*128*	*27*	*836*	*681*
August 4	21	36	58	8	7	109	94
	22	13	27	3	9	52	40

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	23	21	8	0	4	33	29
	0	53	68	17	3	141	121
	1	47	4	0	3	54	51
	2	13	6	0	2	21	19
	3	15	27	0	20	62	42
	4	16	49	1	46	112	65
	5	51	68	12	11	142	119
	Total	*265*	*315*	*41*	*105*	*726*	*580*
August 5	21	33	13	0	1	47	46
	22	19	49	5	42	115	68
	23	19	29	0	2	50	48
	0	10	25	2	3	40	35
	1	38	48	6	10	102	86
	2	28	26	0	1	55	54
	3	1	6	1	9	17	7
	4	17	56	5	9	87	73
	5	30	30	5	0	65	60
	Total	*195*	*282*	*24*	*77*	*578*	*477*
August 6	21	74	44	0	1	119	118
	22	30	34	0	25	89	64
	23	49	35	26	1	111	84
	0	20	51	9	7	87	71
	1	11	5	0	1	17	16
	2	25	19	7	2	53	44
	3	32	50	8	5	95	82
	4	5	7	8	30	50	12
	5	48	56	7	9	120	104
	Total	*294*	*301*	*65*	*81*	*741*	*595*
August 7	21	79	30	1	9	119	109
	22	177	31	0	1	209	208
	23	17	19	0	4	40	36
	0	13	6	1	3	23	19
	1	40	8	0	0	48	48
	2	19	28	0	0	47	47
	3	24	19	0	12	55	43
	4	74	4	2	20	100	78

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	5	366	26	0	5	397	392
	6	0	1	0	0	1	1
	Total	*809*	*172*	*4*	*54*	*1,039*	*981*
August 8	21	53	7	0	0	60	60
	22	51	20	9	11	91	71
	23	33	18	0	2	53	51
	0	35	9	0	3	47	44
	1	28	9	0	13	50	37
	2	18	10	1	0	29	28
	3	2	9	0	21	32	11
	4	27	36	0	0	63	63
	5	75	44	2	12	133	119
	Total	*322*	*162*	*12*	*62*	*558*	*484*
August 9	20	2	0	0	0	2	2
	21	24	8	0	0	32	32
	22	61	16	0	17	94	77
	23	33	5	3	3	44	38
	0	43	14	0	0	57	57
	1	56	13	3	0	72	69
	2	88	30	6	5	129	118
	3	72	16	0	12	100	88
	4	22	10	0	6	38	32
	5	144	76	4	9	233	220
	Total	*545*	*188*	*16*	*52*	*801*	*733*
August 10	21	101	27	0	2	130	128
	22	25	11	0	2	38	36
	23	25	9	0	0	34	34
	0	29	12	4	0	45	41
	1	40	35	4	9	88	75
	2	38	48	0	17	103	86
	3	26	14	2	12	54	40
	4	103	35	1	63	202	138
	5	131	62	11	34	238	193
	6	1	0	0	0	1	1
	Total	*519*	*253*	*22*	*139*	*933*	*772*
August 11	21	143	18	6	7	174	161

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	22	85	68	2	4	159	153
	23	58	20	0	6	84	78
	0	41	34	3	5	83	75
	1	75	17	0	3	95	92
	2	25	27	2	4	58	52
	3	27	20	1	1	49	47
	4	25	36	2	9	72	61
	5	77	23	1	1	102	100
	6	0	2	0	0	2	2
	Total	*556*	*265*	*17*	*40*	*878*	*821*
August 12	21	253	11	0	4	268	264
	22	106	58	1	6	171	164
	23	84	17	4	6	111	101
	0	83	24	0	11	118	107
	1	122	41	0	0	163	163
	2	111	8	0	0	119	119
	3	42	15	2	2	61	57
	4	146	41	0	3	190	187
	5	156	40	4	2	202	196
	6	8	2	0	0	10	10
	Total	*1,111*	*257*	*11*	*34*	*1,413*	*1,368*
August 13	21	314	134	6	4	458	448
	22	134	29	7	2	172	163
	23	61	23	4	4	92	84
	0	27	12	0	3	42	39
	1	48	13	0	7	68	61
	2	81	14	4	6	105	95
	3	57	15	0	4	76	72
	4	79	25	0	14	118	104
	5	73	10	1	0	84	83
	6	3	1	0	0	4	4
	Total	*877*	*276*	*22*	*44*	*1,219*	*1,153*
August 14	20	5	0	0	0	5	5
	21	79	7	0	0	86	86
	22	141	75	6	6	228	216
	23	12	3	0	1	16	15

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	0	3	5	0	1	9	8
	1	13	2	0	2	17	15
	2	37	32	0	1	70	69
	3	16	0	0	0	16	16
	4	9	0	0	0	9	9
	5	37	0	0	2	39	37
	Total	*352*	*124*	*6*	*13*	*495*	*476*
August 15	21	192	57	0	5	254	249
	22	4	0	0	2	6	4
	23	45	7	0	2	54	52
	0	25	2	0	0	27	27
	1	12	3	0	0	15	15
	2	88	20	8	0	116	108
	3	14	3	0	0	17	17
	4	53	4	0	0	57	57
	5	110	22	6	2	140	132
	6	8	0	0	0	8	8
	Total	*551*	*118*	*14*	*11*	*694*	*669*
August 16	21	--	--	--	--	--	--
	22	--	--	--	--	--	--
	23	--	--	--	--	--	--
	0	--	--	--	--	--	--
	1	--	--	--	--	--	--
	2	--	--	--	--	--	--
	3	--	--	--	--	--	--
	4	--	--	--	--	--	--
	5	125	18	0	13	156	143
	6	15	4	5	0	24	19
	Total	*140*	*22*	*5*	*13*	*180*	*162*
August 17	21	44	14	7	12	77	58
	22	19	9	0	1	29	28
	23	12	4	0	6	22	16
	0	28	6	3	5	42	34
	1	26	5	8	1	40	31
	2	17	2	10	0	29	19
	3	16	1	0	2	19	17

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	13	3	0	6	22	16
	5	149	6	5	7	167	155
	6	8	0	0	0	8	8
	Total	*332*	*50*	*33*	*40*	*455*	*382*
August 18	20	0	0	0	0	0	0
	21	107	116	4	1	228	223
	22	11	11	0	0	22	22
	23	12	15	0	4	31	27
	0	17	9	0	0	26	26
	1	8	0	0	0	8	8
	2	15	7	0	1	23	22
	3	35	1	0	1	37	36
	4	32	1	0	6	39	33
	5	187	297	11	20	515	484
	6	16	3	1	0	20	19
	Total	*440*	*460*	*16*	*33*	*949*	*900*
August 19	20	9	4	0	0	13	13
	21	271	334	21	10	636	605
	22	196	215	26	9	446	411
	23	114	142	7	54	317	256
	0	68	70	21	6	165	138
	1	82	97	0	2	181	179
	2	90	70	8	3	171	160
	3	114	65	0	0	179	179
	4	115	120	7	8	250	235
	5	146	305	7	38	496	451
	6	58	93	20	0	171	151
	Total	*1,263*	*1,515*	*117*	*130*	*3,025*	*2,778*
August 20	20	7	3	0	0	10	10
	21	290	218	21	9	538	508
	22	52	64	10	2	128	116
	23	50	15	0	2	67	65
	0	92	22	6	7	127	114
	1	90	123	4	2	219	213
	2	104	81	1	2	188	185
	3	100	46	13	0	159	146

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	110	94	2	24	230	204
	5	306	440	39	79	864	746
	6	78	21	0	22	121	99
	Total	*1,279*	*1,127*	*96*	*149*	*2,651*	*2,406*
August 21	20	9	0	0	0	9	9
	21	244	89	0	13	346	333
	22	55	20	5	1	81	75
	23	22	6	0	16	44	28
	0	47	7	0	0	54	54
	1	51	8	4	25	88	59
	2	42	16	9	8	75	58
	3	54	27	4	30	115	81
	4	59	85	2	28	174	144
	5	282	270	20	24	596	552
	6	114	99	0	0	213	213
	Total	*979*	*627*	*44*	*145*	*1,795*	*1,606*
August 22	20	1	0	0	0	1	1
	21	217	96	0	14	327	313
	22	72	92	21	1	186	164
	23	45	11	0	1	57	56
	0	58	40	0	4	102	98
	1	64	26	0	2	92	90
	2	33	37	0	4	74	70
	3	29	13	4	3	49	42
	4	72	55	4	12	143	127
	5	161	435	38	30	664	596
	6	95	465	31	6	597	560
	Total	*847*	*1,270*	*98*	*77*	*2,292*	*2,117*
August 23	20	61	106	0	0	167	167
	21	183	82	1	7	273	265
	22	41	18	0	8	67	59
	23	53	11	0	1	65	64
	0	86	21	0	4	111	107
	1	70	6	0	0	76	76
	2	49	27	0	17	93	76
	3	22	20	0	1	43	42

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	51	34	0	8	93	85
	5	96	92	2	6	196	188
	6	73	21	0	3	97	94
	Total	*785*	*438*	*3*	*55*	*1,281*	*1,223*
August 24	20	83	77	0	0	160	160
	21	135	34	3	1	173	169
	22	21	14	3	0	38	35
	23	27	30	0	4	61	57
	0	48	19	1	0	68	67
	1	31	46	0	6	83	77
	2	24	25	0	3	52	49
	3	26	16	0	2	44	42
	4	96	219	46	10	371	315
	5	194	735	124	81	1,134	929
	6	43	141	25	0	209	184
	Total	*728*	*1,356*	*202*	*107*	*2,393*	*2,084*
August 25	20	55	44	6	0	105	99
	21	250	187	10	6	453	437
	22	141	216	10	10	377	357
	23	132	106	17	56	311	238
	0	78	57	0	14	149	135
	1	60	54	1	0	115	114
	2	69	119	36	4	228	188
	3	90	23	2	6	121	113
	4	110	113	10	15	248	223
	5	126	252	5	15	398	378
	6	37	102	3	9	151	139
	Total	*1,148*	*1,273*	*100*	*135*	*2,656*	*2,421*
August 26	20	32	32	0	0	64	64
	21	258	178	24	7	467	436
	22	141	41	13	0	195	182
	23	78	47	0	9	134	125
	0	49	16	0	12	77	65
	1	84	8	0	5	97	92
	2	55	6	0	3	64	61
	3	38	19	0	1	58	57

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	63	88	0	6	157	151
	5	200	208	0	14	422	408
	6	112	144	0	0	256	256
	Total	*1,110*	*787*	*37*	*57*	*1,991*	*1,897*
August 27	20	52	18	0	0	70	70
	21	389	159	7	17	572	548
	22	83	24	0	1	108	107
	23	246	54	0	2	302	300
	0	97	3	0	14	114	100
	1	57	22	0	0	79	79
	2	109	30	0	0	139	139
	3	36	10	0	1	47	46
	4	46	19	0	2	67	65
	5	159	133	0	22	314	292
	6	66	122	0	0	188	188
	Total	*1,340*	*594*	*7*	*59*	*2,000*	*1,934*
August 28	20	111	38	0	3	152	149
	21	262	164	0	1	427	426
	22	92	90	0	3	185	182
	23	116	58	0	5	179	174
	0	47	38	0	0	85	85
	1	30	7	0	16	53	37
	2	38	32	0	8	78	70
	3	60	21	0	14	95	81
	4	60	35	0	8	103	95
	5	115	141	4	34	294	256
	6	121	53	0	2	176	174
	Total	*1,052*	*677*	*4*	*94*	*1,827*	*1,729*
August 29	20	97	19	0	17	133	116
	21	191	112	0	53	356	303
	22	84	60	0	2	146	144
	23	111	81	0	10	202	192
	0	54	66	0	9	129	120
	1	94	30	0	1	125	124
	2	116	125	0	0	241	241
	3	35	31	0	5	71	66

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	50	53	0	7	110	103
	5	95	46	7	17	165	141
	6	228	47	0	0	275	275
	Total	*1,155*	*670*	*7*	*121*	*1,953*	*1,825*
August 30	20	109	20	0	2	131	129
	21	62	16	0	0	78	78
	22	68	8	0	0	76	76
	23	53	6	0	2	61	59
	0	18	0	0	4	22	18
	1	9	1	0	7	17	10
	2	50	19	0	5	74	69
	3	9	1	0	6	16	10
	4	29	10	0	12	51	39
	5	23	44	4	9	80	67
	6	89	49	3	2	143	138
	Total	*519*	*174*	*7*	*49*	*749*	*693*
August 31	20	38	20	0	1	59	58
	21	77	103	3	12	195	180
	22	25	62	4	9	100	87
	23	16	13	5	6	40	29
	0	9	19	0	0	28	28
	1	7	13	6	3	29	20
	2	4	6	0	3	13	10
	3	5	10	0	21	36	15
	4	7	27	0	22	56	34
	5	28	106	0	85	219	134
	6	30	121	8	39	198	151
	Total	*246*	*500*	*26*	*201*	*973*	*746*
September 1	20	30	48	0	8	86	78
	21	49	50	8	0	107	99
	22	24	60	0	0	84	84
	23	19	37	12	10	78	56
	0	2	24	11	6	43	26
	1	1	19	4	2	26	20
	2	6	36	5	20	67	42
	3	12	44	2	9	67	56

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	13	42	6	59	120	55
	5	25	51	4	143	223	76
	6	13	59	0	79	151	72
	Total	*194*	*470*	*52*	*336*	*1,052*	*664*
September 2	20	64	61	0	20	145	125
	21	49	60	3	5	117	109
	22	20	62	8	26	116	82
	23	5	35	4	15	59	40
	0	11	17	3	15	46	28
	1	2	15	5	3	25	17
	2	6	36	16	0	58	42
	3	14	18	3	14	49	32
	4	22	57	0	54	133	79
	5	13	60	6	111	190	73
	6	10	185	9	4	208	195
	Total	*216*	*606*	*57*	*267*	*1,146*	*822*
September 3	20	41	50	0	0	91	91
	21	15	130	15	7	167	145
	22	21	62	23	38	144	83
	23	9	124	14	11	158	133
	0	35	176	22	6	239	211
	1	9	31	1	11	52	40
	2	25	68	5	27	125	93
	3	18	67	2	5	92	85
	4	11	31	4	9	55	42
	5	41	58	2	22	123	99
	6	4	12	0	0	16	16
	Total	*229*	*809*	*88*	*136*	*1,262*	*1,038*
September 4	20	3	132	0	7	142	135
	21	32	88	20	22	162	120
	22	18	76	4	0	98	94
	23	4	61	13	0	78	65
	0	3	5	0	0	8	8
	1	0	5	0	0	5	5
	Total	*60*	*367*	*37*	*29*	*493*	*427*
September 21	20	8	0	0	0	8	8

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	21	9	0	0	0	9	9
	23	0	0	0	1	1	0
	Total	*17*	*0*	*0*	*1*	*18*	*17*
September 23	20	58	8	0	0	66	66
	23	0	0	0	1	1	0
	Total	*58*	*8*	*0*	*1*	*67*	*66*
September 23	19	**0**	6	**0**	0	6	6
	20	9	1	**0**	6	16	10
	21	**0**	**0**	**0**	2	2	0
	2	**0**	**0**	**0**	2	2	0
	Total	*9*	*7*	*0*	*10*	*26*	*16*
September 24	19	6	**0**	**0**	6	12	6
	20	3	1	**0**	2	6	4
	21	0	1	**0**	5	6	1
	22	4	**0**	**0**	2	6	4
	23	0	**0**	**0**	2	2	0
	0	10	**0**	**0**	4	14	10
	4	8	**0**	**0**	3	11	8
	5	**0**	**0**	**0**	2	2	0
	6	10	**0**	**0**	0	10	10
	Total	*41*	*2*	*0*	*26*	*69*	*43*
September 25	19	0	9	**0**	0	9	9
	20	1	6	**0**	1	8	7
	22	2	0	**0**	0	2	2
	23	2	1	**0**	0	3	3
	1	2	1	**0**	0	3	3
	2	3	4	**0**	1	8	7
	3	4	**0**	6	0	10	4
	5	0	**0**	**0**	3	3	0
	Total	*14*	*21*	*6*	*5*	*46*	*35*
September 26	20	6	3	**0**	0	9	9
	21	9	13	**0**	0	22	22
	3	0	0	**0**	1	1	0
	4	2	0	**0**	0	2	2
	Total	*17*	*16*	*0*	*1*	*34*	*33*
September 27	20	4	11	**0**	0	15	15

Table E1 Detailed Results of Acoustic Monitoring at Site M1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	22	0	5	**0**	0	5	5
	23	0	0	**0**	1	1	0
	2	1	0	**0**	0	1	1
	Total	*5*	*16*	*0*	*1*	*22*	*21*
September 28	19	1	7	**0**	0	8	8
	20	7	5	2	2	16	12
	1	4	0	**0**	0	4	4
	Total	*12*	*12*	*2*	*2*	*28*	*24*
September 29	19	0	2	**0**	0	2	2
	20	2	0	**0**	0	2	2
	23	2	7	**0**	0	9	9
	1	3	5	**0**	0	8	8
	2	2	0	**0**	0	2	2
	4	2	0	**0**	0	2	2
	5	5	0	**0**	0	5	5
	6	5	0	**0**	0	5	5
	Total	*21*	*14*	*0*	*0*	*35*	*35*
September 30	22	0	0	3	0	3	0
	3	0	0	**0**	1	1	0
	4	0	0	**0**	2	2	0
	5	0	0	**0**	1	1	0
	6	0	0	**0**	1	1	0
	Total	*0*	*0*	*3*	*5*	*8*	*0*
October 1	21	7	0	**0**	0	7	7
	Total	*7*	*0*	*0*	*0*	*7*	*7*
October 4	19	**0**	**0**	**0**	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
October 10	1	**0**	**0**	**0**	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
Total		**22,328**	**18,453**	**1,865**	**3,193**	**45,839**	**40,781**

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

-- Acoustic monitor turned off while mist netting nearby

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
July 28	22	1	0	0	1	2	1
	0	2	0	0	0	2	2
	3	0	0	0	1	1	0
	5	8	0	0	0	8	8
	Total	*11*	*0*	*0*	*2*	*13*	*11*
July 29	2	1	0	0	0	1	1
	3	0	0	0	2	2	0
	Total	*1*	*0*	*0*	*2*	*3*	*1*
July 30	2	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
July 31	3	0	0	0	1	1	0
	5	2	0	0	0	2	2
	Total	*2*	*0*	*0*	*1*	*3*	*2*
August 1	21	--	--	--	--	--	--
	22	--	--	--	--	--	--
	23	--	--	--	--	--	--
	0	--	--	--	--	--	--
	1	--	--	--	--	--	--
	2	--	--	--	--	--	--
	3	0	0	0	0	0	0
	4	5	0	0	4	9	5
	5	0	0	0	2	2	0
	Total	*5*	*0*	*0*	*6*	*11*	*5*
August 2	22	0	0	0	1	1	0
	0	2	0	0	0	2	2
	1	0	0	0	2	2	0
	3	2	0	0	4	6	2
	4	0	0	0	6	6	0
	Total	*4*	*0*	*0*	*13*	*17*	*4*
August 3	20	0	0	0	0	0	0
	22	8	0	0	5	13	8
	23	0	0	0	4	4	0
	0	0	0	0	1	1	0
	1	0	0	0	1	1	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	2	3	0	0	1	4	3
	4	0	0	0	2	2	0
	5	8	0	0	7	15	8
	Total	*19*	*0*	*0*	*21*	*40*	*19*
August 4	21	0	0	0	7	7	0
	22	0	0	0	2	2	0
	23	0	0	0	3	3	0
	2	2	0	0	2	4	2
	4	1	0	0	1	2	1
	5	0	0	0	4	4	0
	Total	*3*	*0*	*0*	*19*	*22*	*3*
August 5	22	0	0	0	3	3	0
	23	1	0	0	2	3	1
	0	2	0	0	0	2	2
	1	2	0	0	0	2	2
	2	0	0	0	1	1	0
	3	0	0	0	6	6	0
	4	0	0	0	1	1	0
	5	1	0	0	1	2	1
	Total	*6*	*0*	*0*	*14*	*20*	*6*
August 6	22	4	0	0	4	8	4
	23	4	0	0	0	4	4
	0	1	0	0	0	1	1
	2	6	0	0	2	8	6
	3	2	0	0	5	7	2
	4	0	0	0	3	3	0
	Total	*17*	*0*	*0*	*14*	*31*	*17*
August 7	21	1	0	0	0	1	1
	22	0	0	0	1	1	0
	23	2	0	0	0	2	2
	3	2	0	0	3	5	2
	4	2	0	0	21	23	2
	5	0	0	0	6	6	0
	Total	*7*	*0*	*0*	*31*	*38*	*7*
August 8	21	0	0	0	1	1	0
	22	0	0	0	4	4	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	23	2	0	0	2	4	2
	0	1	0	0	1	2	1
	1	4	0	0	0	4	4
	2	0	0	0	2	2	0
	3	0	0	0	2	2	0
	4	2	0	0	3	5	2
	5	4	0	1	1	6	4
	6	0	0	0	0	0	0
	Total	*13*	*0*	*1*	*16*	*30*	*13*
August 9	21	0	0	0	3	3	0
	22	0	1	0	0	1	1
	23	2	0	0	8	10	2
	0	4	0	0	1	5	4
	1	0	0	0	1	1	0
	2	4	0	0	2	6	4
	3	0	0	0	1	1	0
	4	0	0	0	6	6	0
	5	1	0	0	7	8	1
	Total	*11*	*1*	*0*	*29*	*41*	*12*
August 10	22	0	0	3	0	3	0
	23	0	0	2	1	3	0
	0	1	0	0	35	36	1
	1	2	0	0	6	8	2
	2	4	0	0	0	4	4
	3	0	0	0	0	0	0
	4	1	0	0	3	4	1
	5	5	0	0	9	14	5
	Total	*13*	*0*	*5*	*54*	*72*	*13*
August 11	21	0	2	0	6	8	2
	22	0	0	0	4	4	0
	23	5	0	0	4	9	5
	0	0	0	0	4	4	0
	1	0	0	0	1	1	0
	3	0	0	0	1	1	0
	4	0	0	0	3	3	0
	5	0	1	19	4	24	1

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	6	0	0	0	0	0	0
	Total	*5*	*3*	*19*	*27*	*54*	*8*
August 12	21	0	0	0	7	7	0
	23	3	0	0	4	7	3
	0	7	0	0	1	8	7
	1	3	0	0	0	3	3
	2	2	0	2	0	4	2
	3	0	0	0	3	3	0
	4	2	0	0	1	3	2
	5	1	0	0	2	3	1
	Total	*18*	*0*	*2*	*18*	*38*	*18*
August 13	21	2	0	0	2	4	2
	22	4	0	0	1	5	4
	23	1	0	0	1	2	1
	0	2	0	0	4	6	2
	1	3	0	0	6	9	3
	4	0	0	0	2	2	0
	5	1	0	0	0	1	1
	Total	*13*	*0*	*0*	*16*	*29*	*13*
August 14	21	0	0	0	2	2	0
	22	0	0	0	1	1	0
	23	0	0	0	3	3	0
	1	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*7*	*7*	*0*
August 15	21	--	--	--	--	--	--
	22	--	--	--	--	--	--
	23	--	--	--	--	--	--
	0	--	--	--	--	--	--
	1	--	--	--	--	--	--
	2	--	--	--	--	--	--
	3	0	0	0	2	2	0
	4	3	0	0	2	5	3
	6	0	0	0	0	0	0
	Total	*3*	*0*	*0*	*4*	*7*	*3*
August 16	21	4	0	0	4	8	4
	22	1	0	0	0	1	1

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	0	2	0	0	1	3	2
	1	0	0	0	2	2	0
	2	0	0	0	1	1	0
	3	0	3	0	4	7	3
	4	0	0	0	2	2	0
	5	0	0	0	8	8	0
	6	0	2	0	0	2	2
	Total	*7*	*5*	*0*	*22*	*34*	*12*
August 17	21	1	0	0	3	4	1
	22	4	0	0	4	8	4
	23	0	0	0	1	1	0
	0	0	0	0	1	1	0
	1	0	0	0	6	6	0
	2	0	0	0	7	7	0
	3	2	0	0	2	4	2
	4	0	0	0	2	2	0
	5	0	0	0	9	9	0
	Total	*7*	*0*	*0*	*35*	*42*	*7*
August 18	21	1	0	0	2	3	1
	22	0	0	0	4	4	0
	23	0	0	0	1	1	0
	0	0	0	0	4	4	0
	1	5	0	0	7	12	5
	2	0	0	0	10	10	0
	3	0	0	0	2	2	0
	4	2	0	0	7	9	2
	5	3	0	0	13	16	3
	6	0	0	0	2	2	0
	Total	*11*	*0*	*0*	*52*	*63*	*11*
August 19	21	0	0	0	5	5	0
	22	2	0	0	8	10	2
	23	2	0	0	1	3	2
	0	0	0	0	7	7	0
	1	0	0	0	2	2	0
	2	4	0	0	6	10	4
	3	3	0	0	12	15	3

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	4	1	0	0	6	7	1
	5	0	0	0	6	6	0
	Total	*12*	*0*	*0*	*53*	*65*	*12*
August 20	21	0	3	0	26	29	3
	22	1	0	0	14	15	1
	23	2	0	0	7	9	2
	0	1	0	0	9	10	1
	1	1	0	0	1	2	1
	2	0	0	0	6	6	0
	3	4	0	0	3	7	4
	4	2	0	0	18	20	2
	5	0	0	0	18	18	0
	Total	*11*	*3*	*0*	*102*	*116*	*14*
August 21	21	1	0	0	3	4	1
	22	2	0	0	1	3	2
	23	3	0	0	0	3	3
	0	4	3	0	2	9	7
	1	0	0	0	7	7	0
	2	0	0	0	5	5	0
	3	0	0	0	2	2	0
	4	0	0	0	2	2	0
	5	2	0	0	13	15	2
	6	0	4	0	0	4	4
	Total	*12*	*7*	*0*	*35*	*54*	*19*
August 22	21	0	2	0	20	22	2
	22	0	0	0	1	1	0
	23	2	0	0	2	4	2
	1	1	0	0	6	7	1
	3	0	0	0	1	1	0
	4	0	0	0	4	4	0
	5	0	0	2	3	5	0
	Total	*3*	*2*	*2*	*37*	*44*	*5*
August 23	21	0	0	2	11	13	0
	22	0	0	0	7	7	0
	23	0	0	0	5	5	0
	1	0	0	0	4	4	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	2	0	0	0	7	7	0
	4	0	0	0	1	1	0
	5	0	0	0	2	2	0
	Total	*0*	*0*	*2*	*37*	*39*	*0*
August 24	21	2	0	0	1	3	2
	22	2	0	0	3	5	2
	23	0	0	0	3	3	0
	0	0	0	0	10	10	0
	1	1	0	0	3	4	1
	2	0	0	0	5	5	0
	3	1	0	0	6	7	1
	4	2	0	0	7	9	2
	5	0	0	0	10	10	0
	6	0	0	0	1	1	0
	Total	*8*	*0*	*0*	*49*	*57*	*8*
August 25	21	0	0	0	49	49	0
	22	0	0	0	26	26	0
	23	5	0	0	4	9	5
	0	1	0	0	11	12	1
	1	8	0	0	4	12	8
	2	2	3	0	8	13	5
	3	0	0	0	7	7	0
	4	0	0	0	63	63	0
	5	0	0	0	18	18	0
	Total	*16*	*3*	*0*	*190*	*209*	*19*
August 26	21	0	0	0	27	27	0
	22	0	0	0	2	2	0
	23	3	0	0	3	6	3
	0	0	0	0	3	3	0
	1	0	0	0	2	2	0
	3	0	0	0	2	2	0
	4	3	0	0	7	10	3
	5	1	0	0	21	22	1
	Total	*7*	*0*	*0*	*67*	*74*	*7*
August 27	20	0	0	0	2	2	0
	21	5	0	0	0	5	5

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	22	0	0	0	1	1	0
	0	0	0	0	1	1	0
	1	0	0	0	7	7	0
	2	0	0	0	4	4	0
	3	0	0	0	2	2	0
	4	0	0	0	6	6	0
	5	2	0	0	2	4	2
	Total	*7*	*0*	*0*	*25*	*32*	*7*
August 28	20	0	0	0	3	3	0
	21	0	0	0	3	3	0
	22	2	0	0	0	2	2
	23	1	0	0	4	5	1
	0	2	0	0	4	6	2
	1	2	0	2	3	7	2
	2	0	3	0	1	4	3
	3	1	0	0	2	3	1
	5	2	0	0	5	7	2
	Total	*10*	*3*	*2*	*25*	*40*	*13*
August 29	20	0	0	0	2	2	0
	21	1	0	0	5	6	1
	22	3	0	0	2	5	3
	23	2	2	0	2	6	4
	0	0	0	0	1	1	0
	1	0	0	0	5	5	0
	2	0	0	0	1	1	0
	3	0	0	0	3	3	0
	5	0	0	0	8	8	0
	Total	*6*	*2*	*0*	*29*	*37*	*8*
August 30	21	1	0	0	0	1	1
	22	0	0	0	2	2	0
	23	0	0	0	3	3	0
	0	0	0	0	3	3	0
	1	1	0	0	0	1	1
	2	0	0	0	2	2	0
	3	2	0	0	5	7	2
	4	0	0	0	2	2	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	5	1	0	0	4	5	1
	6	0	0	0	2	2	0
	Total	*5*	*0*	*0*	*23*	*28*	*5*
August 31	20	0	0	0	4	4	0
	21	0	0	0	10	10	0
	22	0	0	0	4	4	0
	23	0	0	0	1	1	0
	1	2	0	0	2	4	2
	2	0	0	0	4	4	0
	3	0	0	0	8	8	0
	4	0	0	0	1	1	0
	5	0	0	0	9	9	0
	6	0	0	0	5	5	0
	Total	*2*	*0*	*0*	*48*	*50*	*2*
September 1	20	0	0	0	1	1	0
	21	0	0	0	3	3	0
	22	2	0	0	2	4	2
	0	0	0	0	5	5	0
	2	1	0	0	1	2	1
	3	0	0	0	1	1	0
	4	0	0	0	3	3	0
	5	0	0	0	6	6	0
	6	0	0	0	4	4	0
	Total	*3*	*0*	*0*	*26*	*29*	*3*
September 2	20	0	0	0	4	4	0
	21	0	0	0	39	39	0
	22	0	0	0	29	29	0
	23	0	0	0	11	11	0
	0	0	0	0	7	7	0
	1	0	0	0	6	6	0
	2	1	0	0	0	1	1
	3	0	0	0	4	4	0
	4	0	0	0	1	1	0
	5	0	0	0	6	6	0
	Total	*1*	*0*	*0*	*107*	*108*	*1*
September 3	20	2	0	0	3	5	2

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	21	1	0	0	3	4	1
	22	0	0	0	4	4	0
	23	0	0	0	2	2	0
	0	1	0	0	1	2	1
	1	0	0	0	2	2	0
	2	0	0	0	4	4	0
	3	0	0	0	2	2	0
	4	0	0	0	5	5	0
	Total	*4*	*0*	*0*	*26*	*30*	*4*
September 4	20	0	0	0	2	2	0
	22	1	0	0	3	4	1
	1	0	0	0	1	1	0
	2	0	0	0	1	1	0
	3	0	0	0	5	5	0
	4	0	0	0	2	2	0
	Total	*1*	*0*	*0*	*14*	*15*	*1*
September 5	20	0	0	0	2	2	0
	1	0	0	0	2	2	0
	4	0	0	0	1	1	0
	6	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*7*	*7*	*0*
September 6	20	0	0	0	5	5	0
	21	1	0	0	4	5	1
	2	0	0	0	1	1	0
	5	0	0	0	12	12	0
	6	0	0	0	1	1	0
	Total	*1*	*0*	*0*	*23*	*24*	*1*
September 7	3	0	0	0	2	2	0
	4	0	0	0	3	3	0
	5	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*7*	*7*	*0*
September 8	20	0	0	0	2	2	0
	21	0	0	0	4	4	0
	22	0	0	0	3	3	0
	23	0	0	0	1	1	0
	5	0	0	0	2	2	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	6	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*15*	*15*	*0*
September 10	20	0	0	0	13	13	0
	21	0	0	0	14	14	0
	22	0	0	0	11	11	0
	Total	*0*	*0*	*0*	*38*	*38*	*0*
September 22	6	0	0	0	0	0	0
	7	0	0	0	0	0	0
	Total	*0*	*0*	*0*	*0*	*0*	*0*
September 23	20	0	0	0	1	1	0
	21	0	0	0	5	5	0
	23	0	0	0	1	1	0
	1	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*9*	*9*	*0*
September 24	23	0	0	0	2	2	0
	3	0	0	0	3	3	0
	4	0	0	0	2	2	0
	5	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*8*	*8*	*0*
September 25	21	0	0	0	5	5	0
	22	0	0	0	1	1	0
	23	0	0	0	5	5	0
	5	0	0	0	1	1	0
	6	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*14*	*14*	*0*
September 26	20	0	0	0	0	0	0
	21	0	0	0	2	2	0
	22	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 27	20	0	0	0	2	2	0
	21	0	0	0	3	3	0
	22	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*6*	*6*	*0*
September 29	21	0	0	0	1	1	0
	22	0	0	0	1	1	0
	5	0	0	0	2	2	0

Table E2 Detailed Results of Acoustic Monitoring at Site M2-1							
Night	**Hour**	**MYLU[1]**	**UNID >35 kHz[2]**	**MYVO[3]**	**Other[4]**	**Total**	**MYLU + UNID >35[5]**
	Total	*0*	*0*	*0*	*4*	*4*	*0*
October 4	20	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
October 5	4	0	0	0	5	5	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
Grand Total		285	29	33	1,439	1,786	314

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified Myotis spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

-- Acoustic monitor turned off while mist netting nearby

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	22	7	0	0	4	11	7
	23	5	1	0	13	19	6
	0	12	0	0	36	48	12
	1	2	0	0	18	20	2
	2	6	0	0	50	56	6
	3	1	0	5	22	28	1
	4	27	10	17	38	92	*37*
	5	19	0	0	27	46	19
	Total	*79*	*11*	*22*	*208*	*320*	*90*
July 29	21	1	0	0	1	2	1
	22	1	0	0	10	11	1
	23	11	0	0	28	39	11
	0	0	0	0	30	30	0
	1	6	0	0	20	26	6
	2	26	6	0	2	34	32
	3	5	0	0	5	10	5
	4	16	0	0	21	37	16
	5	0	0	0	4	4	0
	Total	*66*	*6*	*0*	*121*	*193*	*72*
July 30	21	1	0	0	3	4	1
	22	22	0	0	5	27	22
	23	5	0	0	26	31	5
	0	2	0	0	23	25	2
	1	1	0	0	3	4	1
	2	1	0	0	50	51	1
	3	0	1	0	7	8	1
	4	3	0	0	25	28	3
	5	6	0	2	9	17	6
	Total	*41*	*1*	*2*	*151*	*195*	*42*
July 31	21	0	0	0	2	2	0
	22	1	0	0	18	19	1
	23	1	0	0	12	13	1
	0	3	0	0	5	8	3
	1	2	0	0	21	23	2
	2	3	0	0	6	9	3

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	5	0	0	2	7	5
	4	1	0	0	11	12	1
	5	1	0	0	3	4	1
	Total	*17*	*0*	*0*	*80*	*97*	*17*
August 1	21	0	0	0	6	6	0
	22	5	0	0	8	13	5
	23	2	0	0	7	9	2
	0	2	0	0	4	6	2
	1	8	3	0	2	13	11
	2	0	0	0	16	16	0
	3	0	0	3	13	16	0
	4	0	0	0	12	12	0
	5	0	0	0	6	6	0
	Total	*17*	*3*	*3*	*74*	*97*	*20*
August 2	21	0	0	0	2	2	0
	22	0	0	0	11	11	0
	23	3	0	0	10	13	3
	0	2	0	0	7	9	2
	1	3	0	0	0	3	3
	2	2	0	0	21	23	2
	3	1	0	1	7	9	1
	4	1	0	0	15	16	1
	Total	*12*	*0*	*1*	*73*	*86*	*12*
August 3	21	3	0	0	3	6	3
	22	0	0	10	10	20	0
	23	9	0	0	8	17	9
	0	1	0	0	4	5	1
	1	3	4	0	26	33	7
	2	0	0	0	4	4	0
	3	9	1	0	26	36	10
	4	5	0	0	42	47	5
	5	8	0	1	16	25	8
	Total	*38*	*5*	*11*	*139*	*193*	*43*
August 4	21	0	0	0	8	8	0
	22	12	3	0	32	47	15

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	23	4	1	0	19	24	5
	0	0	0	0	2	2	0
	1	6	3	0	0	9	9
	4	5	0	0	3	8	5
	5	0	0	2	4	6	0
	Total	*27*	*7*	*2*	*68*	*104*	*34*
August 5	21	4	0	0	2	6	4
	22	8	0	0	9	17	8
	23	9	0	0	4	13	9
	0	3	0	0	5	8	3
	1	0	0	0	1	1	0
	2	11	8	0	7	26	19
	3	6	0	0	7	13	6
	4	0	0	1	3	4	0
	5	0	0	0	14	14	0
	Total	*41*	*8*	*1*	*52*	*102*	*49*
August 6	21	2	0	0	12	14	2
	22	5	0	0	18	23	5
	23	9	4	1	22	36	13
	0	4	3	0	76	83	7
	1	8	0	0	3	11	8
	2	8	0	0	12	20	8
	3	6	0	0	14	20	6
	4	2	0	0	21	23	2
	5	4	0	0	26	30	4
	Total	*48*	*7*	*1*	*204*	*260*	*55*
August 7	21	0	0	0	8	8	0
	22	0	0	0	7	7	0
	23	4	1	0	6	11	5
	0	0	1	0	0	1	1
	1	0	0	0	12	12	0
	2	0	0	0	4	4	0
	3	0	0	1	0	1	0
	4	0	0	0	11	11	0
	5	0	0	0	11	11	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*4*	*2*	*1*	*59*	*66*	*6*
August 8	21	2	0	0	10	12	2
	22	7	0	0	13	20	7
	23	28	0	0	23	51	28
	0	5	0	2	1	8	5
	1	1	0	0	10	11	1
	2	3	0	0	11	14	3
	3	3	1	0	10	14	4
	4	0	0	0	3	3	0
	5	0	0	0	18	18	0
	Total	*49*	*1*	*2*	*99*	*151*	*50*
August 9	21	6	0	0	6	12	6
	22	3	0	0	3	6	3
	23	6	0	0	15	21	6
	0	13	0	0	2	15	13
	1	2	0	0	9	11	2
	2	4	0	0	1	5	4
	3	2	0	0	6	8	2
	4	1	0	0	14	15	1
	5	1	0	0	44	45	1
	Total	*38*	*0*	*0*	*100*	*138*	*38*
August 10	0	4	0	3	8	15	4
	21	4	0	0	3	7	4
	22	5	0	1	4	10	5
	23	3	0	0	14	17	3
	1	9	0	0	38	47	9
	2	0	0	0	4	4	0
	3	5	0	0	8	13	5
	4	6	0	0	27	33	6
	5	1	0	0	28	29	1
	Total	*37*	*0*	*4*	*134*	*175*	*37*
August 11	21	0	0	0	2	2	0
	22	9	0	11	4	24	9
	23	10	0	0	25	35	10
	0	5	0	13	19	37	5

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	1	0	0	0	22	22	0
	2	8	0	0	0	8	8
	3	24	2	0	15	41	26
	4	6	0	0	16	22	6
	5	2	0	0	58	60	2
	6	0	0	0	0	0	0
	Total	*64*	*2*	*24*	*161*	*251*	*66*
August 12	21	7	3	0	8	18	10
	22	23	2	0	0	25	25
	23	6	7	0	16	29	13
	0	4	3	0	30	37	7
	1	14	12	0	16	42	26
	2	7	2	0	11	20	9
	3	3	0	1	17	21	3
	4	6	2	0	9	17	8
	5	8	11	0	5	24	19
	Total	*78*	*42*	*1*	*112*	*233*	*120*
August 13	21	2	0	0	8	10	2
	22	1	7	0	2	10	8
	0	18	3	0	7	28	21
	1	4	0	1	11	16	4
	2	9	0	1	18	28	9
	3	2	1	1	3	7	3
	4	7	0	0	3	10	7
	5	7	10	0	24	41	17
	6	6	1	0	0	7	7
	Total	*56*	*22*	*3*	*76*	*157*	*78*
August 14	21	9	1	0	2	12	10
	22	1	1	0	3	5	2
	23	3	0	0	1	4	3
	0	8	0	0	3	11	8
	1	1	0	0	3	4	1
	2	2	0	0	6	8	2
	3	2	0	0	3	5	2
	4	0	0	0	1	1	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	2	0	0	0	2	2
	6	0	0	0	0	0	0
	Total	*28*	*2*	*0*	*22*	*52*	*30*
August 15	21	5	0	0	15	20	5
	22	9	0	0	7	16	9
	23	18	4	0	5	27	22
	0	8	6	0	6	20	14
	1	3	0	0	2	5	3
	2	2	0	0	1	3	2
	3	6	0	0	10	16	6
	4	1	4	0	10	15	5
	5	2	0	0	2	4	2
	6	0	0	0	0	0	0
	Total	*54*	*14*	*0*	*58*	*126*	*68*
August 16	21	12	0	0	25	37	12
	22	4	0	0	1	5	4
	0	10	3	0	8	21	13
	1	14	4	0	1	19	18
	2	15	0	0	10	25	15
	3	8	1	3	5	17	9
	4	2	1	0	6	9	3
	5	2	0	0	21	23	2
	6	0	3	0	0	3	3
	Total	*67*	*12*	*3*	*77*	*159*	*79*
August 17	21	7	0	0	15	22	7
	22	7	1	0	0	8	8
	23	1	1	0	6	8	2
	0	11	4	0	2	17	15
	1	12	0	2	3	17	12
	2	6	0	2	4	12	6
	3	0	0	0	17	17	0
	4	9	2	0	15	26	11
	5	3	0	0	13	16	3
	6	1	0	0	1	2	1
	Total	*57*	*8*	*4*	*76*	*145*	*65*

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 18	20	0	0	0	0	0	0
	21	6	0	0	4	10	6
	22	0	2	2	5	9	2
	23	0	0	0	17	17	0
	0	0	1	0	4	5	1
	1	1	1	0	1	3	2
	2	4	0	0	8	12	4
	3	3	3	0	9	15	6
	4	6	0	0	11	17	6
	5	6	3	0	6	15	9
	6	3	0	0	0	3	3
	Total	*29*	*10*	*2*	*65*	*106*	*39*
August 19	20	2	0	0	0	2	2
	21	12	0	0	27	39	12
	22	2	0	0	9	11	2
	23	5	2	6	17	30	7
	0	2	0	0	3	5	2
	1	0	0	0	3	3	0
	2	0	0	0	21	21	0
	3	6	0	0	46	52	6
	4	10	2	0	29	41	12
	5	2	0	0	40	42	2
	6	0	0	0	1	1	0
	Total	*41*	*4*	*6*	*196*	*247*	*45*
August 20	21	7	2	0	59	68	9
	22	5	3	0	14	22	8
	23	0	0	0	1	1	0
	0	0	0	0	18	18	0
	1	0	0	0	5	5	0
	2	5	1	0	13	19	6
	3	5	1	0	1	7	6
	4	4	2	0	33	39	6
	5	4	0	0	17	21	4
	Total	*30*	*9*	*0*	*161*	*200*	*39*
August 21	20	0	0	0	0	0	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	21	3	0	0	17	20	3
	22	3	0	0	7	10	3
	23	0	0	0	6	6	0
	0	0	2	0	2	4	2
	1	2	0	0	2	4	2
	2	7	0	0	8	15	7
	3	7	2	0	5	14	9
	4	2	2	0	2	6	4
	5	2	0	4	6	12	2
	6	0	0	0	7	7	0
	Total	*26*	*6*	*4*	*62*	*98*	*32*
August 22	21	0	0	0	15	15	0
	22	0	0	0	4	4	0
	23	8	0	5	17	30	8
	0	7	10	0	5	22	17
	1	3	0	0	8	11	3
	2	5	0	0	11	16	5
	3	2	2	0	3	7	4
	4	6	8	0	21	35	14
	5	4	0	0	12	16	4
	6	1	2	0	0	3	3
	Total	*36*	*22*	*5*	*96*	*159*	*58*
August 23	20	0	0	0	0	0	0
	21	1	2	0	16	19	3
	22	1	0	0	8	9	1
	23	0	0	0	11	11	0
	0	3	1	0	4	8	4
	1	1	0	0	0	1	1
	2	3	1	0	1	5	4
	3	0	0	0	3	3	0
	4	0	0	0	10	10	0
	5	0	0	0	16	16	0
	6	0	1	0	20	21	1
	Total	*9*	*5*	*0*	*89*	*103*	*14*
August 24	21	0	2	0	1	3	2

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	22	4	0	0	6	10	4
	23	1	0	0	2	3	1
	0	2	2	0	4	8	4
	1	2	3	0	6	11	5
	2	1	0	0	28	29	1
	3	3	0	0	19	22	3
	4	5	0	0	8	13	5
	5	1	0	0	23	24	1
	6	0	0	0	3	3	0
	Total	*19*	*7*	*0*	*100*	*126*	*26*
August 25	20	0	0	0	2	2	0
	21	4	0	0	43	47	4
	22	9	0	0	70	79	9
	23	4	0	0	7	11	4
	0	4	8	0	7	19	12
	1	6	0	0	21	27	6
	2	5	0	0	6	11	5
	3	3	1	0	10	14	4
	4	3	1	0	49	53	4
	5	0	3	0	3	6	3
	6	0	0	0	3	3	0
	Total	*38*	*13*	*0*	*221*	*272*	*51*
August 26	21	0	0	0	27	27	0
	22	4	0	0	6	10	4
	23	2	5	0	6	13	7
	0	6	0	0	5	11	6
	1	5	0	0	13	18	5
	2	3	3	0	8	14	6
	3	2	0	0	0	2	2
	4	0	0	0	47	47	0
	5	0	0	0	19	19	0
	6	0	0	0	15	15	0
	Total	*22*	*8*	*0*	*146*	*176*	*30*
August 27	21	0	2	0	23	25	2
	22	0	0	0	1	1	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	23	3	0	0	0	3	3
	1	0	0	0	7	7	0
	2	0	1	0	6	7	1
	3	0	0	0	1	1	0
	4	0	0	0	2	2	0
	5	0	0	0	21	21	0
	Total	*3*	*3*	*0*	*61*	*67*	*6*
August 28	20	3	0	0	7	10	3
	21	1	0	0	5	6	1
	22	0	0	0	8	8	0
	23	0	0	0	8	8	0
	0	5	0	0	2	7	5
	1	3	5	0	2	10	8
	2	1	0	0	0	1	1
	3	0	0	0	2	2	0
	4	0	0	0	4	4	0
	5	2	0	0	34	36	2
	6	4	2	0	80	86	6
	Total	*19*	*7*	*0*	*152*	*178*	*26*
August 29	20	2	0	0	4	6	2
	21	3	1	0	22	26	4
	22	0	4	0	3	7	4
	23	2	0	0	0	2	2
	1	0	0	0	5	5	0
	2	2	0	0	0	2	2
	3	1	0	0	0	1	1
	4	1	1	0	0	2	2
	5	0	0	0	24	24	0
	6	3	0	0	0	3	3
	Total	*14*	*6*	*0*	*58*	*78*	*20*
August 30	20	0	0	0	1	1	0
	21	6	0	0	8	14	6
	22	0	0	0	2	2	0
	23	0	0	0	4	4	0
	1	0	0	0	1	1	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	2	0	0	0	2	2
	3	0	0	0	12	12	0
	4	0	0	0	12	12	0
	5	2	0	0	21	23	2
	6	0	0	0	4	4	0
	Total	*10*	*0*	*0*	*65*	*75*	*10*
August 31	20	0	0	0	5	5	0
	21	0	0	0	15	15	0
	22	3	0	0	0	3	3
	23	3	0	0	0	3	3
	0	0	0	0	6	6	0
	1	0	0	0	1	1	0
	3	2	0	0	1	3	2
	4	1	0	0	5	6	1
	5	0	0	0	25	25	0
	6	0	0	0	19	19	0
	7	0	0	0	0	0	0
	Total	*9*	*0*	*0*	*77*	*86*	*9*
September 1	20	0	0	0	8	8	0
	21	0	0	0	5	5	0
	22	0	0	0	2	2	0
	23	0	0	0	9	9	0
	0	0	0	0	9	9	0
	1	0	0	0	3	3	0
	2	0	0	0	1	1	0
	3	0	1	0	3	4	1
	4	0	0	0	3	3	0
	5	0	0	0	32	32	0
	6	0	2	0	22	24	2
	7	0	0	0	0	0	0
	Total	*0*	*3*	*0*	*97*	*100*	*3*
September 2	20	3	0	0	18	21	3
	21	0	0	0	69	69	0
	22	0	0	0	10	10	0
	23	0	0	0	12	12	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	0	0	0	14	14	0
	1	0	0	0	11	11	0
	2	0	0	0	3	3	0
	3	0	0	0	6	6	0
	5	0	0	0	9	9	0
	6	0	0	0	3	3	0
	Total	*3*	*0*	*0*	*155*	*158*	*3*
September 3	20	1	0	0	0	1	1
	21	3	0	0	11	14	3
	23	0	0	0	19	19	0
	0	1	0	0	9	10	1
	1	0	0	0	1	1	0
	2	0	0	0	9	9	0
	3	0	0	0	4	4	0
	4	0	0	0	11	11	0
	6	0	0	0	3	3	0
	Total	*5*	*0*	*0*	*67*	*72*	*5*
September 4	20	2	0	0	7	9	2
	22	2	0	0	3	5	2
	23	2	0	0	2	4	2
	0	0	0	0	4	4	0
	1	0	0	0	1	1	0
	2	0	0	0	3	3	0
	3	0	0	0	16	16	0
	4	0	0	0	4	4	0
	5	0	0	0	3	3	0
	Total	*6*	*0*	*0*	*43*	*49*	*6*
September 5	20	1	0	0	0	1	1
	23	3	0	0	6	9	3
	1	0	0	0	4	4	0
	3	1	0	0	0	1	1
	4	0	0	0	2	2	0
	6	0	0	0	4	4	0
	Total	*5*	*0*	*0*	*16*	*21*	*5*
September 6	19	0	0	0	0	0	0

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	21	0	0	0	4	4	0
	22	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*7*	*7*	*0*
September 7	19	0	0	0	0	0	0
	20	0	0	0	3	3	0
	23	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 8	20	0	0	0	5	5	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 22	20	0	0	0	1	1	0
	23	0	0	0	1	1	0
	3	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*4*	*4*	*0*
September 23	20	0	0	0	6	6	0
	21	0	0	0	8	8	0
	22	0	0	0	2	2	0
	23	0	0	0	5	5	0
	0	0	0	0	5	5	0
	1	0	0	0	2	2	0
	7	0	0	0	0	0	0
	Total	*0*	*0*	*0*	*28*	*28*	*0*
September 24	21	0	0	0	8	8	0
	22	0	0	0	1	1	0
	23	0	0	0	1	1	0
	2	0	0	0	5	5	0
	3	0	0	0	2	2	0
	4	0	0	0	3	3	0
	5	0	0	0	8	8	0
	6	0	0	0	13	13	0
	Total	*0*	*0*	*0*	*41*	*41*	*0*
September 25	19	0	0	0	0	0	0
	23	0	0	0	8	8	0
	1	0	0	0	3	3	0
	6	0	0	0	5	5	0
	Total	*0*	*0*	*0*	*16*	*16*	*0*

Table E3 Detailed Results of Acoustic Monitoring at Site M2-2&3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 26	22	0	0	0	2	2	0
	1	0	0	0	5	5	0
	5	0	0	0	2	2	0
	6	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*11*	*11*	*0*
September 27	21	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*
September 28	21	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*
September 29	20	0	0	0	1	1	0
	6	0	0	0	12	12	0
	Total	*0*	*0*	*0*	*13*	*13*	*0*
Total		1,242	256	102	4,207	5,807	1,498

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	22	6	0	2	38	46	6
	23	1	2	0	50	53	3
	0	6	1	3	7	17	7
	1	0	2	0	10	12	2
	2	3	1	0	5	9	4
	3	12	4	1	60	77	16
	4	7	11	0	24	42	18
	5	1	0	0	2	3	1
	Total	*36*	*21*	*6*	*196*	*259*	*57*
July 29	21	0	1	0	0	1	1
	22	8	1	0	3	12	9
	23	5	0	0	18	23	5
	0	4	3	4	36	47	7
	1	10	8	0	39	57	18
	2	9	1	0	15	25	10
	3	0	2	0	35	37	2
	4	6	0	1	24	31	6
	5	3	1	0	5	9	4
	Total	*45*	*17*	*5*	*175*	*242*	*62*
July 30	22	25	0	0	6	31	25
	0	8	0	0	20	28	8
	1	1	0	0	30	31	1
	2	0	0	0	8	8	0
	3	3	0	0	0	3	3
	4	0	0	0	10	10	0
	5	0	0	0	9	9	0
	23	1	0	0	12	13	1
	Total	*38*	*0*	*0*	*95*	*133*	*38*
July 31	22	0	0	0	28	28	0
	23	1	0	0	8	9	1
	0	0	0	3	6	9	0
	1	1	0	0	7	8	1
	2	0	0	0	5	5	0
	3	0	0	0	16	16	0
	4	1	0	0	7	8	1
	5	3	0	0	1	4	3

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*6*	*0*	*3*	*78*	*87*	*6*
August 1	21	2	0	0	12	14	2
	22	4	0	0	12	16	4
	23	1	0	1	8	10	1
	0	6	0	0	27	33	6
	1	1	0	0	2	3	1
	2	2	3	0	23	28	5
	3	0	0	0	13	13	0
	4	0	0	0	6	6	0
	5	0	0	0	18	18	0
	Total	*16*	*3*	*1*	*121*	*141*	*19*
August 2	21	1	0	0	0	1	1
	22	0	0	0	6	6	0
	23	0	1	0	17	18	1
	0	0	0	0	32	32	0
	1	3	0	0	19	22	3
	2	7	0	0	16	23	7
	4	0	0	0	3	3	0
	Total	*11*	*1*	*0*	*93*	*105*	*12*
August 3	21	0	0	0	9	9	0
	22	8	0	0	9	17	8
	23	4	0	0	11	15	4
	0	7	1	0	0	8	8
	1	5	0	0	1	6	5
	2	5	0	0	2	7	5
	3	6	1	0	9	16	7
	4	0	0	0	32	32	0
	5	9	0	0	1	10	9
	6	0	0	0	2	2	0
	Total	*44*	*2*	*0*	*76*	*122*	*46*
August 4	21	6	0	0	2	8	6
	22	0	0	0	1	1	0
	23	9	0	0	21	30	9
	0	2	0	0	2	4	2
	2	3	2	0	0	5	5
	3	0	0	0	5	5	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	1	0	0	10	11	1
	5	5	0	0	2	7	5
	Total	*26*	*2*	*0*	*43*	*71*	*28*
August 5	21	3	0	0	0	3	3
	22	17	0	0	38	55	17
	23	4	1	0	28	33	5
	0	0	0	0	1	1	0
	1	0	0	0	4	4	0
	2	1	0	0	10	11	1
	3	6	0	0	0	6	6
	4	1	0	0	4	5	1
	5	2	0	0	10	12	2
	Total	*34*	*1*	*0*	*95*	*130*	*35*
August 6	22	11	4	0	21	36	15
	23	5	0	0	70	75	5
	0	25	4	0	40	69	29
	1	12	0	0	11	23	12
	2	4	5	0	30	39	9
	3	15	0	0	32	47	15
	4	3	0	0	24	27	3
	5	0	0	0	16	16	0
	6	0	0	0	0	0	0
	Total	*75*	*13*	*0*	*244*	*332*	*88*
August 7	21	3	0	0	4	7	3
	22	3	3	0	18	24	6
	23	14	0	0	22	36	14
	0	0	0	0	26	26	0
	1	0	0	0	9	9	0
	2	0	0	0	1	1	0
	3	4	0	0	4	8	4
	4	8	0	0	34	42	8
	5	5	3	0	45	53	8
	Total	*37*	*6*	*0*	*163*	*206*	*43*
August 8	21	0	0	0	22	22	0
	22	1	0	0	30	31	1
	23	4	0	1	11	16	4

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	5	0	0	40	45	5
	1	3	0	0	24	27	3
	2	2	0	0	17	19	2
	3	1	0	0	19	20	1
	4	2	0	0	16	18	2
	5	2	0	0	29	31	2
	Total	*20*	*0*	*1*	*208*	*229*	*20*
August 9	21	0	0	0	3	3	0
	22	3	0	0	7	10	3
	23	1	0	0	7	8	1
	0	3	0	0	14	17	3
	1	3	0	0	7	10	3
	2	5	0	0	1	6	5
	3	8	0	1	22	31	8
	4	18	0	0	19	37	18
	5	2	0	0	32	34	2
	Total	*43*	*0*	*1*	*112*	*156*	*43*
August 10	21	0	0	0	11	11	0
	22	0	0	0	17	17	0
	23	3	0	0	15	18	3
	0	10	0	0	52	62	10
	1	4	0	0	28	32	4
	2	14	0	0	20	34	14
	3	16	0	0	10	26	16
	4	2	0	0	7	9	2
	5	3	1	0	118	122	4
	Total	*52*	*1*	*0*	*278*	*331*	*53*
August 11	22	7	0	0	7	14	7
	23	34	0	0	31	65	34
	0	11	0	0	61	72	11
	1	9	0	0	9	18	9
	2	7	0	0	8	15	7
	3	10	16	21	18	65	26
	4	33	8	0	25	66	41
	5	2	0	0	48	50	2
	6	0	0	0	0	0	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*113*	*24*	*21*	*207*	*365*	*137*
August 12	21	5	0	0	16	21	5
	22	11	0	0	38	49	11
	23	13	2	0	63	78	15
	0	12	0	0	26	38	12
	1	6	3	0	19	28	9
	2	9	0	0	32	41	9
	3	14	7	0	40	61	21
	4	6	0	0	4	10	6
	5	2	0	0	16	18	2
	Total	*78*	*12*	*0*	*254*	*344*	*90*
August 13	21	1	0	0	12	13	1
	22	2	0	0	0	2	2
	23	1	0	0	2	3	1
	0	5	3	0	10	18	8
	1	5	0	0	25	30	5
	2	0	0	0	1	1	0
	3	2	2	0	3	7	4
	4	2	0	0	12	14	2
	5	4	0	0	13	17	4
	Total	*22*	*5*	*0*	*78*	*105*	*27*
August 14	21	0	1	0	10	11	1
	22	0	0	0	4	4	0
	23	0	0	0	4	4	0
	0	0	0	0	5	5	0
	1	0	0	0	3	3	0
	2	0	0	0	16	16	0
	3	13	0	0	63	76	13
	4	0	0	0	2	2	0
	5	0	0	0	4	4	0
	Total	*13*	*1*	*0*	*111*	*125*	*14*
August 15	21	2	0	0	9	11	2
	22	4	0	0	15	19	4
	23	2	0	0	12	14	2
	0	10	3	0	13	26	13
	1	0	2	3	15	20	2

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	3	0	0	4	7	3
	3	0	2	0	12	14	2
	4	9	0	0	13	22	9
	5	0	0	0	14	14	0
	Total	*30*	*7*	*3*	*107*	*147*	*37*
August 16	20	0	1	0	0	1	1
	21	14	4	0	5	23	18
	22	0	2	0	4	6	2
	23	2	0	0	2	4	2
	0	5	0	0	9	14	5
	1	0	0	0	7	7	0
	2	7	3	0	9	19	10
	3	6	8	0	8	22	14
	4	6	0	0	6	12	6
	5	8	0	0	29	37	8
	6	0	0	0	5	5	0
	Total	*48*	*18*	*0*	*84*	*150*	*66*
August 17	21	5	0	0	9	14	5
	22	2	0	0	8	10	2
	23	6	0	0	10	16	6
	0	25	12	0	9	46	37
	1	0	0	0	11	11	0
	2	10	0	0	9	19	10
	3	3	0	0	21	24	3
	4	0	0	0	38	38	0
	5	2	3	0	33	38	5
	Total	*53*	*15*	*0*	*148*	*216*	*68*
August 18	21	3	0	0	5	8	3
	22	1	0	0	12	13	1
	23	0	0	0	6	6	0
	0	4	0	0	10	14	4
	1	5	3	0	57	65	8
	2	0	0	0	8	8	0
	3	3	0	0	20	23	3
	4	4	0	0	13	17	4
	5	0	0	0	23	23	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	6	1	0	0	0	1	1
	Total	*21*	*3*	*0*	*154*	*178*	*24*
August 19	21	0	6	0	22	28	6
	22	6	0	0	8	14	6
	23	1	0	0	35	36	1
	0	6	2	0	89	97	8
	1	5	0	0	7	12	5
	2	7	4	0	92	103	11
	3	30	0	0	104	134	30
	4	61	2	0	51	114	63
	5	0	2	0	62	64	2
	6	6	0	0	3	9	6
	Total	*122*	*16*	*0*	*473*	*611*	*138*
August 20	20	0	0	0	3	3	0
	21	26	10	0	16	52	36
	22	1	0	0	12	13	1
	23	9	2	0	19	30	11
	0	5	0	0	39	44	5
	1	0	0	0	15	15	0
	2	2	3	0	35	40	5
	3	15	5	0	4	24	20
	4	4	0	0	16	20	4
	5	16	0	0	126	142	16
	6	4	0	0	0	4	4
	Total	*82*	*20*	*0*	*285*	*387*	*102*
August 21	21	2	0	0	11	13	2
	22	3	0	0	9	12	3
	23	0	0	0	8	8	0
	0	12	0	0	10	22	12
	1	14	1	0	45	60	15
	2	2	0	0	3	5	2
	3	1	0	0	21	22	1
	4	12	0	0	14	26	12
	5	11	0	0	43	54	11
	Total	*57*	*1*	*0*	*164*	*222*	*58*
August 22	21	6	1	0	20	27	7

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	22	3	0	0	14	17	3
	23	13	0	0	40	53	13
	0	8	0	0	58	66	8
	1	2	0	0	48	50	2
	2	4	0	0	72	76	4
	3	12	0	0	117	129	12
	4	5	0	0	27	32	5
	5	0	0	0	28	28	0
	6	22	2	0	68	92	24
	Total	*75*	*3*	*0*	*492*	*570*	*78*
August 23	21	5	0	0	41	46	5
	23	3	0	0	18	21	3
	0	29	0	0	30	59	29
	1	14	7	0	8	29	21
	2	4	10	0	5	19	14
	3	0	0	0	7	7	0
	4	0	0	0	18	18	0
	5	2	0	0	6	8	2
	6	4	0	0	23	27	4
	Total	*61*	*17*	*0*	*156*	*234*	*78*
August 24	21	5	0	0	0	5	5
	22	9	3	0	36	48	12
	23	3	0	0	2	5	3
	0	3	0	0	2	5	3
	1	1	0	0	8	9	1
	2	1	1	0	25	27	2
	3	4	0	0	26	30	4
	4	11	0	0	7	18	11
	5	3	0	0	50	53	3
	6	0	0	0	10	10	0
	Total	*40*	*4*	*0*	*166*	*210*	*44*
August 25	21	8	3	0	57	68	11
	22	7	0	0	96	103	7
	23	17	0	0	19	36	17
	0	5	3	0	53	61	8
	1	4	0	0	47	51	4

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	0	0	0	8	8	0
	3	0	0	0	9	9	0
	4	2	1	0	41	44	3
	5	0	0	0	7	7	0
	Total	*43*	*7*	*0*	*337*	*387*	*50*
August 26	21	7	0	0	17	24	7
	22	0	0	0	8	8	0
	23	4	0	0	3	7	4
	0	5	0	0	21	26	5
	1	4	10	0	30	44	14
	2	0	0	0	8	8	0
	3	3	5	0	8	16	8
	4	0	0	0	52	52	0
	5	2	0	0	27	29	2
	6	0	8	0	10	18	8
	Total	*25*	*23*	*0*	*184*	*232*	*48*
August 27	21	3	0	0	7	10	3
	22	6	0	0	1	7	6
	23	3	2	3	15	23	5
	0	0	0	0	10	10	0
	1	2	0	0	6	8	2
	2	1	0	0	114	115	1
	3	2	4	0	12	18	6
	4	2	0	0	17	19	2
	5	2	0	0	17	19	2
	6	1	0	0	0	1	1
	7	0	0	0	0	0	0
	Total	*22*	*6*	*3*	*199*	*230*	*28*
August 28	20	3	0	0	4	7	3
	21	5	0	0	21	26	5
	22	0	0	0	3	3	0
	23	2	0	0	2	4	2
	0	0	0	0	3	3	0
	1	0	0	0	8	8	0
	2	0	0	0	2	2	0
	3	0	0	0	1	1	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	0	0	0	6	6	0
	5	1	0	0	25	26	1
	6	0	0	0	19	19	0
	Total	*11*	*0*	*0*	*94*	*105*	*11*
August 29	21	0	0	0	29	29	0
	22	0	0	0	4	4	0
	23	0	0	0	4	4	0
	0	3	0	0	0	3	3
	1	0	0	0	5	5	0
	2	3	0	0	9	12	3
	3	0	0	0	3	3	0
	4	3	0	0	12	15	3
	5	5	0	0	11	16	5
	6	0	0	0	135	135	0
	Total	*14*	*0*	*0*	*212*	*226*	*14*
August 30	20	4	0	0	0	4	4
	21	8	0	0	3	11	8
	22	0	0	0	6	6	0
	23	0	0	0	1	1	0
	0	3	0	0	8	11	3
	1	3	0	0	0	3	3
	2	0	0	0	4	4	0
	3	0	0	0	7	7	0
	4	0	0	0	5	5	0
	5	2	0	0	5	7	2
	6	0	0	0	2	2	0
	Total	*20*	*0*	*0*	*41*	*61*	*20*
August 31	21	0	0	0	11	11	0
	22	1	0	0	0	1	1
	23	2	0	0	19	21	2
	0	0	0	0	4	4	0
	1	2	0	0	11	13	2
	2	0	0	0	6	6	0
	3	0	0	0	12	12	0
	4	0	0	0	4	4	0
	5	0	0	0	25	25	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	6	0	0	0	12	12	0
	Total	*5*	*0*	*0*	*104*	*109*	*5*
September 1	20	0	0	0	8	8	0
	21	2	0	0	18	20	2
	22	0	0	0	5	5	0
	23	0	0	0	5	5	0
	0	0	0	0	19	19	0
	1	0	0	0	2	2	0
	2	0	0	0	3	3	0
	3	0	0	0	3	3	0
	4	0	0	0	7	7	0
	5	0	0	0	23	23	0
	6	0	0	0	11	11	0
	Total	*2*	*0*	*0*	*104*	*106*	*2*
September 2	20	0	0	0	5	5	0
	21	0	0	0	42	42	0
	22	3	0	0	5	8	3
	23	0	0	0	6	6	0
	0	0	0	0	15	15	0
	1	0	0	0	21	21	0
	2	4	0	0	1	5	4
	3	0	0	0	11	11	0
	4	0	0	0	9	9	0
	5	0	0	0	3	3	0
	6	0	0	0	4	4	0
	Total	*7*	*0*	*0*	*122*	*129*	*7*
September 3	20	2	0	0	3	5	2
	21	2	0	0	0	2	2
	22	3	0	0	9	12	3
	23	3	0	0	7	10	3
	1	0	0	0	3	3	0
	2	0	0	0	1	1	0
	Total	*10*	*0*	*0*	*23*	*33*	*10*
September 21	22	0	0	0	1	1	0
	0	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 22	21	0	0	0	2	2	0
	22	0	0	0	1	1	0
	23	0	0	0	1	1	0
	2	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*6*	*6*	*0*
September 23	20	0	0	0	11	11	0
	21	0	0	0	4	4	0
	22	0	0	0	2	2	0
	0	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*20*	*20*	*0*
September 24	22	0	0	0	1	1	0
	5	0	0	0	14	14	0
	6	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*16*	*16*	*0*
September 25	20	0	0	0	4	4	0
	21	0	0	0	4	4	0
	22	0	0	0	4	4	0
	23	0	0	0	3	3	0
	4	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*16*	*16*	*0*
September 26	1	0	0	0	3	3	0
	6	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*4*	*4*	*0*
September 27	19	0	0	0	3	3	0
	20	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*7*	*7*	*0*
September 28	20	0	0	0	7	7	0
	21	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*11*	*11*	*0*
September 29	5	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
October 1	20	0	0	0	4	4	0
	Total	**0**	**0**	**0**	**4**	4	0

Table E4 Detailed Results of Acoustic Monitoring at Site M2-4

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
October 4	19	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
Total		1,457	249	44	6,367	8,117	1,706

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*.

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	21	1	1	0	0	2	2
	22	1	0	0	5	6	1
	23	2	0	0	3	5	2
	0	2	2	0	0	4	4
	1	1	0	0	0	1	1
	2	0	0	0	1	1	0
	4	0	0	0	8	8	0
	5	0	0	0	9	9	0
	Total	*7*	*3*	*0*	*26*	*36*	*10*
July 29	21	0	0	0	1	1	0
	22	0	0	0	1	1	0
	23	5	0	0	8	13	5
	0	4	0	0	2	6	4
	1	1	0	0	0	1	1
	2	1	0	0	2	3	1
	3	1	0	0	1	2	1
	4	0	0	0	2	2	0
	5	0	0	0	7	7	0
	Total	*12*	*0*	*0*	*24*	*36*	*12*
July 30	22	0	0	0	2	2	0
	23	1	0	0	4	5	1
	0	5	0	0	5	10	5
	1	7	0	0	2	9	7
	2	2	0	0	8	10	2
	3	0	1	0	5	6	1
	4	2	0	0	3	5	2
	5	0	0	0	5	5	0
	Total	*17*	*1*	*0*	*34*	*52*	*18*
July 31	21	2	0	0	1	3	2
	22	1	0	0	6	7	1
	23	2	0	0	8	10	2
	0	5	0	0	10	15	5
	1	13	0	0	6	19	13
	2	5	0	0	1	6	5
	3	5	0	0	2	7	5
	4	2	0	0	6	8	2

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	0	0	0	3	3	0
	Total	*35*	*0*	*0*	*43*	*78*	*35*
August 1	21	0	0	0	7	7	0
	22	2	0	0	16	18	2
	23	2	0	0	5	7	2
	0	0	0	0	4	4	0
	1	6	0	0	5	11	6
	2	2	0	0	0	2	2
	3	3	0	0	12	15	3
	4	2	0	0	8	10	2
	5	5	0	0	2	7	5
	Total	*22*	*0*	*0*	*59*	*81*	*22*
August 2	21	6	0	0	3	9	6
	22	2	0	1	7	10	2
	23	0	0	0	2	2	0
	0	15	0	0	32	47	15
	1	19	0	0	4	23	19
	3	2	1	0	2	5	3
	4	0	0	0	4	4	0
	Total	*44*	*1*	*1*	*54*	*100*	*45*
August 3	21	6	0	0	5	11	6
	22	8	0	0	26	34	8
	23	4	0	0	22	26	4
	0	3	0	0	3	6	3
	1	1	0	0	10	11	1
	2	1	0	0	16	17	1
	3	0	0	0	5	5	0
	4	1	0	0	19	20	1
	5	4	0	0	15	19	4
	Total	*28*	*0*	*0*	*121*	*149*	*28*
August 4	21	3	0	0	6	9	3
	22	3	0	0	8	11	3
	23	4	1	0	26	31	5
	0	3	0	0	13	16	3
	1	5	0	0	11	16	5
	2	0	0	0	8	8	0

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	0	0	0	11	11	0
	4	5	0	0	9	14	5
	5	6	0	0	14	20	6
	Total	*29*	*1*	*0*	*106*	*136*	*30*
August 5	21	5	0	0	3	8	5
	22	2	0	2	7	11	2
	23	6	1	1	7	15	7
	0	6	0	2	17	25	6
	1	1	0	0	72	73	1
	2	4	0	0	36	40	4
	3	1	0	0	13	14	1
	4	10	0	0	17	27	10
	Total	*35*	*1*	*5*	*172*	*213*	*36*
August 6	21	4	0	0	48	52	4
	22	4	0	2	15	21	4
	23	4	0	0	8	12	4
	0	2	0	0	4	6	2
	1	1	0	0	10	11	1
	2	0	0	0	10	10	0
	3	3	0	0	2	5	3
	4	0	0	0	3	3	0
	5	0	0	0	17	17	0
	Total	*18*	*0*	*2*	*117*	*137*	*18*
August 7	21	1	0	0	3	4	1
	22	0	0	0	22	22	0
	23	4	0	0	2	6	4
	0	3	0	0	5	8	3
	1	0	0	0	3	3	0
	2	2	0	0	1	3	2
	3	0	0	0	2	2	0
	4	0	1	0	20	21	1
	5	0	0	0	29	29	0
	Total	*10*	*1*	*0*	*87*	*98*	*11*
August 8	21	7	0	0	6	13	7
	22	2	0	0	9	11	2
	23	2	0	0	4	6	2

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	0	0	0	7	7	0
	1	4	0	0	7	11	4
	2	0	0	0	5	5	0
	3	0	0	0	5	5	0
	4	0	0	0	3	3	0
	5	1	0	0	10	11	1
	Total	*16*	*0*	*0*	*56*	*72*	*16*
August 9	21	2	0	0	16	18	2
	22	0	0	0	9	9	0
	23	6	0	0	7	13	6
	0	1	0	0	6	7	1
	1	0	0	0	1	1	0
	2	0	0	0	3	3	0
	4	2	0	0	6	8	2
	5	0	0	0	1	1	0
	Total	*11*	*0*	*0*	*49*	*60*	*11*
August 10	21	0	0	0	11	11	0
	22	0	0	0	7	7	0
	23	3	0	5	9	17	3
	0	0	0	0	14	14	0
	1	4	0	0	3	7	4
	2	4	0	0	3	7	4
	3	3	0	0	10	13	3
	4	11	0	0	2	13	11
	5	2	0	0	9	11	2
	Total	*27*	*0*	*5*	*68*	*100*	*27*
August 11	21	3	0	0	30	33	3
	22	12	0	0	29	41	12
	23	15	0	0	38	53	15
	0	3	0	0	9	12	3
	1	2	0	0	7	9	2
	2	8	0	0	6	14	8
	3	2	0	0	5	7	2
	4	0	0	5	26	31	0
	5	1	0	0	8	9	1
	Total	*46*	*0*	*5*	*158*	*209*	*46*

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 12	21	7	0	0	24	31	7
	22	0	3	0	1	4	3
	23	1	0	0	13	14	1
	0	8	0	0	24	32	8
	1	4	0	0	3	7	4
	2	0	0	0	6	6	0
	3	4	0	0	2	6	4
	4	2	0	0	6	8	2
	5	0	0	0	10	10	0
	Total	*26*	*3*	*0*	*89*	*118*	*29*
August 13	21	4	0	0	5	9	4
	22	2	0	0	14	16	2
	23	3	0	0	30	33	3
	0	1	0	0	24	25	1
	1	2	13	1	15	31	15
	2	0	0	0	8	8	0
	3	0	0	0	2	2	0
	4	0	0	0	12	12	0
	5	25	3	0	36	64	28
	Total	*37*	*16*	*1*	*146*	*200*	*53*
August 14	21	--	--	--	--	--	--
	22	--	--	--	--	--	--
	23	--	--	--	--	--	--
	0	--	--	--	--	--	--
	1	--	--	--	--	--	--
	2	--	--	--	--	--	--
	3	--	--	--	--	--	--
	4	--	--	--	--	--	--
	5	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
August 15	21	0	0	0	11	11	0
	22	4	**0**	**0**	8	12	4
	23	2	0	0	7	9	2
	0	4	**0**	**0**	0	4	4
	1	0	6	0	0	6	6
	2	0	**0**	**0**	3	3	0

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	0	0	0	2	2	0
	Total	*10*	*6*	*0*	*31*	*47*	*16*
August 16	21	1	0	0	5	6	1
	22	13	**0**	**0**	19	32	13
	23	26	6	0	1	33	32
	0	0	5	**0**	5	10	5
	1	6	2	0	26	34	8
	2	0	1	0	3	4	1
	3	3	0	0	3	6	3
	4	0	0	0	20	20	0
	5	0	0	0	50	50	0
	Total	*49*	*14*	*0*	*132*	*195*	*63*
August 17	21	17	0	0	56	73	17
	22	4	0	0	16	20	4
	23	1	0	0	8	9	1
	0	3	0	0	2	5	3
	1	0	0	0	16	16	0
	2	0	0	0	15	15	0
	3	0	0	0	9	9	0
	4	0	0	0	5	5	0
	5	1	0	0	27	28	1
	Total	*26*	*0*	*0*	*154*	*180*	*26*
August 18	21	5	0	0	7	12	5
	22	4	0	0	9	13	4
	23	0	0	0	2	2	0
	0	0	0	0	4	4	0
	1	0	1	0	64	65	1
	2	0	1	0	60	61	1
	3	1	0	0	38	39	1
	4	0	0	0	33	33	0
	5	0	0	0	48	48	0
	6	0	0	0	13	13	0
	Total	*10*	*2*	*0*	*278*	*290*	*12*
August 19	21	3	0	0	23	26	3
	22	7	0	0	19	26	7
	23	10	0	0	24	34	10

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	9	3	0	34	46	12
	1	5	0	0	7	12	5
	2	0	0	0	12	12	0
	3	0	0	0	8	8	0
	4	2	2	0	6	10	4
	5	11	0	0	30	41	11
	Total	*47*	*5*	*0*	*163*	*215*	*52*
August 20	21	1	0	0	24	25	1
	22	1	0	0	20	21	1
	23	4	3	0	11	18	7
	0	0	0	0	16	16	0
	1	2	2	0	21	25	4
	2	2	0	0	7	9	2
	3	2	0	0	29	31	2
	4	1	0	0	9	10	1
	5	0	0	0	14	14	0
	Total	*13*	*5*	*0*	*151*	*169*	*18*
August 21	21	0	0	0	41	41	0
	22	1	0	0	11	12	1
	23	5	0	0	12	17	5
	0	4	0	0	8	12	4
	1	0	0	0	5	5	0
	2	2	0	0	11	13	2
	3	0	0	0	11	11	0
	4	0	0	0	29	29	0
	5	2	0	0	24	26	2
	Total	*14*	*0*	*0*	*152*	*166*	*14*
August 22	21	15	0	0	102	117	15
	22	8	0	0	4	12	8
	23	8	0	0	0	8	8
	0	0	0	0	3	3	0
	1	1	0	0	2	3	1
	2	3	1	0	5	9	4
	3	0	0	0	0	0	0
	4	0	0	0	8	8	0
	5	3	0	0	13	16	3

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*38*	*1*	*0*	*137*	*176*	*39*
August 23	21	2	0	0	43	45	2
	22	2	4	0	14	20	6
	23	0	0	0	12	12	0
	0	2	0	0	46	48	2
	1	7	0	0	51	58	7
	2	4	0	0	21	25	4
	3	0	0	0	5	5	0
	5	0	0	0	7	7	0
	6	3	0	0	6	9	3
	Total	*20*	*4*	*0*	*205*	*229*	*24*
August 24	20	0	0	0	5	5	0
	21	7	0	0	14	21	7
	22	4	0	0	8	12	4
	23	1	0	0	69	70	1
	0	4	0	0	94	98	4
	1	2	3	0	21	26	5
	2	0	0	1	7	8	0
	3	2	0	0	6	8	2
	4	0	0	0	18	18	0
	5	0	0	0	28	28	0
	Total	*20*	*3*	*1*	*270*	*294*	*23*
August 25	20	0	0	0	3	3	0
	21	15	0	0	27	42	15
	22	8	0	0	57	65	8
	23	3	0	3	11	17	3
	0	5	2	0	20	27	7
	1	0	0	0	18	18	0
	2	0	0	0	1	1	0
	4	4	0	0	0	4	4
	5	0	0	0	6	6	0
	Total	*35*	*2*	*3*	*143*	*183*	*37*
August 26	21	7	0	0	22	29	7
	22	2	9	0	14	25	11
	23	7	1	0	11	19	8
	0	2	0	0	22	24	2

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	1	0	0	0	3	3	0
	2	1	0	0	2	3	1
	4	3	3	0	9	15	6
	5	0	0	0	17	17	0
	Total	*22*	*13*	*0*	*100*	*135*	*35*
August 27	20	0	0	0	2	2	0
	21	2	0	0	15	17	2
	22	9	0	0	10	19	9
	23	0	0	0	3	3	0
	0	2	0	0	6	8	2
	1	2	0	0	5	7	2
	2	3	0	0	17	20	3
	3	0	0	0	15	15	0
	4	2	0	0	8	10	2
	5	1	0	0	18	19	1
	Total	*21*	*0*	*0*	*99*	*120*	*21*
August 28	21	8	0	0	55	63	8
	22	0	0	0	4	4	0
	23	0	0	0	3	3	0
	0	1	0	0	4	5	1
	1	6	2	0	16	24	8
	2	3	0	0	21	24	3
	3	3	0	0	24	27	3
	4	0	0	0	23	23	0
	5	0	0	0	9	9	0
	6	0	0	0	9	9	0
	Total	*21*	*2*	*0*	*168*	*191*	*23*
August 29	20	0	0	0	2	2	0
	21	9	0	0	85	94	9
	22	5	1	0	10	16	6
	23	0	0	0	12	12	0
	0	0	0	0	4	4	0
	1	0	0	0	11	11	0
	2	1	0	0	1	2	1
	3	0	3	0	1	4	3
	4	0	0	0	2	2	0

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	1	0	0	3	4	1
	6	0	0	0	2	2	0
	Total	*16*	*4*	*0*	*133*	*153*	*20*
August 30	20	1	0	0	0	1	1
	21	4	1	0	28	33	5
	22	1	0	0	16	17	1
	23	1	0	0	19	20	1
	0	2	0	0	9	11	2
	1	1	0	0	14	15	1
	2	0	0	0	33	33	0
	3	2	2	0	5	9	4
	4	0	0	0	2	2	0
	5	2	0	0	16	18	2
	6	0	0	0	2	2	0
	Total	*14*	*3*	*0*	*144*	*161*	*17*
August 31	20	2	0	0	0	2	2
	21	0	0	0	21	21	0
	22	1	0	0	21	22	1
	23	5	0	0	10	15	5
	0	0	0	0	18	18	0
	1	0	0	0	6	6	0
	2	0	0	0	11	11	0
	3	0	0	0	11	11	0
	4	3	0	0	4	7	3
	5	0	0	0	23	23	0
	6	0	0	0	13	13	0
	Total	*11*	*0*	*0*	*138*	*149*	*11*
September 1	20	3	0	0	28	31	3
	21	4	0	0	61	65	4
	22	2	0	0	19	21	2
	23	6	0	0	73	79	6
	0	0	0	0	77	77	0
	1	0	0	0	48	48	0
	2	0	0	0	34	34	0
	3	0	0	0	36	36	0
	4	6	0	0	31	37	6

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	1	0	0	83	84	1
	6	0	0	0	52	52	0
	Total	*22*	*0*	*0*	*542*	*564*	*22*
September 2	20	2	0	0	7	9	2
	21	3	2	0	216	221	5
	22	7	1	0	513	521	8
	23	2	1	0	163	166	3
	0	6	2	0	157	165	8
	1	2	0	0	145	147	2
	2	0	0	0	29	29	0
	3	5	0	0	21	26	5
	4	0	0	0	41	41	0
	5	3	0	0	28	31	3
	6	1	0	0	5	6	1
	Total	*31*	*6*	*0*	*1,325*	*1,362*	*37*
September 3	20	0	0	0	2	2	0
	21	0	0	0	1	1	0
	22	2	0	0	6	8	2
	23	1	0	0	5	6	1
	0	0	0	0	8	8	0
	2	3	0	0	8	11	3
	3	0	0	0	3	3	0
	4	0	0	0	4	4	0
	5	0	0	0	1	1	0
	6	0	0	0	6	6	0
	Total	*6*	*0*	*0*	*44*	*50*	*6*
September 4	21	3	0	0	4	7	3
	22	0	1	0	2	3	1
	23	0	0	0	5	5	0
	0	0	0	0	1	1	0
	Total	*3*	*1*	*0*	*12*	*16*	*4*
September 5	20	0	0	0	7	7	0
	21	11	1	0	0	12	12
	22	1	0	0	2	3	1
	Total	*12*	*1*	*0*	*9*	*22*	*13*
September 21	22	0	0	0	2	2	0

Table E5 Detailed Results of Acoustic Monitoring at Site M3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*0*	*0*	*0*	*2*	*2*	*0*
September 23	20	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*4*	*4*	*0*
September 24	20	0	0	0	4	4	0
	21	**0**	**0**	**0**	5	5	0
	23	0	0	0	2	2	0
	0	**0**	**0**	**0**	1	1	0
	Total	*0*	*0*	*0*	*12*	*12*	*0*
September 25	20	**0**	**0**	**0**	5	5	0
	21	**0**	**0**	**0**	1	1	0
	4	**0**	**0**	**0**	1	1	0
	6	**0**	**0**	**0**	1	1	0
	Total	*0*	*0*	*0*	*8*	*8*	*0*
September 30	3	**0**	**0**	**0**	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
October 2	21	**0**	**0**	**0**	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
Total		881	99	23	5,969	6,972	980

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

-- Acoustic monitor turned off while mist netting nearby

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	21	0	0	0	8	8	0
	22	3	0	0	23	26	3
	23	4	0	0	1	5	4
	0	5	0	0	9	14	5
	1	1	9	0	5	15	10
	2	7	5	0	9	21	12
	3	14	0	0	3	17	14
	4	7	0	0	0	7	7
	5	8	0	0	1	9	8
	Total	*49*	*14*	*0*	*59*	*122*	*63*
July 29	22	6	0	0	9	15	6
	23	0	0	0	13	13	0
	0	1	0	0	2	3	1
	1	0	2	0	10	12	2
	2	3	5	0	2	10	8
	3	5	4	6	1	16	9
	4	54	9	2	7	72	63
	5	14	1	0	0	15	15
	Total	*83*	*21*	*8*	*44*	*156*	*104*
July 30	21	1	1	0	0	2	2
	22	12	1	0	9	22	13
	23	5	0	0	15	20	5
	0	2	0	0	3	5	2
	1	0	0	0	5	5	0
	2	0	1	0	1	2	1
	3	20	13	0	7	40	33
	4	7	7	0	0	14	14
	5	74	8	0	0	82	82
	Total	*121*	*31*	*0*	*40*	*192*	*152*
	21	3	0	0	11	14	3
	22	4	0	0	36	40	4
	23	2	0	0	10	12	2
	0	1	0	0	0	1	1
	1	0	0	0	1	1	0
	2	8	0	0	2	10	8
	3	0	0	0	1	1	0

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	22	0	0	0	22	22
	5	4	1	0	29	34	5
	Total	*44*	*1*	*0*	*90*	*135*	*45*
August 1	22	0	0	0	11	11	0
	23	0	8	0	0	8	8
	0	2	1	0	0	3	3
	1	1	0	0	0	1	1
	2	6	0	0	0	6	6
	4	3	0	0	0	3	3
	5	24	2	0	0	26	26
	Total	*36*	*11*	*0*	*11*	*58*	*47*
August 2	21	3	0	0	6	9	3
	22	0	0	0	7	7	0
	23	3	0	0	7	10	3
	0	3	0	0	14	17	3
	1	0	0	0	2	2	0
	2	7	2	0	4	13	9
	3	26	3	3	3	35	29
	4	17	6	5	5	33	23
	5	31	8	0	44	83	39
	Total	*90*	*19*	*8*	*92*	*209*	*109*
August 3	21	0	0	0	2	2	0
	22	1	0	0	0	1	1
	23	9	0	0	12	21	9
	0	0	1	0	17	18	1
	1	6	0	0	0	6	6
	2	0	0	0	3	3	0
	3	7	0	0	11	18	7
	4	0	0	0	14	14	0
	5	20	6	0	11	37	26
	Total	*43*	*7*	*0*	*70*	*120*	*50*
August 4	21	4	0	0	1	5	4
	22	0	0	0	2	2	0
	23	6	0	0	0	6	6
	0	6	2	0	0	8	8
	1	6	3	0	0	9	9

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	0	0	0	1	1	0
	3	3	0	0	0	3	3
	4	8	2	0	0	10	10
	5	29	1	2	9	41	30
	Total	*62*	*8*	*2*	*13*	*85*	*70*
August 5	21	0	0	1	1	2	0
	22	2	3	0	3	8	5
	23	0	0	0	1	1	0
	0	0	0	0	2	2	0
	1	3	0	0	3	6	3
	2	0	0	0	0	0	0
	4	5	0	0	4	9	5
	5	12	0	0	0	12	12
	Total	*22*	*3*	*1*	*14*	*40*	*25*
August 6	22	0	0	0	7	7	0
	23	3	0	0	5	8	3
	0	0	0	0	1	1	0
	1	0	0	0	2	2	0
	2	4	0	0	1	5	4
	3	0	1	0	1	2	1
	4	1	0	0	6	7	1
	5	13	17	0	28	58	30
	Total	*21*	*18*	*0*	*51*	*90*	*39*
August 7	20	0	0	0	0	0	0
	21	0	0	0	10	10	0
	22	0	0	0	0	0	0
	23	4	0	0	0	4	4
	1	3	0	0	10	13	3
	2	8	3	0	0	11	11
	3	1	0	0	0	1	1
	4	6	1	0	0	7	7
	5	11	0	0	0	11	11
	Total	*33*	*4*	*0*	*20*	*57*	*37*
August 8	21	2	0	0	3	5	2
	22	1	0	0	3	4	1
	23	2	2	0	1	5	4

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	2	0	5	0	7	2
	1	2	0	0	0	2	2
	2	2	0	0	0	2	2
	3	3	0	0	0	3	3
	4	0	0	0	3	3	0
	5	11	1	0	0	12	12
	Total	*25*	*3*	*5*	*10*	*43*	*28*
August 9	21	0	0	0	3	3	0
	22	0	0	0	5	5	0
	23	5	0	0	2	7	5
	0	2	0	0	5	7	2
	1	0	0	0	18	18	0
	2	0	0	0	2	2	0
	3	4	0	0	8	12	4
	4	3	0	0	5	8	3
	5	40	0	7	0	47	40
	Total	*54*	*0*	*7*	*48*	*109*	*54*
August 10	21	2	0	1	19	22	2
	22	3	0	0	1	4	3
	23	2	0	0	6	8	2
	0	6	0	0	1	7	6
	1	0	0	0	2	2	0
	2	0	0	0	7	7	0
	3	0	7	0	2	9	7
	4	0	0	0	3	3	0
	5	5	1	0	3	9	6
	Total	*18*	*8*	*1*	*44*	*71*	*26*
August 11	21	0	0	0	11	11	0
	22	0	0	0	10	10	0
	23	0	0	0	4	4	0
	0	0	1	0	3	4	1
	1	2	0	0	1	3	2
	2	0	2	0	4	6	2
	3	2	0	0	4	6	2
	4	5	2	3	3	13	7
	5	0	3	0	0	3	3

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*9*	*8*	*3*	*40*	*60*	*17*
August 12	22	2	0	0	3	5	2
	23	5	0	0	12	17	5
	0	13	0	0	4	17	13
	1	3	0	0	7	10	3
	2	0	0	0	10	10	0
	3	1	0	0	1	2	1
	4	7	0	0	23	30	7
	5	5	0	0	4	9	5
	Total	*36*	*0*	*0*	*64*	*100*	*36*
August 13	21	22	0	0	1	23	22
	22	3	3	0	18	24	6
	23	0	0	0	2	2	0
	0	15	1	0	3	19	16
	1	2	0	0	0	2	2
	2	6	0	0	0	6	6
	3	5	0	0	2	7	5
	4	2	0	0	10	12	2
	5	26	0	0	6	32	26
	6	1	0	0	0	1	1
	Total	*82*	*4*	*0*	*42*	*128*	*86*
August 14	21	3	0	0	0	3	3
	22	0	0	0	5	5	0
	23	83	5	0	11	99	88
	0	4	0	0	7	11	4
	1	0	0	0	3	3	0
	4	2	0	0	1	3	2
	Total	*92*	*5*	*0*	*27*	*124*	*97*
August 15	21	0	0	0	3	3	0
	22	0	0	0	2	2	0
	23	2	0	0	3	5	2
	0	2	0	0	4	6	2
	1	0	0	0	9	9	0
	2	22	0	0	5	27	22
	3	0	0	0	4	4	0
	4	8	0	0	5	13	8

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	4	0	0	6	10	4
	6	3	0	0	0	3	3
	Total	*41*	*0*	*0*	*41*	*82*	*41*
August 16	21	9	0	0	0	9	9
	22	8	0	0	12	20	8
	23	0	0	0	5	5	0
	0	0	0	0	2	2	0
	1	0	0	0	20	20	0
	2	0	0	0	2	2	0
	3	3	0	0	24	27	3
	4	0	0	0	26	26	0
	5	4	0	0	58	62	4
	Total	*24*	*0*	*0*	*149*	*173*	*24*
August 17	21	3	0	0	5	8	3
	22	0	0	0	5	5	0
	23	0	0	0	15	15	0
	0	2	0	0	1	3	2
	1	0	0	0	6	6	0
	2	0	0	0	2	2	0
	3	0	0	0	8	8	0
	4	3	0	0	5	8	3
	5	4	0	0	7	11	4
	Total	*12*	*0*	*0*	*54*	*66*	*12*
August 18	21	0	0	0	11	11	0
	22	0	0	0	2	2	0
	23	0	0	0	5	5	0
	0	0	0	0	1	1	0
	1	0	0	0	12	12	0
	2	2	0	0	28	30	2
	3	3	0	0	37	40	3
	4	0	0	0	12	12	0
	5	2	0	0	2	4	2
	Total	*7*	*0*	*0*	*110*	*117*	*7*
August 19	21	6	0	0	14	20	6
	22	0	0	0	5	5	0
	23	2	0	0	4	6	2

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	2	0	0	15	17	2
	1	21	0	0	21	42	21
	2	3	0	0	25	28	3
	3	2	0	0	24	26	2
	5	44	0	0	1	45	44
	Total	*80*	*0*	*0*	*109*	*189*	*80*
August 20	21	3	0	0	3	6	3
	22	14	0	0	1	15	14
	23	7	0	0	7	14	7
	0	1	0	0	21	22	1
	1	0	0	0	16	16	0
	2	0	0	0	13	13	0
	3	2	0	0	14	16	2
	4	12	0	0	7	19	12
	5	16	0	0	16	32	16
	Total	*55*	*0*	*0*	*98*	*153*	*55*
August 21	20	0	0	0	3	3	0
	22	0	1	0	6	7	1
	23	0	0	0	1	1	0
	1	0	1	0	0	1	1
	2	1	0	0	1	2	1
	3	0	0	0	7	7	0
	4	1	0	0	3	4	1
	5	0	0	0	6	6	0
	6	2	0	0	0	2	2
	Total	*4*	*2*	*0*	*27*	*33*	*6*
August 22	21	2	0	0	1	3	2
	22	0	0	0	5	5	0
	23	0	0	0	1	1	0
	0	0	0	0	9	9	0
	1	0	0	0	8	8	0
	2	8	0	0	0	8	8
	3	0	0	0	10	10	0
	4	12	0	0	15	27	12
	5	8	0	0	6	14	8
	Total	*30*	*0*	*0*	*55*	*85*	*30*

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 23	21	1	0	0	0	1	1
	22	1	0	0	5	6	1
	0	0	0	0	3	3	0
	1	2	0	0	0	2	2
	2	0	0	0	5	5	0
	3	0	0	0	1	1	0
	4	2	0	0	1	3	2
	5	1	0	0	3	4	1
	6	20	0	0	0	20	20
	Total	*27*	*0*	*0*	*18*	*45*	*27*
August 24	20	0	0	0	3	3	0
	21	0	0	0	6	6	0
	22	0	0	0	3	3	0
	23	0	0	0	5	5	0
	0	3	0	0	11	14	3
	2	0	0	0	23	23	0
	3	0	0	0	12	12	0
	4	0	0	0	24	24	0
	5	0	0	0	1	1	0
	Total	*3*	*0*	*0*	*88*	*91*	*3*
August 25	21	0	0	0	9	9	0
	22	9	0	0	18	27	9
	23	2	0	0	2	4	2
	0	0	0	0	7	7	0
	1	0	0	0	10	10	0
	2	1	0	0	6	7	1
	3	4	0	0	14	18	4
	4	3	0	0	7	10	3
	Total	*19*	*0*	*0*	*73*	*92*	*19*
August 26	21	0	0	0	11	11	0
	22	0	0	0	2	2	0
	23	0	0	0	2	2	0
	1	0	0	0	1	1	0
	2	2	0	0	5	7	2
	3	3	0	0	2	5	3
	4	0	0	0	3	3	0

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	0	0	0	4	4	0
	6	3	0	0	0	3	3
	Total	*8*	*0*	*0*	*30*	*38*	*8*
August 27	21	1	0	0	3	4	1
	22	0	0	0	11	11	0
	23	0	0	0	9	9	0
	0	0	0	0	12	12	0
	1	0	0	0	13	13	0
	2	0	0	0	24	24	0
	4	0	0	0	5	5	0
	5	2	0	0	19	21	2
	Total	*3*	*0*	*0*	*96*	*99*	*3*
August 28	21	0	0	0	10	10	0
	23	0	0	0	4	4	0
	0	0	0	0	7	7	0
	1	0	2	0	0	2	2
	2	2	0	0	5	7	2
	3	0	0	0	2	2	0
	4	4	0	0	2	6	4
	5	0	0	0	14	14	0
	6	0	0	0	2	2	0
	Total	*6*	*2*	*0*	*46*	*54*	*8*
August 29	20	2	0	0	0	2	2
	22	0	0	0	2	2	0
	0	0	0	0	6	6	0
	1	0	0	0	7	7	0
	3	3	0	0	3	6	3
	5	0	0	0	5	5	0
	Total	*5*	*0*	*0*	*23*	*28*	*5*
August 30	21	2	0	0	41	43	2
	22	0	0	0	0	0	0
	23	2	0	0	0	2	2
	1	0	2	0	10	12	2
	2	0	0	0	2	2	0
	3	0	0	0	1	1	0
	4	0	0	0	2	2	0

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	6	8	0	0	1	9	8
	Total	*12*	*2*	*0*	*57*	*71*	*14*
August 31	21	0	0	0	4	4	0
	22	0	0	0	13	13	0
	23	0	0	0	8	8	0
	0	0	0	0	19	19	0
	1	0	0	0	29	29	0
	2	2	0	0	184	186	2
	3	0	0	0	26	26	0
	4	0	0	0	4	4	0
	5	3	0	0	7	10	3
	Total	*5*	*0*	*0*	*294*	*299*	*5*
September 1	20	2	0	0	0	2	2
	21	3	0	0	12	15	3
	22	0	0	0	9	9	0
	23	0	0	0	17	17	0
	0	0	0	0	61	61	0
	1	0	0	0	29	29	0
	2	0	0	0	48	48	0
	3	0	0	0	53	53	0
	4	0	0	0	31	31	0
	5	4	0	0	45	49	4
	6	0	0	0	17	17	0
	Total	*9*	*0*	*0*	*322*	*331*	*9*
September 2	20	5	0	0	4	9	5
	21	0	0	0	18	18	0
	22	0	0	0	16	16	0
	23	0	0	0	40	40	0
	0	0	0	0	76	76	0
	1	0	0	0	315	315	0
	2	0	0	0	20	20	0
	3	0	0	0	17	17	0
	4	0	0	0	7	7	0
	5	0	0	0	9	9	0
	6	0	0	0	7	7	0
	Total	*5*	*0*	*0*	*529*	*534*	*5*

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 3	22	0	0	0	2	2	0
	23	4	0	0	0	4	4
	0	0	0	0	3	3	0
	1	2	0	0	0	2	2
	4	3	0	0	0	3	3
	Total	*9*	*0*	*0*	*5*	*14*	*9*
September22	0	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
September 23	20	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
September 24	4	0	0	0	3	3	0
	6	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*6*	*6*	*0*
September 25	21	0	0	0	2	2	0
	22	0	0	0	1	1	0
	23	0	0	0	8	8	0
	1	2	0	0	28	30	2
	2	0	0	0	1	1	0
	4	0	0	0	10	10	0
	5	0	0	0	3	3	0
	Total	*2*	*0*	*0*	*53*	*55*	*2*
September 26	20	0	0	0	2	2	0
	21	0	0	0	8	8	0
	1	0	0	0	1	1	0
	4	0	0	0	1	1	0
	5	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*13*	*13*	*0*
September 27	20	0	0	0	2	2	0
	21	0	0	0	10	10	0
	19	0	0	0	2	2	0
	6	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*18*	*18*	*0*
September 28	21	0	0	0	3	3	0
	23	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 29	20	0	0	0	25	25	0

Table E6 Detailed Results of Acoustic Monitoring at Site R1-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	22	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*29*	*29*	*0*
October 2	0	0	1	0	0	1	1
	Total	*0*	*1*	*0*	*0*	*1*	*1*
October 5	21	0	0	0	6	6	0
	22	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*10*	*10*	*0*
October 6	20	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
October 7	20	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
Total		1,286	172	35	3,143	4,636	1,458

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	21	14	0	0	10	24	14
	22	0	0	0	23	23	0
	23	4	0	0	3	7	4
	0	0	0	0	0	0	0
	1	0	0	0	0	0	0
	2	2	0	0	2	4	2
	3	6	0	0	4	10	6
	4	15	0	0	2	17	15
	5	8	0	0	5	13	8
	Total	*49*	*0*	*0*	*49*	*98*	*49*
July 29	21	11	0	0	6	17	11
	22	4	0	0	10	14	4
	23	2	0	0	26	28	2
	0	4	0	0	1	5	4
	1	2	0	0	1	3	2
	2	5	0	0	3	8	5
	4	2	0	0	1	3	2
	5	161	0	0	21	182	161
	Total	*191*	*0*	*0*	*69*	*260*	*191*
July 30	21	12	0	0	5	17	12
	22	22	0	0	16	38	22
	23	7	0	0	2	9	7
	0	3	0	0	3	6	3
	2	2	0	0	3	5	2
	3	17	4	0	0	21	21
	4	10	0	0	11	21	10
	5	14	0	0	22	36	14
	Total	*87*	*4*	*0*	*62*	*153*	*91*
July 31	21	14	0	0	2	16	14
	22	9	0	0	9	18	9
	23	3	0	0	0	3	3
	0	4	0	0	0	4	4
	2	31	0	0	0	31	31
	3	9	0	0	5	14	9
	4	12	0	0	0	12	12
	5	11	0	0	4	15	11

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*93*	*0*	*0*	*20*	*113*	*93*
August 1	21	13	0	0	0	13	13
	23	217	2	0	0	219	219
	0	44	0	0	3	47	44
	1	0	0	0	23	23	0
	2	17	0	0	0	17	17
	3	4	0	0	0	4	4
	5	22	0	0	20	42	22
	Total	*317*	*2*	*0*	*46*	*365*	*319*
August 2	21	15	0	0	11	26	15
	22	17	0	0	4	21	17
	23	0	0	0	0	0	0
	0	2	0	0	0	2	2
	1	0	0	0	13	13	0
	2	13	0	0	3	16	13
	3	9	0	0	0	9	9
	4	12	0	0	21	33	12
	5	35	0	0	0	35	35
	Total	*103*	*0*	*0*	*52*	*155*	*103*
August 3	21	14	0	0	0	14	14
	22	3	0	0	6	9	3
	23	6	0	0	12	18	6
	0	15	0	0	1	16	15
	1	2	0	0	5	7	2
	2	0	0	0	3	3	0
	3	7	0	0	5	12	7
	4	11	0	0	0	11	11
	5	40	0	0	5	45	40
	6	0	0	0	0	0	0
	Total	*98*	*0*	*0*	*37*	*135*	*98*
August 4	21	13	0	0	1	14	13
	22	5	0	0	7	12	5
	23	11	0	0	0	11	11
	0	1	0	0	13	14	1
	1	0	0	0	9	9	0
	3	3	0	0	1	4	3

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	14	0	0	0	14	14
	5	32	0	0	8	40	32
	Total	*79*	*0*	*0*	*39*	*118*	*79*
August 5	21	30	0	0	4	34	30
	22	21	0	0	0	21	21
	0	14	0	0	0	14	14
	2	12	0	0	2	14	12
	3	2	0	0	1	3	2
	4	4	0	0	0	4	4
	5	0	0	0	7	7	0
	Total	*83*	*0*	*0*	*14*	*97*	*83*
August 6	21	4	0	0	5	9	4
	22	4	0	0	0	4	4
	23	6	0	1	3	10	6
	0	0	0	0	0	0	0
	1	5	0	0	2	7	5
	3	6	0	0	0	6	6
	4	3	0	0	7	10	3
	5	27	0	0	2	29	27
	Total	*55*	*0*	*1*	*19*	*75*	*55*
August 7	21	13	0	0	0	13	13
	22	63	0	0	0	63	63
	0	1	0	0	0	1	1
	1	21	0	0	2	23	21
	2	1	0	0	0	1	1
	3	4	0	0	0	4	4
	4	3	0	0	0	3	3
	5	123	0	0	11	134	123
	Total	*229*	*0*	*0*	*13*	*242*	*229*
August 8	21	29	0	0	1	30	29
	22	35	0	0	0	35	35
	23	4	0	0	7	11	4
	0	2	0	0	0	2	2
	1	5	0	0	0	5	5
	2	3	0	0	0	3	3
	3	3	0	0	13	16	3

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	22	0	0	5	27	22
	5	12	0	0	1	13	12
	6	0	0	0	0	0	0
	Total	*115*	*0*	*0*	*27*	*142*	*115*
August 9	21	40	0	0	4	44	40
	22	3	0	0	0	3	3
	23	76	0	0	0	76	76
	0	6	0	0	1	7	6
	1	2	0	0	0	2	2
	2	9	0	0	0	9	9
	3	5	0	0	0	5	5
	4	17	0	0	4	21	17
	5	29	0	0	70	99	29
	Total	*187*	*0*	*0*	*79*	*266*	*187*
August 10	21	6	0	0	9	15	6
	0	8	0	0	0	8	8
	1	9	0	0	5	14	9
	2	8	0	0	0	8	8
	3	4	0	0	0	4	4
	4	3	0	0	35	38	3
	5	15	0	0	11	26	15
	Total	*53*	*0*	*0*	*60*	*113*	*53*
August 11	21	15	1	0	7	23	16
	22	0	0	0	3	3	0
	0	0	0	0	1	1	0
	2	1	0	0	1	2	1
	3	8	0	0	0	8	8
	4	8	0	0	4	12	8
	5	8	0	0	0	8	8
	Total	*40*	*1*	*0*	*16*	*57*	*41*
August 12	22	0	0	0	1	1	0
	23	13	0	0	6	19	13
	0	2	0	0	0	2	2
	1	2	0	0	10	12	2
	2	0	0	0	6	6	0
	3	3	0	0	0	3	3

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	17	0	0	13	30	17
	5	32	0	0	15	47	32
	Total	*69*	*0*	*0*	*51*	*120*	*69*
August 13	21	249	1	0	57	307	250
	22	31	0	0	8	39	31
	23	136	6	0	1	143	142
	0	3	0	0	2	5	3
	1	13	0	0	0	13	13
	2	5	0	0	0	5	5
	3	17	0	0	3	20	17
	4	32	0	0	14	46	32
	5	13	0	0	6	19	13
	Total	*499*	*7*	*0*	*91*	*597*	*506*
August 14	21	53	0	0	7	60	53
	22	13	0	0	10	23	13
	23	78	0	0	1	79	78
	0	13	0	0	1	14	13
	1	4	0	0	0	4	4
	2	5	0	0	5	10	5
	3	17	0	0	2	19	17
	5	0	0	0	2	2	0
	Total	*183*	*0*	*0*	*28*	*211*	*183*
August 15	21	27	0	0	49	76	27
	22	59	0	0	3	62	59
	23	8	0	0	1	9	8
	0	0	0	0	74	74	0
	1	21	0	0	4	25	21
	2	15	0	0	6	21	15
	3	16	0	0	7	23	16
	4	15	0	0	5	20	15
	5	30	0	0	51	81	30
	6	0	0	0	3	3	0
	Total	*191*	*0*	*0*	*203*	*394*	*191*
August 16	21	41	0	0	18	59	41
	22	54	0	0	2	56	54
	23	17	0	0	4	21	17

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	0	0	0	1	1	0
	1	0	0	0	4	4	0
	2	0	0	0	19	19	0
	3	3	0	0	13	16	3
	4	3	0	0	19	22	3
	5	5	0	0	55	60	5
	6	7	2	0	0	9	9
	Total	*130*	*2*	*0*	*135*	*267*	*132*
August 17	21	124	0	0	66	190	124
	22	58	0	0	7	65	58
	23	0	0	0	1	1	0
	0	0	0	0	2	2	0
	1	2	0	0	13	15	2
	2	5	0	0	14	19	5
	3	5	0	0	19	24	5
	4	6	0	0	32	38	6
	5	50	0	0	8	58	50
	6	2	0	0	1	3	2
	Total	*252*	*0*	*0*	*163*	*415*	*252*
August 18	21	105	0	0	48	153	105
	22	2	0	0	31	33	2
	23	13	0	0	27	40	13
	0	4	0	0	1	5	4
	1	0	0	0	10	10	0
	2	0	0	0	6	6	0
	3	5	0	0	24	29	5
	4	54	0	0	1	55	54
	5	43	0	0	39	82	43
	Total	*226*	*0*	*0*	*187*	*413*	*226*
August 19	21	32	0	0	10	42	32
	22	0	0	0	3	3	0
	23	3	0	0	7	10	3
	0	17	0	0	3	20	17
	1	12	0	0	10	22	12
	2	8	0	0	12	20	8
	3	0	0	0	10	10	0

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	19	0	0	0	19	19
	5	22	0	0	0	22	22
	Total	*113*	*0*	*0*	*55*	*168*	*113*
August 20	21	20	1	0	10	31	21
	22	2	0	0	0	2	2
	20	3	0	0	0	3	3
	0	2	0	0	7	9	2
	1	3	0	0	0	3	3
	2	3	0	0	0	3	3
	3	3	0	0	0	3	3
	4	14	0	0	3	17	14
	5	7	0	0	3	10	7
	Total	*57*	*1*	*0*	*23*	*81*	*58*
August 21	21	63	0	0	7	70	63
	22	5	0	0	6	11	5
	23	8	0	0	0	8	8
	20	1	0	0	0	1	1
	1	1	1	0	0	2	2
	2	1	0	0	2	3	1
	3	0	0	0	2	2	0
	4	0	0	0	3	3	0
	5	8	0	0	2	10	8
	Total	*87*	*1*	*0*	*22*	*110*	*88*
August 22	21	13	0	0	0	13	13
	22	0	0	0	2	2	0
	2	0	0	0	1	1	0
	3	6	4	0	5	15	10
	4	11	0	0	1	12	11
	5	45	0	0	50	95	45
	6	36	0	0	0	36	36
	Total	*111*	*4*	*0*	*59*	*174*	*115*
August 23	21	46	0	0	9	55	46
	22	2	0	0	2	4	2
	23	22	0	0	4	26	22
	0	12	0	0	2	14	12
	1	7	0	0	0	7	7

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	27	0	0	0	27	27
	3	19	0	0	4	23	19
	4	2	0	0	0	2	2
	6	21	0	0	1	22	21
	Total	*158*	*0*	*0*	*22*	*180*	*158*
August 24	21	54	0	0	19	73	54
	22	15	1	0	4	20	16
	23	8	0	0	2	10	8
	0	8	0	0	1	9	8
	2	0	0	0	1	1	0
	3	0	0	0	1	1	0
	4	9	0	0	22	31	9
	5	0	0	0	3	3	0
	6	19	0	0	0	19	19
	Total	*113*	*1*	*0*	*53*	*167*	*114*
August 25	21	114	0	0	60	174	114
	22	5	0	0	3	8	5
	23	1	0	0	0	1	1
	20	28	0	0	7	35	28
	1	6	0	0	5	11	6
	2	4	0	0	0	4	4
	3	2	0	0	0	2	2
	4	3	0	0	2	5	3
	6	3	0	0	0	3	3
	Total	*166*	*0*	*0*	*77*	*243*	*166*
August 26	21	9	0	0	8	17	9
	23	1	0	0	0	1	1
	20	4	0	0	0	4	4
	0	3	0	0	0	3	3
	4	1	0	0	0	1	1
	6	0	0	0	1	1	0
	Total	*18*	*0*	*0*	*9*	*27*	*18*
August 27	21	3	0	0	3	6	3
	23	4	0	0	0	4	4
	20	6	0	0	0	6	6
	0	0	0	0	8	8	0

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	0	0	0	11	11	0
	3	0	0	0	3	3	0
	4	0	0	0	6	6	0
	5	0	0	0	5	5	0
	6	0	0	0	1	1	0
	Total	*13*	*0*	*0*	*37*	*50*	*13*
August 28	21	5	0	0	0	5	5
	23	0	0	0	1	1	0
	20	4	0	0	0	4	4
	1	3	0	0	0	3	3
	3	2	0	0	4	6	2
	4	2	0	0	0	2	2
	5	2	0	0	1	3	2
	Total	*18*	*0*	*0*	*6*	*24*	*18*
August 29	23	0	0	0	2	2	0
	20	4	0	0	0	4	4
	1	0	0	0	2	2	0
	5	0	0	0	1	1	0
	Total	*4*	*0*	*0*	*5*	*9*	*4*
	830	0	0	0	0	0	0
August 30	21	11	0	0	37	48	11
	20	7	0	0	13	20	7
	2	35	0	0	0	35	35
	4	0	0	0	2	2	0
	5	3	0	0	2	5	3
	6	5	0	0	1	6	5
	Total	*61*	*0*	*0*	*55*	*116*	*61*
August 31	21	12	0	0	3	15	12
	22	0	0	0	4	4	0
	20	31	0	0	0	31	31
	2	0	0	0	3	3	0
	3	0	0	0	1	1	0
	4	0	0	0	1	1	0
	5	1	0	0	1	2	1
	6	0	0	0	5	5	0
	Total	*44*	*0*	*0*	*18*	*62*	*44*

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 1	20	17	0	0	5	22	17
	21	6	0	0	1	7	6
	22	0	0	0	1	1	0
	23	0	0	0	2	2	0
	0	0	0	0	7	7	0
	1	1	0	0	4	5	1
	2	0	0	0	10	10	0
	4	1	0	0	17	18	1
	5	0	0	0	26	26	0
	6	0	0	0	43	43	0
	Total	*25*	*0*	*0*	*116*	*141*	*25*
September 2	21	7	0	0	14	21	7
	22	0	0	0	1	1	0
	23	0	0	0	3	3	0
	20	67	0	0	23	90	67
	0	0	0	0	3	3	0
	1	0	0	0	7	7	0
	4	0	0	0	1	1	0
	6	4	0	0	60	64	4
	Total	*78*	*0*	*0*	*112*	*190*	*78*
September 3	22	0	0	0	1	1	0
	23	0	0	0	3	3	0
	0	0	0	0	5	5	0
	2	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*12*	*12*	*0*
September 4	22	0	0	0	11	11	0
	23	0	0	0	1	1	0
	20	4	0	0	1	5	4
	Total	*4*	*0*	*0*	*13*	*17*	*4*
September 22	4	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
September 25	19	0	0	0	1	1	0
	20	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*
October 3	4	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*

Table E7 Detailed Results of Acoustic Monitoring at Site R1-7

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
October 6	19	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
Total		4,399	23	1	2,162	6,585	4,422

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 29	22	7	1	0	4	12	8
	23	1	0	0	1	2	1
	0	6	0	0	4	10	6
	1	0	0	0	4	4	0
	2	2	0	0	3	5	2
	3	0	0	0	19	19	0
	5	2	0	0	3	5	2
	Total	*18*	*1*	*0*	*38*	*57*	*19*
July 30	22	1	0	0	3	4	1
	23	2	0	0	3	5	2
	0	0	0	0	1	1	0
	1	2	0	0	1	3	2
	2	2	0	0	2	4	2
	3	1	0	0	1	2	1
	5	0	0	0	19	19	0
	Total	*8*	*0*	*0*	*30*	*38*	*8*
July 31	0	2	0	0	5	7	2
	1	2	1	0	4	7	3
	2	0	0	0	1	1	0
	3	0	0	0	3	3	0
	4	6	0	0	2	8	6
	5	0	0	0	3	3	0
	6	0	0	0	1	1	0
	Total	*10*	*1*	*0*	*19*	*30*	11
August 1	23	1	0	0	0	1	1
	5	2	0	1	0	3	2
	Total	*3*	*0*	*1*	*0*	*4*	*3*
August 2	22	2	0	0	1	3	2
	23	1	0	0	1	2	1
	0	7	2	0	2	11	9
	1	2	0	0	0	2	2
	2	6	0	0	0	6	6
	3	0	0	2	1	3	0
	4	12	0	0	29	41	12
	5	5	2	0	22	29	7
	Total	*35*	*4*	*2*	*56*	*97*	*39*

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 3	0	0	0	0	2	2	0
	1	0	0	0	0	0	0
	2	2	0	0	1	3	2
	3	5	0	0	1	6	5
	4	0	0	0	9	9	0
	5	0	0	0	1	1	0
	Total	*7*	*0*	*0*	*14*	*21*	*7*
August 4	21	2	0	0	2	4	2
	22	0	0	0	3	3	0
	0	4	0	0	2	6	4
	1	7	0	0	0	7	7
	2	0	0	2	0	2	0
	5	0	0	0	3	3	0
	Total	*13*	*0*	*2*	*10*	*25*	*13*
August 5	22	3	0	0	4	7	3
	23	0	1	5	4	10	1
	2	2	0	0	1	3	2
	3	6	0	2	0	8	6
	5	8	2	0	0	10	10
	Total	*19*	*3*	*7*	*9*	*38*	*22*
August 6	21	0	0	0	6	6	0
	22	4	0	0	7	11	4
	23	2	2	0	2	6	4
	0	0	0	0	3	3	0
	1	0	0	0	4	4	0
	2	0	0	0	3	3	0
	3	1	0	0	0	1	1
	5	0	0	7	0	7	0
	Total	*7*	*2*	*7*	*25*	*41*	*9*
August 7	21	2	0	0	0	2	2
	22	0	0	0	5	5	0
	23	10	0	1	3	14	10
	0	4	0	0	0	4	4
	1	2	0	0	6	8	2
	3	0	0	0	1	1	0
	5	0	0	0	2	2	0

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*18*	*0*	*1*	*17*	*36*	*18*
August 8	21	0	0	0	5	5	0
	22	0	0	0	4	4	0
	0	0	2	0	0	2	2
	1	0	0	0	1	1	0
	3	1	0	0	0	1	1
	4	8	0	0	4	12	8
	5	1	0	0	0	1	1
	Total	*10*	*2*	*0*	*14*	*26*	*12*
August 9	21	3	0	0	6	9	3
	22	1	0	0	1	2	1
	23	0	0	0	6	6	0
	0	2	0	0	9	11	2
	1	0	0	0	3	3	0
	2	0	0	2	15	17	0
	3	19	0	0	8	27	19
	4	5	0	0	9	14	5
	5	2	0	0	0	2	2
	Total	*32*	*0*	*2*	*57*	*91*	*32*
August 10	21	0	1	0	2	3	1
	22	0	0	0	4	4	0
	23	2	0	0	0	2	2
	0	0	0	0	4	4	0
	1	0	0	0	3	3	0
	2	0	0	0	16	16	0
	4	2	0	0	2	4	2
	5	3	0	0	0	3	3
	Total	*7*	*1*	*0*	*31*	*39*	*8*
August 11	21	2	0	0	2	4	2
	22	0	0	2	17	19	0
	23	0	0	0	3	3	0
	0	3	0	0	5	8	3
	1	0	0	4	3	7	0
	2	2	0	0	0	2	2
	5	0	0	9	0	9	0
	Total	*7*	*0*	*15*	*30*	*52*	*7*

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 12	21	2	1	0	2	5	3
	22	0	0	0	8	8	0
	23	0	0	0	4	4	0
	0	0	0	0	1	1	0
	1	7	0	0	3	10	7
	2	0	0	0	2	2	0
	3	0	0	0	5	5	0
	4	4	0	0	3	7	4
	5	0	0	0	2	2	0
	Total	*13*	*1*	*0*	*30*	*44*	*14*
August 13	21	2	0	0	1	3	2
	22	0	0	0	1	1	0
	23	0	0	0	3	3	0
	0	6	0	0	2	8	6
	2	0	0	0	3	3	0
	4	0	0	0	1	1	0
	Total	*8*	*0*	*0*	*11*	*19*	*8*
August 14	21	0	0	0	1	1	0
	22	0	0	0	2	2	0
	23	0	0	0	2	2	0
	2	2	0	0	0	2	2
	4	2	0	0	0	2	2
	Total	*4*	*0*	*0*	*5*	*9*	*4*
August 15	21	8	0	0	3	11	8
	22	0	0	0	4	4	0
	23	0	0	0	5	5	0
	0	2	0	0	3	5	2
	1	2	0	0	0	2	2
	2	3	0	0	3	6	3
	3	4	0	0	0	4	4
	4	1	0	0	0	1	1
	5	0	0	0	4	4	0
	Total	*20*	*0*	*0*	*22*	*42*	*20*
August 16	21	0	0	0	3	3	0
	22	0	0	0	3	3	0
	23	1	0	0	1	2	1

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	1	0	0	0	2	2	0
	3	0	0	0	3	3	0
	5	0	0	0	2	2	0
	6	0	5	0	0	5	5
	Total	*1*	*5*	*0*	*14*	*20*	*6*
August 17	21	0	0	0	3	3	0
	22	0	0	0	2	2	0
	23	0	0	0	2	2	0
	0	0	0	0	5	5	0
	3	1	0	0	0	1	1
	4	2	0	0	1	3	2
	6	0	0	2	0	2	0
	Total	*3*	*0*	*2*	*13*	*18*	*3*
August 18	21	1	0	0	5	6	1
	22	0	0	0	2	2	0
	1	0	0	0	2	2	0
	2	0	0	0	1	1	0
	3	0	0	0	3	3	0
	Total	*1*	*0*	*0*	*13*	*14*	*1*
August 19	21	2	0	0	4	6	2
	22	0	0	0	10	10	0
	23	0	1	0	0	1	1
	0	0	2	0	4	6	2
	2	0	0	0	1	1	0
	3	0	0	0	1	1	0
	4	0	0	0	4	4	0
	5	1	0	0	0	1	1
	Total	*3*	*3*	*0*	*24*	*30*	*6*
August 20	20	0	0	0	3	3	0
	21	0	0	0	2	2	0
	22	2	0	0	19	21	2
	1	2	0	0	5	7	2
	2	3	0	0	4	7	3
	3	4	0	0	2	6	4
	Total	*11*	*0*	*0*	*35*	*46*	*11*
August 21	20	0	1	0	0	1	1

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	21	1	0	0	4	5	1
	22	0	0	0	6	6	0
	23	0	0	0	15	15	0
	0	0	0	0	3	3	0
	4	5	0	0	2	7	5
	Total	*6*	*1*	*0*	*30*	*37*	*7*
August 22	21	4	0	0	0	4	4
	22	0	0	0	4	4	0
	23	7	3	0	10	20	10
	0	3	0	0	38	41	3
	1	0	0	0	3	3	0
	2	0	0	0	4	4	0
	4	4	0	0	0	4	4
	5	2	0	0	0	2	2
	Total	*20*	*3*	*0*	*59*	*82*	*23*
August 23	21	0	0	0	3	3	0
	22	0	0	0	4	4	0
	23	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*8*	*8*	*0*
August 24	21	0	0	0	1	1	0
	22	0	0	0	1	1	0
	0	0	0	0	5	5	0
	1	0	0	0	3	3	0
	2	0	0	0	1	1	0
	4	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*15*	*15*	*0*
August 25	20	0	0	0	2	2	0
	21	0	0	0	6	6	0
	22	0	0	0	2	2	0
	23	0	0	0	4	4	0
	0	0	0	0	3	3	0
	1	1	0	0	0	1	1
	2	0	0	0	1	1	0
	3	0	0	0	3	3	0
	4	2	0	0	0	2	2
	Total	*3*	*0*	*0*	*21*	*24*	*3*

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 26	22	1	0	0	0	1	1
	Total	*1*	*0*	*0*	*0*	*1*	*1*
August 27	22	1	0	0	3	4	1
	23	3	1	0	2	6	4
	0	0	0	0	8	8	0
	2	10	0	0	9	19	10
	3	0	0	0	3	3	0
	4	0	0	0	5	5	0
	5	4	0	0	5	9	4
	Total	*18*	*1*	*0*	*35*	*54*	*19*
August 28	20	0	1	0	0	1	1
	21	1	0	0	4	5	1
	3	3	0	0	1	4	3
	4	2	0	0	0	2	2
	5	1	0	0	0	1	1
	Total	*7*	*1*	*0*	*5*	*13*	*8*
August 29	22	0	0	0	2	2	0
	0	2	0	0	0	2	2
	4	0	0	0	1	1	0
	5	0	0	0	1	1	0
	Total	*2*	*0*	*0*	*4*	*6*	*2*
August 30	21	0	0	0	1	1	0
	23	0	0	0	2	2	0
	1	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
August 31	20	0	0	0	1	1	0
	23	0	0	0	2	2	0
	0	1	0	0	0	1	1
	1	0	0	0	1	1	0
	2	0	0	0	2	2	0
	4	0	0	0	2	2	0
	5	0	0	0	1	1	0
	Total	*1*	*0*	*0*	*9*	*10*	*1*
September 1	21	1	0	0	5	6	1
	23	0	0	0	2	2	0
	3	0	0	0	2	2	0

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	4	0	0	0	6	6	0
	5	0	0	0	6	6	0
	Total	*1*	*0*	*0*	*21*	*22*	*1*
September 2	20	0	0	0	1	1	0
	21	0	0	0	1	1	0
	23	0	0	0	1	1	0
	0	2	0	0	3	5	2
	1	0	0	0	8	8	0
	3	0	0	0	1	1	0
	5	0	0	0	2	2	0
	Total	*2*	*0*	*0*	*17*	*19*	*2*
September 3	20	2	0	0	0	2	2
	23	0	1	0	0	1	1
	0	0	0	0	1	1	0
	2	0	0	0	4	4	0
	4	0	0	0	1	1	0
	Total	*2*	*1*	*0*	*6*	*9*	*3*
September 4	20	3	0	0	0	3	3
	21	0	0	0	3	3	0
	22	0	3	0	0	3	3
	Total	*3*	*3*	*0*	*3*	*9*	*6*
September 5	20	0	2	0	0	2	2
	22	4	0	0	0	4	4
	0	1	0	0	0	1	1
	3	0	2	0	0	2	2
	Total	*5*	*4*	*0*	*0*	*9*	*9*
September 6	20	0	2	0	1	3	2
	23	2	0	0	0	2	2
	4	0	0	0	2	2	0
	5	0	0	0	15	15	0
	Total	*2*	*2*	*0*	*18*	*22*	*4*
September 7	20	0	0	0	1	1	0
	2	5	2	0	1	8	7
	5	0	0	0	14	14	0
	6	0	0	0	2	2	0
	Total	*5*	*2*	*0*	*18*	*25*	*7*

Table E8 Detailed Results of Acoustic Monitoring at Site R4-2

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 8	21	0	0	0	1	1	0
	23	0	1	0	8	9	1
	0	0	0	0	1	1	0
	Total	*0*	*1*	*0*	*10*	*11*	*1*
September 24	5	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
September 26	22	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
September 28	20	0	0	0	6	6	0
	Total	*0*	*0*	*0*	*6*	*6*	*0*
Total		336	42	39	810	1,227	378

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	21	2	0	0	3	5	2
	22	0	0	0	6	6	0
	23	43	4	5	24	76	47
	0	55	4	0	0	59	59
	1	10	6	7	17	40	16
	2	11	7	7	84	109	18
	3	12	7	2	8	29	19
	4	18	1	1	8	28	19
	5	23	0	2	3	28	23
	Total	*174*	*29*	*24*	*153*	*380*	*203*
July 29	21	19	0	0	1	20	19
	22	1	0	0	6	7	1
	23	5	0	0	0	5	5
	0	34	0	0	4	38	34
	1	4	5	6	0	15	9
	2	12	3	4	3	22	15
	3	3	8	10	3	24	11
	4	13	3	0	10	26	16
	5	15	0	0	0	15	15
	Total	*106*	*19*	*20*	*27*	*172*	*125*
July 30	21	2	0	0	0	2	2
	22	2	0	0	3	5	2
	23	11	7	0	1	19	18
	0	21	0	0	2	23	21
	1	0	0	0	10	10	0
	2	0	0	1	4	5	0
	3	9	0	0	3	12	9
	4	4	0	0	8	12	4
	5	5	0	0	1	6	5
	Total	*54*	*7*	*1*	*32*	*94*	*61*
July 31	21	16	2	0	32	50	18
	22	0	0	0	3	3	0
	23	12	0	0	0	12	12
	0	3	2	0	1	6	5
	1	3	2	6	23	34	5
	2	1	0	3	0	4	1

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	0	3	0	0	3	3
	4	3	0	7	16	26	3
	5	16	0	10	1	27	16
	Total	*54*	*9*	*26*	*76*	*165*	*63*
August 1	21	2	0	0	2	4	2
	2	0	0	0	1	1	0
	3	0	0	0	4	4	0
	4	0	5	0	0	5	5
	5	6	0	0	0	6	6
	Total	*8*	*5*	*0*	*7*	*20*	*13*
August 2	21	0	0	0	3	3	0
	22	3	0	0	6	9	3
	1	0	2	0	2	4	2
	3	1	0	0	0	1	1
	4	3	0	0	0	3	3
	5	0	0	1	4	5	0
	Total	*7*	*2*	*1*	*15*	*25*	*9*
August 3	21	8	0	0	4	12	8
	22	0	0	0	11	11	0
	23	1	0	0	11	12	1
	0	25	4	2	2	33	29
	1	39	1	0	0	40	40
	2	33	0	0	11	44	33
	3	14	4	8	2	28	18
	4	2	0	0	1	3	2
	5	11	0	0	6	17	11
	6	2	0	0	0	2	2
	Total	*135*	*9*	*10*	*48*	*202*	*144*
August 4	20	2	0	0	0	2	2
	21	7	0	0	0	7	7
	22	0	0	0	1	1	0
	23	16	1	0	8	25	17
	1	6	2	0	0	8	8
	3	3	0	0	0	3	3
	4	1	0	6	0	7	1
	5	0	0	0	3	3	0

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*35*	*3*	*6*	*12*	*56*	*38*
August 5	21	0	0	0	5	5	0
	22	0	0	0	0	0	0
	23	3	0	0	1	4	3
	1	2	0	0	3	5	2
	5	2	0	1	0	3	2
	6	2	0	0	0	2	2
	Total	*9*	*0*	*1*	*9*	*19*	*9*
August 6	21	9	0	0	6	15	9
	22	4	0	0	4	8	4
	23	6	0	0	6	12	6
	0	0	0	0	4	4	0
	1	6	0	0	5	11	6
	2	4	1	0	4	9	5
	3	0	0	0	1	1	0
	4	1	0	0	3	4	1
	5	13	5	0	5	23	18
	Total	*43*	*6*	*0*	*38*	*87*	*49*
August 7	21	4	0	0	5	9	4
	22	1	1	0	2	4	2
	23	5	2	3	0	10	7
	0	3	0	0	0	3	3
	1	2	0	0	4	6	2
	2	2	2	0	68	72	4
	3	14	7	0	0	21	21
	4	2	0	0	2	4	2
	5	19	0	0	2	21	19
	Total	*52*	*12*	*3*	*83*	*150*	*64*
August 8	21	10	1	0	6	17	11
	22	2	0	0	1	3	2
	23	2	0	0	6	8	2
	0	3	0	0	15	18	3
	1	1	0	0	9	10	1
	2	0	0	0	8	8	0
	3	5	1	2	8	16	6
	4	8	5	3	0	16	13

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	3	0	0	11	14	3
	Total	*34*	*7*	*5*	*64*	*110*	*41*
August 9	21	23	0	0	2	25	23
	22	40	0	0	4	44	40
	23	35	0	0	10	45	35
	0	3	0	0	0	3	3
	1	5	0	0	4	9	5
	2	9	0	0	0	9	9
	3	27	2	3	0	32	29
	4	2	0	1	2	5	2
	5	12	0	0	6	18	12
	Total	*156*	*2*	*4*	*28*	*190*	*158*
August 10	21	8	0	0	7	15	8
	23	0	0	0	3	3	0
	0	0	0	0	7	7	0
	1	1	0	0	10	11	1
	2	3	2	7	7	19	5
	3	15	0	0	14	29	15
	4	4	0	5	6	15	4
	5	5	2	0	7	14	7
	Total	*36*	*4*	*12*	*61*	*113*	*40*
August 11	21	7	0	0	3	10	7
	22	50	0	0	13	63	50
	23	0	0	0	2	2	0
	0	16	0	1	6	23	16
	1	20	2	0	19	41	22
	2	2	0	10	18	30	2
	3	6	0	0	29	35	6
	4	0	0	0	4	4	0
	5	5	2	1	4	12	7
	Total	*106*	*4*	*12*	*98*	*220*	*110*
August 12	21	14	8	9	13	44	22
	22	1	0	0	4	5	1
	23	2	3	0	1	6	5
	0	25	4	0	17	46	29
	1	41	4	0	6	51	45

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	62	3	0	9	74	65
	3	23	4	0	15	42	27
	4	4	2	0	2	8	6
	5	8	1	0	4	13	9
	Total	*180*	*29*	*9*	*71*	*289*	*209*
August 13	21	8	0	0	4	12	8
	22	0	0	0	2	2	0
	23	2	0	0	0	2	2
	1	0	0	0	13	13	0
	2	6	5	0	0	11	11
	3	3	0	4	1	8	3
	4	0	0	0	1	1	0
	5	6	0	0	6	12	6
	6	0	0	0	5	5	0
	Total	*25*	*5*	*4*	*32*	*66*	*30*
August 14	21	2	0	0	1	3	2
	22	4	0	2	0	6	4
	23	2	3	0	6	11	5
	0	0	0	3	0	3	0
	1	0	0	0	2	2	0
	2	0	0	0	4	4	0
	3	0	0	0	3	3	0
	4	2	0	2	3	7	2
	5	5	0	0	34	39	5
	6	2	0	0	0	2	2
	Total	*17*	*3*	*7*	*53*	*80*	*20*
August 15	21	33	1	0	9	43	34
	22	9	5	0	3	17	14
	23	28	9	4	1	42	37
	0	16	15	7	3	41	31
	1	2	8	3	5	18	10
	2	2	5	0	1	8	7
	3	4	0	0	0	4	4
	4	2	0	0	3	5	2
	5	11	5	0	4	20	16
	Total	*107*	*48*	*14*	*29*	*198*	*155*

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 16	21	2	0	2	4	8	2
	22	20	0	0	7	27	20
	23	5	2	0	94	101	7
	0	36	2	0	1	39	38
	1	5	0	0	5	10	5
	2	12	10	6	3	31	22
	3	0	0	0	9	9	0
	4	2	0	0	2	4	2
	5	3	0	0	7	10	3
	6	3	1	0	2	6	4
	Total	*88*	*15*	*8*	*134*	*245*	*103*
August 17	21	3	0	0	3	6	3
	22	13	0	0	0	13	13
	23	2	0	2	1	5	2
	0	7	2	2	20	31	9
	1	14	5	0	0	19	19
	2	8	0	0	10	18	8
	4	5	0	0	2	7	5
	5	3	0	0	5	8	3
	Total	*55*	*7*	*4*	*41*	*107*	*62*
August 18	21	1	0	0	2	3	1
	2	32	0	0	0	32	32
	3	11	0	0	4	15	11
	6	2	0	0	2	4	2
	Total	*46*	*0*	*0*	*8*	*54*	*46*
August 19	21	0	0	0	15	15	0
	22	22	0	2	10	34	22
	23	4	0	0	8	12	4
	0	3	0	0	1	4	3
	1	2	13	5	11	31	15
	2	4	3	8	5	20	7
	3	2	0	0	7	9	2
	4	8	0	0	0	8	8
	5	5	1	3	8	17	6
	6	0	0	0	3	3	0
	Total	*50*	*17*	*18*	*68*	*153*	*67*

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
August 20	21	51	4	0	19	74	55
	22	2	0	0	0	2	2
	23	10	0	0	0	10	10
	0	4	0	0	2	6	4
	1	1	0	5	0	6	1
	2	0	5	0	2	7	5
	3	0	0	0	2	2	0
	4	5	0	0	2	7	5
	5	0	1	0	9	10	1
	Total	*73*	*10*	*5*	*36*	*124*	*83*
August 21	20	13	6	0	3	22	19
	21	2	0	0	2	4	2
	0	15	0	0	0	15	15
	2	5	0	0	10	15	5
	3	0	2	0	0	2	2
	4	2	0	1	2	5	2
	5	12	2	0	0	14	14
	6	2	0	1	0	3	2
	Total	*51*	*10*	*2*	*17*	*80*	*61*
August 22	20	0	0	0	5	5	0
	21	8	0	0	4	12	8
	22	0	0	0	1	1	0
	23	0	2	1	0	3	2
	0	0	0	0	2	2	0
	1	43	57	0	24	124	100
	2	70	6	0	0	76	76
	3	28	2	0	84	114	30
	4	5	5	0	6	16	10
	5	35	2	0	8	45	37
	6	1	0	0	15	16	1
	Total	*190*	*74*	*1*	*149*	*414*	*264*
August 23	20	0	0	0	4	4	0
	21	2	0	0	3	5	2
	22	2	0	2	0	4	2
	23	5	9	0	6	20	14
	0	27	0	0	2	29	27

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	1	8	0	0	4	12	8
	2	26	0	0	0	26	26
	3	19	0	0	10	29	19
	4	0	0	0	3	3	0
	5	10	1	0	0	11	11
	6	41	0	0	15	56	41
	Total	*140*	*10*	*2*	*47*	*199*	*150*
August 24	20	2	0	0	0	2	2
	21	3	0	0	7	10	3
	22	0	0	0	5	5	0
	23	0	0	0	4	4	0
	0	18	0	0	1	19	18
	1	0	0	0	8	8	0
	2	0	0	0	25	25	0
	3	0	0	0	4	4	0
	4	2	0	0	13	15	2
	5	0	0	0	9	9	0
	6	2	0	0	6	8	2
	Total	*27*	*0*	*0*	*82*	*109*	*27*
August 25	20	0	0	0	2	2	0
	21	3	0	0	6	9	3
	22	0	0	0	18	18	0
	23	0	0	0	4	4	0
	0	1	0	0	5	6	1
	1	1	0	0	4	5	1
	2	0	0	0	9	9	0
	3	0	0	0	9	9	0
	4	0	0	0	13	13	0
	5	0	0	0	6	6	0
	6	0	2	0	17	19	2
	Total	*5*	*2*	*0*	*93*	*100*	*7*
August 26	20	0	0	0	11	11	0
	21	3	0	0	6	9	3
	22	16	4	0	15	35	20
	23	0	0	0	1	1	0
	0	4	0	0	73	77	4

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	1	0	0	0	2	2	0
	2	0	0	0	4	4	0
	3	0	0	0	2	2	0
	4	0	0	0	2	2	0
	5	0	0	0	6	6	0
	6	2	0	0	2	4	2
	Total	*25*	*4*	*0*	*124*	*153*	*29*
August 27	20	0	0	0	48	48	0
	21	8	0	0	10	18	8
	22	19	0	0	0	19	19
	23	11	0	0	0	11	11
	1	8	2	0	9	19	10
	2	1	0	0	0	1	1
	3	0	0	0	14	14	0
	4	0	0	0	9	9	0
	5	0	3	0	15	18	3
	6	0	0	0	10	10	0
	Total	*47*	*5*	*0*	*115*	*167*	*52*
August 28	20	2	0	0	14	16	2
	21	8	0	0	5	13	8
	22	8	0	0	2	10	8
	23	4	1	0	16	21	5
	0	4	0	2	0	6	4
	1	8	5	0	2	15	13
	2	4	25	0	0	29	29
	3	10	12	0	19	41	22
	4	2	0	0	11	13	2
	5	0	0	0	5	5	0
	6	2	0	0	31	33	2
	Total	*52*	*43*	*2*	*105*	*202*	*95*
August 29	20	8	0	0	8	16	8
	21	3	3	0	2	8	6
	22	0	1	0	10	11	1
	23	0	0	0	22	22	0
	0	6	0	0	0	6	6
	1	2	0	0	9	11	2

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	2	0	0	0	1	1	0
	3	0	0	0	8	8	0
	4	0	0	0	3	3	0
	5	0	0	0	2	2	0
	6	2	0	0	5	7	2
	Total	*21*	*4*	*0*	*70*	*95*	*25*
August 30	20	3	0	0	0	3	3
	21	0	0	0	18	18	0
	23	0	0	0	7	7	0
	0	0	0	0	5	5	0
	1	0	0	0	2	2	0
	2	0	0	0	24	24	0
	4	0	0	0	2	2	0
	5	0	0	0	1	1	0
	6	1	4	0	0	5	5
	Total	*4*	*4*	*0*	*59*	*67*	*8*
August 31	20	0	0	0	20	20	0
	21	0	0	0	74	74	0
	22	0	0	0	3	3	0
	0	0	0	0	2	2	0
	1	0	0	0	6	6	0
	2	0	0	0	19	19	0
	3	0	0	0	11	11	0
	4	0	0	0	2	2	0
	5	0	0	0	11	11	0
	6	0	2	0	11	13	2
	Total	*0*	*2*	*0*	*159*	*161*	*2*
September 1	20	0	1	0	0	1	1
	21	0	0	0	16	16	0
	22	0	0	0	1	1	0
	23	2	0	0	2	4	2
	0	0	0	0	9	9	0
	1	0	1	0	3	4	1
	2	0	0	0	5	5	0
	3	0	0	0	2	2	0
	4	0	0	0	18	18	0

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	6	1	0	26	33	7
	6	0	0	0	9	9	0
	Total	*8*	*3*	*0*	*91*	*102*	*11*
September 2	20	2	0	0	15	17	2
	21	0	4	0	3	7	4
	23	0	0	0	5	5	0
	0	0	0	0	10	10	0
	1	0	0	0	16	16	0
	2	0	0	0	7	7	0
	3	0	0	0	1	1	0
	4	0	0	0	2	2	0
	5	5	0	0	3	8	5
	6	1	0	0	14	15	1
	Total	*8*	*4*	*0*	*76*	*88*	*12*
September 3	20	0	0	0	3	3	0
	22	2	0	0	0	2	2
	23	2	0	0	15	17	2
	0	23	39	0	0	62	62
	3	0	1	4	2	7	1
	4	8	37	6	0	51	45
	5	0	10	0	0	10	10
	6	1	4	0	0	5	5
	Total	*36*	*91*	*10*	*20*	*157*	*127*
September 4	20	4	0	0	1	5	4
	21	2	0	0	1	3	2
	22	2	0	0	1	3	2
	1	0	0	0	5	5	0
	4	0	0	0	4	4	0
	5	0	0	0	8	8	0
	Total	*8*	*0*	*0*	*20*	*28*	*8*
September 5	20	23	1	0	18	42	24
	22	0	0	0	8	8	0
	0	10	0	0	3	13	10
	1	0	0	0	1	1	0
	4	2	0	0	0	2	2
	Total	*35*	*1*	*0*	*30*	*66*	*36*

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
September 6	20	1	0	0	2	3	1
	22	0	0	0	5	5	0
	0	0	0	0	1	1	0
	1	6	0	0	0	6	6
	2	0	0	0	3	3	0
	5	0	0	0	1	1	0
	6	0	0	0	21	21	0
	Total	*7*	*0*	*0*	*33*	*40*	*7*
September 7	20	2	0	0	1	3	2
	21	0	0	0	1	1	0
	22	0	0	0	2	2	0
	23	0	0	0	3	3	0
	0	0	0	0	2	2	0
	1	0	0	0	3	3	0
	2	2	0	0	0	2	2
	5	0	0	0	1	1	0
	6	0	0	0	9	9	0
	Total	*4*	*0*	*0*	*22*	*26*	*4*
September 8	20	2	0	0	0	2	2
	21	0	0	0	7	7	0
	Total	*2*	*0*	*0*	*7*	*9*	*2*
September 10	22	0	0	0	2	2	0
	23	0	0	0	2	2	0
	1	0	0	0	5	5	0
	3	0	0	0	7	7	0
	4	0	2	2	6	10	2
	5	0	0	0	2	2	0
	Total	*0*	*2*	*2*	*24*	*28*	*2*
September 22	21	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
September 23	20	0	0	0	9	9	0
	23	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*11*	*11*	*0*
September 24	19	0	0	0	9	9	0
	1	0	0	0	3	3	0
	2	0	0	0	3	3	0

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	6	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*18*	*18*	*0*
September 25	20	0	0	0	6	6	0
	22	0	0	0	1	1	0
	23	0	0	0	1	1	0
	1	0	0	0	3	3	0
	3	0	0	0	2	2	0
	6	0	0	0	21	21	0
	Total	*0*	*0*	*0*	*34*	*34*	*0*
September 26	19	0	0	0	3	3	0
	20	0	0	0	23	23	0
	21	0	0	0	4	4	0
	2	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*31*	*31*	*0*
September 27	20	0	0	0	5	5	0
	21	0	0	0	1	1	0
	22	0	0	0	2	2	0
	23	0	0	0	1	1	0
	0	0	0	0	4	4	0
	3	0	0	0	6	6	0
	Total	*0*	*0*	*0*	*19*	*19*	*0*
September 28	19	0	0	0	3	3	0
	20	0	0	0	5	5	0
	21	0	0	0	13	13	0
	23	0	0	0	3	3	0
	1	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*27*	*27*	*0*
September 29	19	0	0	0	1	1	0
	20	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 30	3	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
October 4	23	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*

Table E9 Detailed Results of Acoustic Monitoring at Site R5a-3

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
October 5	22	0	0	0	1	1	0
	0	0	0	0	2	2	0
	4	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
Total		2,320	511	213	2,721	5,765	2,831

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus,* and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
July 28	21	0	0	0	7	7	0
	22	8	0	0	7	15	8
	23	14	0	1	0	15	14
	0	5	3	0	1	9	8
	1	1	0	0	0	1	1
	2	1	1	0	2	4	2
	3	37	0	4	9	50	37
	4	12	0	0	0	12	12
	5	12	0	0	3	15	12
	Total	*90*	*4*	*5*	*29*	*128*	*94*
July 29	21	2	0	0	4	6	2
	22	5	0	0	19	24	5
	23	4	0	0	12	16	4
	0	1	1	1	1	4	2
	1	0	1	0	43	44	1
	2	11	0	1	1	13	11
	3	0	0	0	9	9	0
	4	13	0	0	0	13	13
	5	13	0	0	11	24	13
	6	0	0	0	0	0	0
	Total	*49*	*2*	*2*	*100*	*153*	*51*
July 30	21	0	0	0	3	3	0
	22	0	0	0	1	1	0
	23	6	3	0	1	10	9
	1	7	1	0	0	8	8
	2	14	0	0	29	43	14
	3	3	0	0	37	40	3
	4	1	0	0	134	135	1
	5	0	0	1	5	6	0
	Total	*31*	*4*	*1*	*210*	*246*	*35*
July 31	21	6	0	0	3	9	6
	22	1	0	0	0	1	1
	23	2	1	0	0	3	3
	0	0	0	0	8	8	0
	1	3	1	0	20	24	4
	2	8	1	0	0	9	9

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	2	0	0	5	7	2
	4	2	0	0	13	15	2
	5	0	0	0	2	2	0
	Total	*24*	*3*	*0*	*51*	*78*	*27*
August 1	21	4	0	0	1	5	4
	0	1	0	0	10	11	1
	1	0	0	0	3	3	0
	2	0	0	1	6	7	0
	3	8	7	0	0	15	15
	4	4	0	0	0	4	4
	5	3	0	0	0	3	3
	Total	*20*	*7*	*1*	*20*	*48*	*27*
August 2	21	0	0	0	0	0	0
	22	0	0	0	1	1	0
	23	7	0	0	0	7	7
	3	5	0	0	0	5	5
	4	1	0	0	1	2	1
	5	0	0	0	11	11	0
	Total	*13*	*0*	*0*	*13*	*26*	*13*
August 3	21	5	0	0	0	5	5
	22	0	0	0	1	1	0
	23	2	0	0	3	5	2
	0	0	0	0	6	6	0
	1	7	0	0	2	9	7
	2	18	0	0	0	18	18
	3	6	1	0	0	7	7
	4	3	2	1	0	6	5
	5	6	0	0	0	6	6
	Total	*47*	*3*	*1*	*12*	*63*	*50*
August 4	21	1	0	0	3	4	1
	22	4	0	0	6	10	4
	23	3	0	0	0	3	3
	0	1	0	0	3	4	1
	2	0	0	0	1	1	0
	3	0	0	1	0	1	0
	4	2	0	0	0	2	2

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	1	0	0	3	4	1
	Total	*12*	*0*	*1*	*16*	*29*	*12*
August 5	23	0	0	0	1	1	0
	1	0	0	0	4	4	0
	2	1	0	0	1	2	1
	3	0	0	0	8	8	0
	4	5	1	0	0	6	6
	5	4	0	0	0	4	4
	Total	*10*	*1*	*0*	*14*	*25*	*11*
August 6	21	0	0	0	1	1	0
	22	0	0	0	9	9	0
	23	8	1	0	16	25	9
	0	3	1	0	4	8	4
	1	1	2	0	0	3	3
	2	9	0	0	2	11	9
	3	9	0	0	1	10	9
	4	14	3	0	0	17	17
	5	16	2	0	7	25	18
	Total	*60*	*9*	*0*	*40*	*109*	*69*
August 7	21	11	0	0	7	18	11
	23	1	0	3	10	14	1
	0	4	0	0	2	6	4
	1	4	0	2	43	49	4
	2	0	0	4	0	4	0
	3	3	0	1	0	4	3
	4	9	0	0	1	10	9
	5	10	0	0	11	21	10
	Total	*42*	*0*	*10*	*74*	*126*	*42*
August 8	21	6	0	0	0	6	6
	22	2	0	0	6	8	2
	23	5	0	0	8	13	5
	0	2	0	2	2	6	2
	1	7	0	0	0	7	7
	2	3	0	0	2	5	3
	3	2	0	0	0	2	2
	4	46	0	0	0	46	46

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	5	7	1	4	10	22	8
	Total	*80*	*1*	*6*	*28*	*115*	*81*
August 9	20	0	0	0	2	2	0
	21	0	0	0	2	2	0
	22	5	0	0	8	13	5
	23	0	0	2	3	5	0
	0	6	0	0	0	6	6
	1	3	0	0	6	9	3
	2	19	9	5	17	50	28
	3	5	0	0	5	10	5
	4	4	0	0	17	21	4
	5	10	0	0	14	24	10
	Total	*52*	*9*	*7*	*74*	*142*	*61*
August 10	21	5	0	0	11	16	5
	23	17	0	0	0	17	17
	0	9	0	0	4	13	9
	1	7	0	0	3	10	7
	2	1	0	1	28	30	1
	3	1	2	0	5	8	3
	4	8	0	0	43	51	8
	5	10	8	8	37	63	18
	6	0	0	0	1	1	0
	Total	*58*	*10*	*9*	*132*	*209*	*68*
August 11	21	6	0	0	4	10	6
	22	8	0	0	0	8	8
	23	0	0	0	2	2	0
	0	10	1	2	31	44	11
	1	5	0	0	11	16	5
	2	4	2	13	21	40	6
	3	8	0	1	88	97	8
	4	7	9	22	200	238	16
	5	19	1	5	58	83	20
	6	7	14	13	0	34	21
	Total	*74*	*27*	*56*	*415*	*572*	*101*
August 12	21	15	0	1	5	21	15
	22	1	0	0	44	45	1

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	23	7	3	0	2	12	10
	0	19	1	0	62	82	20
	1	16	0	0	12	28	16
	2	4	1	0	6	11	5
	3	3	3	0	7	13	6
	4	12	0	0	0	12	12
	5	19	0	0	1	20	19
	Total	*96*	*8*	*1*	*139*	*244*	*104*
August 13	21	0	0	0	1	1	0
	22	2	2	0	0	4	4
	23	1	0	0	1	2	1
	0	3	0	0	0	3	3
	1	2	0	0	0	2	2
	2	2	2	0	2	6	4
	3	5	0	0	5	10	5
	4	1	0	0	4	5	1
	5	6	0	0	0	6	6
	Total	*22*	*4*	*0*	*13*	*39*	*26*
August 14	20	2	0	0	0	2	2
	21	0	0	0	2	2	0
	22	1	1	3	0	5	2
	23	9	0	2	3	14	9
	0	3	0	0	0	3	3
	1	16	2	0	0	18	18
	2	7	9	0	19	35	16
	4	3	0	0	0	3	3
	5	6	0	0	0	6	6
	6	4	0	0	0	4	4
	Total	*51*	*12*	*5*	*24*	*92*	*63*
August 15	20	0	0	0	1	1	0
	21	16	0	0	1	17	16
	22	2	8	0	0	10	10
	23	2	0	0	9	11	2
	0	6	3	6	0	15	9
	1	9	5	0	0	14	14
	2	2	0	0	6	8	2

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	1	0	0	0	1	1
	4	0	1	0	7	8	1
	5	14	1	0	0	15	15
	6	2	0	0	0	2	2
	Total	*54*	*18*	*6*	*24*	*102*	*72*
August 16	21	0	0	0	1	1	0
	22	2	0	0	0	2	2
	23	6	0	0	0	6	6
	0	1	2	2	0	5	3
	1	5	0	0	0	5	5
	2	1	0	0	4	5	1
	4	2	0	0	1	3	2
	5	16	0	0	0	16	16
	6	2	0	0	17	19	2
	Total	*35*	*2*	*2*	*23*	*62*	*37*
August 17	21	0	0	0	3	3	0
	22	7	1	0	0	8	8
	23	4	0	0	0	4	4
	0	6	4	0	0	10	10
	1	4	0	0	0	4	4
	2	6	0	0	1	7	6
	3	0	0	0	1	1	0
	4	4	0	0	4	8	4
	5	2	0	0	23	25	2
	Total	*33*	*5*	*0*	*32*	*70*	*38*
August 18	21	0	0	0	2	2	0
	22	0	0	0	2	2	0
	0	9	0	0	0	9	9
	1	8	0	0	0	8	8
	2	17	0	0	4	21	17
	3	3	9	0	2	14	12
	5	2	0	0	0	2	2
	Total	*39*	*9*	*0*	*10*	*58*	*48*
August 19	21	4	0	0	14	18	4
	22	25	1	0	13	39	26
	23	2	0	0	20	22	2

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	0	1	0	0	0	1	1
	1	3	0	0	1	4	3
	2	12	0	0	10	22	12
	4	12	2	0	2	16	14
	5	22	0	0	0	22	22
	6	5	0	0	0	5	5
	Total	*86*	*3*	*0*	*60*	*149*	*89*
August 20	20	0	0	0	1	1	0
	21	3	0	0	4	7	3
	22	6	0	0	0	6	6
	23	4	0	0	0	4	4
	1	0	5	4	0	9	5
	2	14	0	0	0	14	14
	4	2	0	0	0	2	2
	5	0	0	0	19	19	0
	Total	*29*	*5*	*4*	*24*	*62*	*34*
August 21	20	2	0	0	0	2	2
	21	0	0	0	15	15	0
	0	1	0	0	0	1	1
	1	7	3	0	0	10	10
	2	9	4	0	13	26	13
	3	3	3	0	0	6	6
	4	6	0	0	2	8	6
	5	8	6	0	3	17	14
	6	0	0	0	7	7	0
	Total	*36*	*16*	*0*	*40*	*92*	*52*
August 22	21	2	0	0	3	5	2
	0	10	0	0	2	12	10
	1	1	0	0	8	9	1
	2	2	0	0	0	2	2
	3	3	0	0	0	3	3
	4	0	0	0	9	9	0
	5	46	0	0	6	52	46
	Total	*64*	*0*	*0*	*28*	*92*	*64*
August 23	20	1	0	0	3	4	1
	21	0	0	0	1	1	0

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	22	0	0	0	4	4	0
	23	0	0	0	44	44	0
	0	2	0	0	48	50	2
	1	3	0	0	0	3	3
	2	2	0	0	0	2	2
	3	14	0	0	0	14	14
	4	9	2	0	0	11	11
	5	2	0	0	5	7	2
	6	7	3	0	8	18	10
	Total	*40*	*5*	*0*	*113*	*158*	*45*
August 24	21	0	0	0	3	3	0
	22	2	0	0	4	6	2
	23	3	0	5	3	11	3
	1	0	0	0	9	9	0
	2	0	0	0	11	11	0
	3	0	0	0	4	4	0
	4	2	2	2	0	6	4
	5	0	1	0	10	11	1
	Total	*7*	*3*	*7*	*44*	*61*	*10*
August 25	20	2	0	0	0	2	2
	21	3	0	0	5	8	3
	22	4	0	0	2	6	4
	23	2	0	0	3	5	2
	0	2	2	0	1	5	4
	1	2	0	0	7	9	2
	2	0	0	0	6	6	0
	3	0	3	0	7	10	3
	5	0	0	0	18	18	0
	Total	*15*	*5*	*0*	*49*	*69*	*20*
August 26	20	0	0	0	1	1	0
	21	0	1	0	8	9	1
	22	0	1	0	3	4	1
	23	0	0	0	11	11	0
	0	0	0	0	2	2	0
	1	3	3	0	0	6	6
	2	0	1	0	0	1	1

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	0	0	1	1	2	0
	4	4	0	0	0	4	4
	5	2	0	0	3	5	2
	6	0	0	0	1	1	0
	Total	*9*	*6*	*1*	*30*	*46*	*15*
August 27	20	2	0	0	4	6	2
	21	8	0	0	0	8	8
	23	15	0	0	0	15	15
	0	0	0	0	1	1	0
	1	2	0	0	14	16	2
	3	0	0	0	1	1	0
	5	1	0	0	0	1	1
	6	0	0	0	8	8	0
	Total	*28*	*0*	*0*	*28*	*56*	*28*
August 28	20	5	0	0	37	42	5
	21	4	0	0	2	6	4
	23	2	0	0	2	4	2
	1	2	1	0	0	3	3
	2	6	1	1	4	12	7
	3	0	0	0	18	18	0
	4	0	0	0	19	19	0
	5	0	2	3	12	17	2
	6	0	0	0	2	2	0
	Total	*19*	*4*	*4*	*96*	*123*	*23*
August 29	20	6	0	0	16	22	6
	23	0	0	0	48	48	0
	0	7	1	0	0	8	8
	2	2	0	0	1	3	2
	3	0	0	0	6	6	0
	4	5	0	0	0	5	5
	5	1	0	0	4	5	1
	6	2	0	0	1	3	2
	Total	*23*	*1*	*0*	*76*	*100*	*24*
August 30	20	0	0	0	2	2	0
	21	0	0	0	5	5	0
	22	0	0	0	1	1	0

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	23	7	0	0	5	12	7
	0	0	0	0	5	5	0
	2	0	0	0	2	2	0
	5	1	0	0	2	3	1
	6	1	0	0	5	6	1
	Total	*9*	*0*	*0*	*27*	*36*	*9*
August 31	20	2	0	0	0	2	2
	21	0	0	0	1	1	0
	22	5	6	0	0	11	11
	1	1	0	0	0	1	1
	4	3	2	0	0	5	5
	5	15	0	0	12	27	15
	6	0	0	0	4	4	0
	Total	*26*	*8*	*0*	*17*	*51*	*34*
September 1	20	5	0	0	0	5	5
	21	3	0	0	0	3	3
	22	2	0	0	0	2	2
	23	0	0	0	2	2	0
	0	0	0	0	4	4	0
	1	4	0	0	3	7	4
	2	2	0	0	0	2	2
	4	0	0	0	3	3	0
	5	0	0	0	20	20	0
	6	0	0	0	2	2	0
	Total	*16*	*0*	*0*	*34*	*50*	*16*
September 2	20	0	0	0	3	3	0
	22	1	0	0	0	1	1
	23	0	0	0	1	1	0
	1	0	0	0	2	2	0
	3	3	0	0	0	3	3
	4	0	0	0	2	2	0
	5	0	0	0	4	4	0
	6	0	0	0	7	7	0
	Total	*4*	*0*	*0*	*19*	*23*	*4*
September 3	23	2	0	0	3	5	2
	0	0	0	0	1	1	0

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	3	4	0	0	4	8	4
	4	2	0	0	0	2	2
	5	0	0	0	1	1	0
	6	5	0	0	0	5	5
	Total	*13*	*0*	*0*	*9*	*22*	*13*
September 4	20	1	0	0	1	2	1
	21	1	0	0	1	2	1
	22	0	0	0	9	9	0
	23	6	0	0	1	7	6
	0	0	0	0	1	1	0
	2	0	0	0	11	11	0
	4	0	0	0	4	4	0
	5	0	0	0	2	2	0
	6	0	0	0	1	1	0
	Total	*8*	*0*	*0*	*31*	*39*	*8*
September 5	20	0	0	0	6	6	0
	21	0	0	0	33	33	0
	22	0	0	0	2	2	0
	23	0	0	0	1	1	0
	0	1	0	0	6	7	1
	4	0	0	0	1	1	0
	5	0	0	0	4	4	0
	Total	*1*	*0*	*0*	*53*	*54*	*1*
September 6	20	2	0	0	6	8	2
	1	3	0	0	15	18	3
	4	0	0	0	2	2	0
	5	2	0	0	4	6	2
	6	0	0	0	2	2	0
	Total	*7*	*0*	*0*	*29*	*36*	*7*
September 7	20	4	0	0	3	7	4
	22	0	0	0	12	12	0
	23	0	0	0	12	12	0
	2	1	0	0	0	1	1
	3	0	0	0	1	1	0
	4	0	0	0	4	4	0
	5	0	0	0	1	1	0

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	6	0	0	0	7	7	0
	Total	*5*	*0*	*0*	*40*	*45*	*5*
September 8	20	0	0	0	2	2	0
	22	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*5*	*5*	*0*
September 21	21	0	0	0	6	6	0
	Total	*0*	*0*	*0*	*6*	*6*	*0*
September 22	21	0	0	0	15	15	0
	Total	*0*	*0*	*0*	*15*	*15*	*0*
September 23	20	0	0	0	15	15	0
	0	0	0	0	6	6	0
	Total	*0*	*0*	*0*	*21*	*21*	*0*
September 24	19	0	0	0	2	2	0
	20	0	0	0	1	1	0
	1	0	0	0	9	9	0
	Total	*0*	*0*	*0*	*12*	*12*	*0*
September 25	20	0	0	0	1	1	0
	21	0	0	0	6	6	0
	22	0	0	0	7	7	0
	23	0	0	0	8	8	0
	Total	*0*	*0*	*0*	*22*	*22*	*0*
September 26	19	0	0	0	2	2	0
	20	0	0	0	1	1	0
	21	0	0	0	2	2	0
	23	0	0	0	1	1	0
	3	0	0	0	4	4	0
	Total	*0*	*0*	*0*	*10*	*10*	*0*
September 27	19	0	0	0	2	2	0
	20	0	0	0	7	7	0
	23	0	0	0	2	2	0
	3	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*12*	*12*	*0*
September 28	19	0	0	0	1	1	0
	20	0	0	0	5	5	0
	21	0	0	0	17	17	0
	1	0	0	0	1	1	0

Table E10 Detailed Results of Acoustic Monitoring at Site R5a-5

Night	Hour	MYLU[1]	UNID >35 kHz[2]	MYVO[3]	Other[4]	Total	MYLU + UNID >35[5]
	Total	*0*	*0*	*0*	*24*	*24*	*0*
September 29	20	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*
October 1	22	0	0	0	3	3	0
	Total	*0*	*0*	*0*	*3*	*3*	*0*
October 2	21	0	0	0	1	1	0
	2	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
October 4	21	0	0	0	1	1	0
	23	0	0	0	16	16	0
	Total	*0*	*0*	*0*	*17*	*17*	*0*
October 5	19	0	0	0	5	5	0
	20	0	0	0	10	10	0
	21	0	0	0	2	2	0
	23	0	0	0	7	7	0
	1	0	0	0	8	8	0
	Total	*0*	*0*	*0*	*32*	*32*	*0*
October 8	19	0	0	0	1	1	0
	Total	*0*	*0*	*0*	*1*	*1*	*0*
October 11	20	0	0	0	2	2	0
	Total	*0*	*0*	*0*	*2*	*2*	*0*
Total		1,437	194	129	2,527	4,287	1,631

1 *Myotis lucifugus*

2 Unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHZ.

3 *Myotis volans*

4 *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus cinereus*, and/or *Myotis evotis*

5 *M. lucifugus* calls plus calls of unidentified *Myotis* spp. with lowest apparent call frequency greater than 35 kHz = actual potential number of passes of *M. lucifugus*

APPENDIX A-2: CUMULATIVE EFFECTS ASSESSMENT

2. Outstanding Information Requirements – 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; Agency's Request for Additional Information, December 5, 2016 - AIR #26.

1.0 BACKGROUND

The purpose of this document is to address the information request from CEA Agency, IR #2, dated February 27, 2018 and IR #26 dated December 5, 2016.

A cumulative effects assessment was conducted as part of the EIA for the Grassy Mountain Coal Project (the Project) issued to the Canadian Environmental Assessment Agency (the Agency) on August 15, 2016, as per the Cumulative Effects Assessment in Environmental Impact Assessment Reports Required under the *Alberta Environmental Protection and Enhancement Act*. This document consolidates that cumulative effects assessment information on the relevant topics to better align with the process described in Operational Policy Statement Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012.*

The Operational Policy Statement Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012* lists the environment effects that are to be considered for a cumulative effects assessment as per Section 5 of *CEAA 2012*.

> *5.(1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are*
>
> *a. a change that may be caused to the following components of the environmental that are within the legislative authority of Parliament:*
> *i. fish as defined in section 2 of Fisheries Act and fish habitat as defined in subsection 34(1) of that Act,*
> *ii. aquatic species as defined under subsection 2(1) of the Species at Risk Act,*
> *iii. migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994, and*
> *iv. any other component of the environment that is set out in Schedule 2*
> *b. a change that may be caused to the environment that would occur*
> *i. on federal lands*
> *ii. in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or*
> *iii. outside Canada; and*

c. with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on

i. health and socio-economic conditions,

ii. physical and cultural heritage,

iii. the current use of lands and resources for traditional purposes, or

iv. any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

2.0 INTRODUCTION

For the purpose of the response to CEAA IR 2, references made to various sections and consultant reports (CR) apply to the Grassy Mountain Coal Project Application and Environmental Impact Assessment Report that was filed in August 2016. The methodology followed by the Project for cumulative effects assessment is outlined in the Application, Section D.2.4.5 – Cumulative Effects.

2.1 Scoping

The scoping phase for a cumulative effects assessment includes identifying valued components, determining spatial and temporal boundaries, and identifying the other physical activities to be considered in the assessment.

2.1.1 Identifying Valued Components

As outlined in the Section D.2.4.2, the Project has addressed potential effects by identifying Valued Components (VCs). VCs are those environmental attributes associated with Project development, which have been identified to be of concern either by directly-affected stakeholders, government agencies or the professional community. They can be referred to as key indicators or parameters in the Terms of Reference (ToR). VCs consider both biophysical (*i.e.*, ecosystem) and socio-economic attributes because of the broad-based definition of environmental effect, as outlined in federal and provincial legislation.

For each VC, measurable parameters were selected, where possible and appropriate, to facilitate quantitative or qualitative measurement of potential Project effects and cumulative effects. Measurable parameters provide a means to determine the level or amount of change in a VC. Each environmental discipline was responsible for identifying and defining measurable parameters for their respective VCs. The degree of change in these measurable parameters was used to help characterize Project specific and cumulative effects and evaluate potential residual effects. Thresholds or standards were identified, where possible and appropriate, for each measurable parameter.

A list of the VCs identified for the Project and the rationale for their selection is presented in summary in Section E and in more detail within each of the respective Consultant Reports (CR) of the Application. The VCs assessed in the cumulative effects assessment are outlined in each section below.

2.1.2 Determining Spatial and Temporal Boundaries

A comprehensive description of the selection of temporal and spatial boundaries is discussed in the Section D.2.4.3. The establishment of assessment boundaries for each discipline studied represented a compromise involving limitations such as economic realities and the temporal and spatial scales over which natural systems operate.

2.1.2.1 Spatial Boundaries

The Local Study Area (LSA) is established based on the zone of the Project influence, beyond which the potential environmental, cultural and socio-economic effects of the Project are expected to be non-detectable. The Regional Study Area (RSA) is established based on the extent to which it would be expected that the interaction of residual effects of the Project with the residual effects of other projects would be detectable. It is also the area in which socio-economic effects are expected to be detectable. VC-specific boundaries are established for both the LSA, for Project-specific effects, and the RSA, for cumulative effects. Effects on those VCs that have impacts more directly tied to the footprint of the Project are also assessed at the spatial scale of the Project footprint.

Maps showing the spatial boundaries of each of the disciplines are provided on Figures D.2.4-1 (LSA) and D.2.4-2 (RSA) (Section D).

2.1.2.2 Temporal Boundaries

The temporal boundaries range from the life of the Project (24 years) to Project Closure (up to 41 years following Project initiation). The discipline specific LSA and RSA temporal scales for each of the disciplines studied are discussed in more detail in discipline sections below, in Section E and in the respective Consultant Reports (CR).

2.1.3 Examining Past, Existing, and Future Physical Activities

As outlined in Section D, existing, approved and planned projects and activities in the region (known or reported as of February 1, 2016, which was six months prior to the date of the Application submission) that were considered in the assessment are listed in Table IR 2-1 (same as Table D.2.4-2) and are shown on Figure D.2.4-3. The Planned Development Case (PDC) includes the 'application case' combined with past studies, existing and anticipated future environmental conditions, existing

projects or activities, plus other "planned" projects or activities, and is the same as the Cumulative Effects Case.

Local and Regional Study Areas vary in size for each of the VCs, as discussed in Section D.2.4-3. The project list provided in Table CEAA 2-1 was generated to capture all projects found within the largest RSA (*i.e.,* wildlife grizzly bear RSA). As can be seen on Figure D.2.4-3, not all Projects are contained within the study areas of each of the respective disciplines.

Table CEAA 2-1 Grassy Mountain Coal Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area

Company	Project	Existing & Approved Activity (Baseline Case)	Project (Application Case)	Planned Projects (Cumulative Effects/PDC Case*)
Mining Operations				
Benga Mining Limited	Grassy Mountain Coal Project		☑	
Various	Historic Mining Development ~1890 to 1990	☑		
Teck Coal Limited	Coal Mountain Operations	☑		
	Coal Mountain Phase 2			☑
	Elkview Operations	☑		
	Elkview Baldy Ridge Extension			☑
	Michel Creek Coking Coal Project			☑
Timber Operations				
Crown	Operations to end of 2015	☑		
	Operations to 2025			☑
	Operations to 2030			☑
	Operations to 2041 - predicted			☑
	Operations to 2056 - predicted			☑
Oil and Gas Operations				
Devon Canada Corporation	Multiwell Gas Battery 02-19-011-03 W5M	☑		

Table CEAA 2-1	**Grassy Mountain Coal Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area**			
Company	**Project**	**Existing & Approved Activity (Baseline Case)**	**Project (Application Case)**	**Planned Projects (Cumulative Effects/PDC Case*)**
	Compressor Station 04-13-009-04 W5M	☑		
Harvest Operations Corp.	Burmis Gas Test Battery 12-19-007-02 W5M	☑		
HOC Energy Corp.	Single Well Gas Battery 10-07-006-02 W5M	☑		
Legacy Oil & Gas Inc.	Gas Single-Well Battery 13-35-007-03 W5M	☑		
Nova Gas Transmission Ltd.	Interconnect 01-15-008-05 W5M	☑		
	Interconnect 09-11-008-05 W5M	☑		
Shell Canada Limited	Single Well Gas Battery 10-01-006-03 W5M	☑		
	Compressor Station 06-12-006-03 W5M	☑		
	Multiwell Gas Battery 02-20-006-03 W5M	☑		
	Gas Gathering System 16-07-007-02 W5M	☑		
Misc.	Wellsites	☑		
	Access Roads	☑		
	Pipelines	☑		
Rural Development				
MD of Crowsnest Pass	Community of Coleman	☑		
	Community of Blairmore	☑		
	Community of Frank	☑		
	Community of Bellevue	☑		
	Community of Hillcrest	☑		
	Roadways, Utility Corridors & Services	☑		

Table CEAA 2-1	**Grassy Mountain Coal Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area**			
Company	**Project**	**Existing & Approved Activity (Baseline Case)**	**Project (Application Case)**	**Planned Projects (Cumulative Effects/PDC Case*)**
MD of Ranchlands	Roadways, Utility Corridors & Services	☑		
	Community of Maycroft	☑		
MD of Pincher Creek	Community of Burmis	☑		
	Community of Lundbreck	☑		
	Community of Cowley	☑		
	Community of Beaver Mines	☑		
	Roadways, Utility Corridors & Services	☑		
Alberta Transportation	Roadways and Transportation Corridors	☑		
	Highway 3 Re-Alignment			☑
CP Rail	Rail Lines	☑		
ATCO	Castle Rock Ridge to Chapel Rock Transmission Project			☑
Various	Recreation and Tourism Facilities (discussed in EIA Sec. E10.2.9)	☑		

* In the examination of physical activities that have been carried out, past and existing physical activities were described and incorporated into Benga's baseline case evaluation (as per *Environmental Assessment Program: Guide to Preparing Environmental Impact Assessment Reports in Alberta*[1]). These activities were included and described as they relate to helping predict environmental effects of the Project or identifying appropriate mitigation.

Many past and existing physical activities present in the area that were evaluated and considered in the EIA are outlined in the Land and Resource Use section (Section E.10). Some of them are listed below as they relate to question IR#2(a) of the CEA Agency information request:

- As noted in Table CEAA 2-1, historical mining developments were considered in describing the state of the current conditions. A map was provided in Figure A.3.1-1 showing the locations of historical mining locations (both surface and underground) and other Benga leases.
- The South Saskatchewan Regional Plan was considered in Section E.10.2.2.3. Various land use policies and regional planning initiatives have been developed for the area within the LSA and RSA. The intent of these policies and planning initiatives are to help inform land use decisions. Through a review of regional policies and initiatives environmental issues and concerns have been identified and appropriate mitigation measures included in the design, construction, operation and reclamation plans for the Project. Therefore, development of the Project does not conflict with the intent of these policies and initiatives (Section E.10.3.2, Page E-212). The South Saskatchewan Trail Systems Plan are part of the Regional Plan with an overview provided under Appendix J. The specific locations of the proposed trails are not provided in the plan and are not publicly available. Trails covered under this initiative will be low disturbance impact and use and will have negligible impact.
- The LSA and RSA of the Project fall within both the green and white zones of Alberta, with the majority of the development footprint located within the white zone. The green zone consists of Forest Managements Unit (FMU) C5 which covers approximately 3,522 km^2 of forested land. There are currently five timber quote holders with a total approved Annual Allowable Cut of 197,226 m^3. In addition, there is one privately owned coniferous timber permit that will be directly impacted by development of the Project. As assessment of the potential impacts of the Project on forestry resources has been undertaken (CR#8, Sec. 4.4.1). It was determined that the effects on Annual Allowable Cut will be minimal because all merchantable timber salvaged from the Project will be made available to local timber rights holders and approximately 61.4% of the Project Footprint will be reclaimed to closed conifer forest with another 8.8% reclaimed to moderate mixed forest, including the historically disturbed barren land.
- There are five grazing leases and one grazing permit within the RSA (CR#10, Table 4.6-2 and Figure 4.6-1). Benga has been working with neighbouring grazing lease holders as part of Benga's ongoing consultation process to understand and mitigate any concerns. No adverse effects to existing grazing lease holders are anticipated.
- Due to development of the Project some of the existing facilities associated with the Crowsnest Pass Golf and Country Club will need to be moved. In addition, the existing access to the helipad operated by Alberta Environmental and Parks will need to be rerouted. These changes are required in order to accommodate construction of the rail loop and are shows on CR#10, Figure 5.1-2. Although not part of the proposed Project, the development of these

facilities is included in the entire assessment on the potential impacts of the Project on Land and Resource Use.

- Development of the Project has the potential to impact the historic Greenhill Mine area. Impact to those historical resources identified within or adjacent to the Project footprint will be mitigated by undertaking additional study, where required, and obtaining clearance in accordance with the *Historical Resources Act* prior to development of the Project. The historic Town of Lille, Frank Slide, Bellevue and the Green Creek Wintering site are all located outside of the proposed Project footprint and therefore will not be impacted by development of the Project.

A further description of any other relevant past and existing physical activities and their involvement in the current condition of the VC (baseline) is summarized in the sections below.

2.2 Analysis

The process for analysis of effects in the cumulative effects assessment is described in Section D.2.5.2.

Baseline conditions for each VC were described based on existing information and Project-specific investigations. Once baseline conditions for the resource were determined and Project activities were defined, an evaluation was carried out to determine whether environmental protection measures were required to mitigate impacts on the VC.

The assessment of potential effects involved evaluating changes to VCs arising directly from the Project (*i.e.*, Project effects), as well as effects arising from the Project in combination with past, present and planned projects or activities (*i.e.*, cumulative effects).

The assessment of potential Project effects on each VC is presented in tabular form for each discipline, as shown in Table D.2.5-2. Assessment of potential Project-specific effects on the environment was based on a combination of objective (measurable) and subjective (deduced) evaluations that were specific to the VC being considered. The evaluation considered those protection or mitigation measures which would be required to meet regulatory requirements, company or public acceptance during routine planning/design, construction, operation and/or abandonment phases of the Project. In addition, potential accidents and/or malfunctions were considered in the assessment.

2.3 Mitigation

The process for choosing mitigation for the Project is discussed in Section D.2.5.2 and specific mitigation chosen for the Project as it relates to each discipline, were developed in detail within each Consultant Report. These mitigations were then summarized in Section E (a consistent consolidation

of the pertinent sections of each Consultant Report), Section A (as a summary for the purposes of a provincial EPEA application), and in Summary of Effects tables as part the Agency IR#3.

CEAA 2012 defines mitigation as "the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means." The definition used in Alberta's Environmental Assessment Program is virtually identical (Government of Alberta 2010).

Mitigation is often achieved through iterative Project design (*e.g.*, through site selection to avoid sensitive areas and application of best practices during construction). Additional mitigation measures, over and above mitigation integrated into Project design, were identified for each effect, as required. Types of mitigation measures that were considered include:

- environmental protection measures and protocols;
- site-specific measures (*e.g.*, timing of activities to avoid biologically sensitive periods, site-specific mitigation design measures); and
- contingency measures to address the possibility of accidental events that could affect the environment.

2.4 Significance

The methodology for the evaluation of significance is discussed in Section D.2.5.3, and further clarified in response to a federal conformity information request: December 05, 2016 IR#22, issued to the Agency November 23, 2017 (Attachment 2, Appendix 22). For each identified VC, and assessment of the potential impact was made using the attributes of direction, geographic extent, magnitude, duration, likelihood, reversibility, and confidence in the relationships between cause and effect. An overall impact assessment rating for each VC is derived based on the individual attributes.

2.5 Follow-Up

The methodology for follow-up and monitoring is discussed in Section D.2.5.4. Once residual Project-specific environmental effects and their contribution to cumulative effects have been assessed, a follow-up program or monitoring program might be necessary. As outlined in the Operational Policy Statement Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012*, follow-up programs should address project-specific environmental effects and cumulative environmental effects. The Project has met this requirement by developing Project-specific follow-up monitoring plans for each discipline, which the foundation of each plan was developed and provided within each Consultant Report. These monitoring were then summarized in Section E. If any further follow-up was required due to the assessment of cumulative effects, that was also included in those mitigation and monitoring plans.

3.0 FISH AND FISH HABITAT CUMULATIVE EFFECTS ASSESSMENT

In accordance with Section 19(1) of CEAA, the section for Aquatic Resources (Consultant Report CR#6) takes into account cumulative environmental effects that are likely to result from the Project in combination with other physical activities that have been or will be carried out. Under Section 5(1) of CEAA 2012, environmental effects that are to be taken into account include fish and fish habitat as defined in subsection 2(1) of the *Fisheries Act*, and aquatic species as defined in subsection 2(1) of the *Species at Risk Act*. For the purposes of this response, clarification on the cumulative effects assessment for fish and fish habitat has been provided herein.

3.1 Scoping

3.1.1 Identifying Valued Components

The westslope cutthroat trout (WSCT) valued component (VC) has been carried forward to the cumulative effects assessment based on the following criteria:

- the implementation of the Project may cause direct residual adverse effects on the WSCT VC, taking into account the application of technically and economically feasible mitigation measures; and
- the same WSCT VC may be affected by other past, present or reasonably foreseeable physical activities.

Full detail on the selection of the WSCT VC is provided in the CR#6, Section 3.1. The direct residual adverse effects are described in CR#6, Section 4.0.

3.1.2 Determining Spatial and Temporal Boundaries

3.1.2.1 Spatial Boundaries

The spatial boundary for the cumulative effects assessment of the WSCT VC is the delineated RSA, as described in CR#6, Section 3.2.1.2 (CR#6, Figure 1.1). The RSA is congruent with the RSA for water quality and hydrology. It includes the entire Crowsnest River watershed to evaluate potential cumulative effects at the regional level and considers whether Project effects have the potential to interact with other projects within the Crowsnest River watershed. The Crowsnest River watershed is an ecological-centered spatial boundary, which is appropriate for evaluating the population status of a fish species (*i.e.*, WSCT).

3.1.2.2 Temporal Boundaries

The temporal boundary (CR#6, Section 3.2.2) for the cumulative effects assessment of the WSCT VC is based on the Project description and schedule (Section C.1.3), and includes unique conditions that

may affect fish and aquatic resources. The Project mine life is approximately 24 years excluding pre-mining and closure. This is an activity-centred temporal boundary.

3.1.3 Examining Past, Existing, and Future Physical Activities

In order to identify the source of potential cumulative effects, other projects or activities have been identified that have been or that are likely to be carried out that could cause effects on the WSCT VC within the boundaries defined, and whose effects would act in combination with the predicted residual effects of the Project. Projects or activities that were considered include those listed in Section D, Table D.2.4-2 as well as the additional list provided in IR#2(a).

Rationale for the inclusion of a project or activity is based on the following criteria:

1. project or activity occurs within the RSA;
2. project or activity could potentially interact with the WSCT VC; and
3. effects from other projects or activities on the WSCT VC may act in combination with the Project residual effects on the WSCT VC.

3.1.3.1 Project or Activity Occurs within the RSA

Past, present or reasonably foreseeable projects or activities for consideration in the cumulative effects assessment are identified in Table CEAA 2-1 in this document (and Section D, Table D.2.4-2) under the heading "Planned Projects Cumulative/PDC Case" and IR#2. Table CEAA 2-2 lists these activities and identifies whether they fall within the WSCT VC RSA which is defined in CR#6, Section 3.2.1.2 (Determining Spatial and Temporal Boundaries). Projects or activities which occur in the LSA are assessed in CR#6, Section 4.0 (Effects Assessment) and in CR#6, Section 4.4.

Past physical activities and their relationship to the current state of baseline are discussed in CR#6, page 87. The sport fishery in the Crowsnest River drainage has undergone considerable change as a result of landscape disturbance and past fisheries management decisions. The historical sport fish assemblage in the Crowsnest River mainstem included mountain whitefish, bull trout (*Salvelinus confluentus*), and WSCT. Through several plantings in the 1930s and 1940s, RNTR became established, displacing native WSCT and restricting them to select tributaries. Bull trout, which once occurred in tributaries above and below Lundbreck Falls, have been restricted to the main-stem river below the falls as a result of over harvest and habitat loss. Continued habitat degradation from recreational, industrial and municipal development activities, as well as competition from less desirable exotic species threaten the sport fishery. Species introduced into the drainage since the 1960s include lake trout (*Salvelinus namaycush*), brown trout (*Salmo trutta*) and BKTR. Overall, 10 projects or activities occur within the RSA and were carried forward in the cumulative effects assessment.

Table CEAA 2-2 Projects and activities considered for WSCT VC cumulative effects assessment[1]

Project or Activity	Source	Location	Carried Forward in Cumulative Effects Assessment?
Legacy mines, including Greenhill, Bear Valley, Bellevue underground mines	IR#2	LSA, RSA (see EIA Section D Figure D.2.4-3 for location of legacy mines)	Yes
Teck Elkview Baldy Ridge Extension, BC	EIS Section D Table D.2.4-2 IR#2	Outside RSA (see EIA Section D Figure D.2.4-3 for location of proposed mine)	No
Michel Creek Coking Coal Project, Elk Valley BC	EIS Section D Table D.2.4-2 IR#2	Outside RSA (see EIA Section D Figure D.2.4-3 for location of proposed mine)	No
Timber Operations	EIA Section D Table D.2.4-2	LSA, RSA (see EIA Section D Figure D.2.4-3 for location of operations)	Yes
Highway 3 Re-Alignment	EIA Section D Table D.2.4-2	RSA (see EIA Section D Figure D.2.4-3 for location of proposed project)	Yes
Castle Rock Ridge to Chapel Rock Transmission Project, Alberta	EIA Section D Table D.2.4-2 IR#2	RSA (see EIA Section D Figure D.2.4-3 for location of proposed project)	Yes
Tourism activities: hiking, ATV use, horseback riding, Lost Lemon Campground, local ski hills, mountain bike trails, Crowsnest Trail, South Saskatchewan Trail Systems Plan	IR#2	LSA, RSA: Hiking, ATV use, horseback riding, mountain bike trails, Crowsnest Trail, SS trail system RSA: Lost Lemon Campground, local ski hills (i.e., Pass Powderkeg Ski Area)	Yes
Crowsnest Pass Golf Course	IR#2	LSA (see EIA, CR#6, Figure 1.1)	No
Helicopter pads or activities	IR#2	LSA (EIA Section A Figure A.1.0-6 for location of helipad) see, RSA	Yes
Existing dams on Gold and Blairmore creeks	IR#2	LSA	No
Nearby leases	IR#2	RSA (see EIA Section A Figure A.3.1-1 for location of nearby leases)	Yes

Table CEAA 2-2 Projects and activities considered for WSCT VC cumulative effects assessment[1]

Project or Activity	Source	Location	Carried Forward in Cumulative Effects Assessment?
Future plans and access to the 'green area' defined in the South Saskatchewan Regional Plan	IR#2	RSA	Yes
Agriculture, and ranching, including cattle crossing or creeks and tributaries	IR#2	LSA, RSA	Yes
Condo and/or residential developments in Blairmore	IR#2	RSA (see EIA Section D Figure D.2.4-3 for location of Blairmore)	No
Project/activities from the communities of Maycroft, Burmis, Lundbreck, Cowley	IR#2	RSA: Burmis, Lundbreck, Cowley (see EIA Section D Figure D.2.4-3 for location of communities)	Yes
		Outside RSA: Maycroft (see EIA Section D Figure D.2.4-3 for location of Maycroft)	No

[1] Location is defined based on description in Section 2.1.2 Determining Spatial and Temporal Boundaries

3.1.3.2 Project or Activity has a Potential Interaction with the WSCT VC

The WSCT VC is described in detail in CR#6, Section 3.1 Valued Components. Currently genetically pure cutthroat trout occupy only a small fraction of the original WSCT distribution and occur as relatively small, isolated populations. The Recovery Plan (Alberta Westslope Cutthroat Trout Recovery Team 2013[2], DFO 2014[3]) identifies four parts of other watercourses in the RSA besides Gold Creek and Blairmore Creek, totaling approximately 7.2 km of watercourse, as critical habitat for WSCT and one watercourse in the RSA, approximately one (1) km in length, as containing near-pure WSCT (Table CEAA 2-3 and CR#6, Figure 1.1).

[2] Alberta Westslope Trout Recovery Team. 2013. Alberta Westslope Cutthroat Trout Recovery Plan. Edmonton (AB): Alberta Environment and Sustainable Resource Development, Alberta Species at Risk Recovery Plan No. 28.

[3] [DFO] Fisheries and Oceans Canada. 2014. Recovery Strategy for the Alberta populations of Westslope Cutthroat Trout (Oncorhynchus clarkii lewisi) in Canada [Final]. 2014. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. iv + 28 pp + Appendices

Table CEAA 2-3 Other watercourses in the RSA designated as critical habitat for WSCT (Reproduced from CR#6 Table 3.4)	
Watercourse	**Length of Watercourse (km)**
Critical Habitat (>99% genetically pure)	
Star Creek	1.28
Allison Creek	3.11
Girardi Creek	2.03
Rock Creek	0.77
Near-Pure (95% to 99% genetically pure)	
Island Creek	1.11

The 10 projects or activities carried forward from Table CEAA 2-2 were evaluated for potential interaction with the WSCT VC. The potential interaction was conservatively assessed since it is possible that WSCT could occur in watercourses that have not been identified in the Recovery Plan. Overall, six of these projects and activities could potentially interact with the WSCT VC and were thus carried forward in the cumulative effects assessment (Table CEAA 2-4).

Table CEAA 2-4 Projects or Activities within the RSA that have potential for interaction with the WSCT VC

Project or Activity	Potential Interaction with WSCT VC	Rationale	Carried Forward in Cumulative Effects Assessment?
Legacy mines, including Greenhill, Bear Valley, Bellevue underground mines	Yes	Legacy mines (Section A, Figure A.3.1-1) are located near WSCT VC in Gold and Blairmore creeks	Yes
Timber Operations	Yes	Timber Operations (Section D, Figure D.2.4-3) may interact with WSCT VC on Allison Creek, Star Creek	Yes
Highway 3 Re-Alignment	Yes	Re-alignment (Section D, Figure D.2.4-3) may interact with Star Creek, Girardi Creek	Yes

Table CEAA 2-4 Projects or Activities within the RSA that have potential for interaction with the WSCT VC

Project or Activity	Potential Interaction with WSCT VC	Rationale	Carried Forward in Cumulative Effects Assessment?
Castle Rock Ridge to Chapel Rock Transmission Project, Alberta	No	Proposed project (Section D, Figure D.2.4-3) is not near WSCT VC	No
Tourism activities: hiking, ATV use, horseback riding, Lost Lemon Campground, local ski hills, mountain bike trails, Crowsnest Trail, SS Trail System Plan	Yes	No detailed mapping available however these activities are prevalent in the RSA	Yes
Helicopter pads or activities	No	Not located near any watercourse	No
Nearby leases	Yes	Grassy and Bellevue leases (Section A, Figure A.3.1-1) are located near WSCT VC on Gold and Blairmore creeks	Yes
Future plans and access to the 'green area' defined in the South Saskatchewan Regional Plan	No	Not located near the WSCT VC	No
Agriculture, and ranching, including cattle crossing or creeks and tributaries	Yes	No detailed mapping available however these activities are prevalent in the RSA	Yes
Project/activities from the communities of Burmis, Lundbreck, Cowley	No	Not located near the WSCT VC	No

3.1.3.3 Projects or activities that could act in combination with the Project residual effects on the WSCT VC

When assessing whether the effects from the projects or activities could act in combination with the Project residual effects, the following two Project residual effects were considered:

- Changes to tributary and mainstem aquatic and/or riparian habitat
- Changes to hydrology in Gold and Blairmore creeks potentially affecting WSCT habitat

The physical footprint of the Project will cause permanent change to WSCT habitat, resulting in an adverse residual effect (CR#6, Table 4.11). These changes to tributary and mainstem aquatic and/or riparian habitat will occur only within the LSA, therefore no adverse residual effects will occur in the RSA (described in CR#6 Section 4.3.1.2 Regional Study Area). Thus, the projects and activities in the RSA will not act in combination with this Project residual effect.

The Project will also cause a change in hydrology potentially affecting WSCT habitat. The residual effect within the RSA is minimal, as described in CR#6 Section 4.3.2.2 (Regional Study Area). In the RSA, changes to hydrology in Gold and Blairmore creeks potentially affecting WSCT habitat are in all months, worst case (highest) flow gains to Crowsnest River (through Blairmore Creek) resulting from the Project are 1.5%, and worst case (highest) flow losses to Crowsnest River (through Gold Creek) resulting from the Project are 1.4% (CR #6 Section 4.3.2.2, Table 4.10). Thus, any predicted flow reductions in the Crowsnest River as a result of predicted flow changes in Gold Creek are expected to be negligible during key bioperiods for fish species that inhabit the Crowsnest River. Additionally, with the increase in flows predicted for Blairmore Creek, any change in flow in the Crowsnest River downstream from the Gold Creek confluence will be very short in duration lasting only until the time lag in flow from Blairmore Creek connects with the flows at the Gold Creek confluence.

The potential effects from the six projects or activities carried forward from Table CEAA 2-4 were assessed for potential interaction with the Project residual effect in the RSA (*i.e.*, changes in hydrology in the Crowsnest River between the confluences of Blairmore and Gold creeks). The predicted Project residual effect is very small (1.5% flow increase in Crowsnest River between the confluences of Blairmore and Gold creeks), and potentially a positive habitat gain, therefore, it is highly unlikely that effects from a project or activity could act in combination with the Project residual effect (flow increase in Crowsnest River). None of the identified past, present or reasonable foreseeable projects and activities are considered to potentially interact in combination with this Project's predicted residual effect on the WSCT VC (Table CEAA 2-5).

Table CEAA 2-5 Projects or Activities that could act in combination with the Project residual effect on the WSCT VC

Project or Activity	Potential Interaction with Project residual effect	Rationale	Carried Forward in Cumulative Effects Assessment?
Legacy mines, including Greenhill, Bear Valley, Bellevue underground mines	No	The legacy mines are not expected to cause any potential effects that could act in combination with the Project residual effect.	No
Timber Operations	No	Timber operations are located far upstream of the Project residual effect. Provided the timber operations adhere to the applicable laws and regulations, no potential effects could act in combination with the Project residual effect.	No
Highway 3 Re-Alignment	No	The proposed project is located far upstream of any potential Project residual effects. Provided the project adheres to the applicable laws and regulations, no potential effects could act in combination with the Project residual effect.	No
Tourism activities: hiking, ATV use, horseback riding, Lost Lemon Campground, local ski hills, mountain bike trails, Crowsnest Trail, SS Trail System Plan	No	None of the potential effects from these activities are large enough to act in combination with the Project residual effect.	No
Nearby leases	No	The nearby leases are not expected to cause any potential effects that could act in combination with the Project residual effect.	No
Agriculture, and ranching, including cattle crossing or creeks and tributaries	No	There are no known agriculture or ranching activities which could cause any potential effects that could act in combination with the Project residual effect.	No

3.1.3.4 Past, Present, or Reasonably Foreseeable Physical Activities to Carry Forward in Cumulative Effects Assessment

To identify the source of potential cumulative effects, other projects or activities were considered that have been or that are likely to be carried out that could cause effects on the WSCT VC within the boundaries defined, and whose effects would act in combination with the predicted residual effects of the Project. Overall 10 projects or activities occur within the RSA (Table CEAA 2-2). Six of these projects or activities have the potential to interact with the WSCT VC (Table CEAA 2-4). None of the potential interactions from these projects and activities could potentially act in combination with the Project residual effect on the WSCT VC to result a cumulative effect (Table CEAA 2-5).

There are no potential effects on the WSCT VC within the boundaries defined, and whose effects would act in combination with the residual effects of the Project. The WSCT VC is not carried forward for analysis, based on the results of this scoping phase.

3.2 Analysis

The scoping phase of the cumulative effects assessment eliminated any potential cumulative effects to the WSCT VC, therefore no analysis is required for cumulative effects.

Project-specific assessment of potential effects to the WSCT VC is provided in CR#6, Section 4.0 Effects Assessment.

3.3 Mitigation

The scoping phase of the cumulative effects assessment eliminated any potential cumulative effects to the WSCT VC, therefore no mitigation is required for cumulative effects.

Project-specific mitigation for potential effects to the WSCT VC is provided in CR#, 6 Section 4.0 Effects Assessment.

3.4 Significance

The scoping phase of the cumulative effects assessment eliminated any potential cumulative effects to the WSCT VC, therefore no significance characterization is required.

Project-specific significance for potential effects to the WSCT VC is provided in CR#6, Section 4.5 Residual Effects Classification and Determination.

3.5 Follow-Up

The scoping phase of the cumulative effects assessment eliminated any potential cumulative effects to the WSCT VC, therefore no follow-up is required.

Project-specific follow up for the potential effects to the WSCT VC is provided in CR#6, Section 6.0 Proposed monitoring and follow-up.

4.0 MIGRATORY BIRDS AND SARA-LISTED SPECIES CUMULATIVE EFFECTS ASSESSMENT

4.1 Scoping

The cumulative effects assessment (also referred to as the planned development case (PDC) as per the requirements in Alberta) for wildlife was conducted quantitatively (*e.g.*, habitat suitability modeling, linear features density) where possible, and to provide a context for assessing potential effects on wildlife populations. Available literature and professional judgement were used to establish a conservative 20% habitat change threshold for the wildlife VCs (CR#9, Section 3.2.5). Where sufficient quantitative information did not exist, effects ratings were based on existing literature and professional judgement, taking into consideration the results of the Application Case effects ratings, knowledge of planned developments and activities, and status of wildlife VCs and their sensitivities to disturbance. Wildlife effects related to the Cumulative Effects/PDC were rated using the same key wildlife issues, spatial and temporal boundaries, and effects prediction criteria used in the Application Case assessment. As with the Application Case, Year 14 (maximum disturbance) and Year 27 (progressive reclamation) were used to determine the cumulative effects for the PDC. In assessing cumulative effects, there is typically a greater reliance on using qualitative methods and expert judgment because of the broader scope and uncertainty associated with data limitations and the likelihood that future developments occur.

4.1.1 Identifying Valued Components

Significant residual Project effects were not predicted for any of the wildlife VCs (CR#9, Section 5.3); regardless, five wildlife VCs were selected for a cumulative effects assessment for wildlife due to their requirements for mature and old-growth forests or their potential for increased mortality because of increased access from forestry activities in the grizzly bear regional study area (GBRSA).

Selection rationale is discussed further in CR#9, Section 6.3.1. Of the ten wildlife VCs that were selected for the impact assessment, olive-sided flycatcher, little brown myotis, American marten, and Canada lynx were selected for the cumulative effects assessment because they are all dependent on mature and/or old-growth forest. The predominant driver for cumulative effects in the WRSA and GBRSA over the next 30 years is timber harvest. It was believed that these four species may be particularly sensitive to loss of mature and old-growth forests in the regional area. Additionally, grizzly bear was selected because of the potential for increased mortality risk resulting from increased access at the regional level. With the exception of marten, the selected VCs for the cumulative effects assessment are federally-listed species at risk and/or have a special status designation in Alberta.

The VCs that were chosen for the cumulative effects assessment are umbrella species that have similar habitat requirements to the non-chosen VCs and will therefore act as surrogates for migratory birds.

Columbia spotted frog, western toad, great gray owl, moose, and elk were screened from further consideration in the cumulative effects assessment. Although Columbia spotted frog and western toad are wetland-dependent species, wetland habitats are relatively uncommon in the wildlife local study area (WLSA) and Project effects on these two species are expected to be localized and specific to the Project footprint (*i.e.*, loss of breeding ponds). Both species occur elsewhere in the region, and since forestry is expected to be the main land use activity under the PDC, these species were not considered to be susceptible to regional cumulative effects. In addition, western toads have been reported to be resilient to landscapes fragmented by timber harvesting. Moose and elk are early to mid-successional species that will likely benefit from mining (post-reclamation) and forestry activities in the region. Great gray owl requires mid- to late successional coniferous or deciduous forest for nesting and early to mid-successional forests for foraging. Very little high-quality great gray owl habitat (1.4 ha) will be affected by the proposed Project (CR#9, Table 5.3-4); it was therefore not included in the cumulative effects assessment.

Many of the migratory birds present in the WLSA have habitat requirements that overlap those of the wildlife VCs and special status species included in this assessment (CR#9, Table 4.6-1). Of the species carried into the cumulative effects assessment, the indicator wildlife VCs used to represent migratory birds (CR#9, Table 4.6-1) are:

- Olive-sided flycatcher – represents coniferous-dominant forest birds;
- Little brown myotis - represents deciduous-dominant forest birds;
- American marten – represents old growth forest birds, coniferous-dominant forest birds; and
- Canada Lynx – represents coniferous-dominant forest birds.

Coniferous and mixedwood forests cover a large area of the WLSA (~70%) and host the highest species richness and diversity of all habitats occurring in the WLSA.

Several species prefer habitats that are more limited in the WLSA. The scarcity of these habitats limits the presence and abundance of these species in Baseline conditions. There are only 18 ha of shrubby wetland, 5 ha of treed wetland, and 64 ha of waterbody habitats in the WLSA, limiting the presence and abundance of shorebirds, waterfowl, and other wetland-dependent birds in the WLSA. Similarly, grassland species (*e.g.*, mountain bluebird and vesper sparrow; CR #9, Table 4.6-1) are also limited in the WLSA due to the relative scarcity of grassland habitat (290 ha) and upland shrub habitat (< 1 ha). Some species display a strong preference for mature and old-growth forests (*e.g.*, woodpeckers), and are limited by the presence of only 169 ha of old-growth forest in the WLSA. Species preferring open,

rocky habitats, including alpine habitats have 49 ha of suitable habitat in the WLSA. The VCs for the cumulative effects assessment excluded species that were habitat specialists for the very limited habitats that exist in the WLSA. The VCs were determined as per CR#9, Section 6.3.

4.1.2 Determining Spatial and Temporal Boundaries

4.1.2.1 Spatial Boundaries

Spatial boundaries for wildlife include both a local study area and a regional study area. Baseline wildlife inventories were conducted in a WLSA that occupies 5,646.4 ha of land in Townships 7, 8 and 9 and Ranges 3 and 4, West of the 5th Meridian (CR#9, Figure 1.2-2). The WLSA is comprised of the proposed Mine Permit Boundary with a minimum 500 m zone established around major disturbance features (primarily the southern one-third of the WLSA). The WLSA was established to account for potential disturbance effects of Project development on wildlife that may extend beyond the proposed Mine Permit Boundary.

For the purposes of the wildlife baseline inventories, supporting sampling sites immediately to the west boundary of the WLSA are included. These sampling sites were part of the wildlife sampling program conducted prior to the Project's engineering Mine Permit Boundary being defined.

The RSA encompass an area within which Project-specific effects on wildlife can be assessed in a broad spatial context. For the Project wildlife assessment, two RSAs were defined (EIA, CR#9, Figure 1.2-3). The Wildlife RSA (WRSA) was defined as the area within 10 km of the WLSA boundary (73,547.0 ha), and the Grizzly Bear RSA (GBRSA) was defined as the area within 25 km of the WLSA boundary (284,024.7 ha). The WRSA was selected to reflect the approximate average size of two elk winter home ranges, while the GBRSA was selected to represent the average area of an adult female grizzly bear home range. The GBRSA was used for the cumulative effects assessment.

4.1.2.2 Temporal Boundaries

Temporal boundaries were defined as lasting approximately 27 years, concomitant with the life of the Project (baseline, construction, operation, reclamation, mitigation, and post-reclamation phases).

4.1.3 Examining Past, Existing, and Future Physical Activities

This section discusses the physical activities evaluated for the wildlife VCs covered in the EIA. Baseline and approved projects and projects planned for the foreseeable future in the WRSA and GBRSA are summarized in Table CEAA 2-6 (EIA, CR#9, Table 6.2-1). Most of the resource development currently occurring within the WRSA and GBRSA at baseline is associated with coal mining, forestry, and oil and gas activities. Other existing and approved developments and activities include various urban areas, road/rail/utility corridors, and recreational areas.

Table CEAA 2-6 Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area and Grizzly Bear Regional Study Area

Company	Project	Existing & Approved Activity (Baseline Case)	Project (Application Case)	Planned Projects Cumulative effects/PDC Case
Mining Operations				
Benga Mining Limited	Grassy Mountain Coal Project		☑	
Various	Historic Mining Development ~1890 to 1990	☑		
Teck Coal Limited	Coal Mountain Operations	☑		
	Elkview Operations	☑		
	Elkview Baldy Ridge Extension			☑
	Michel Creek Coking Coal Project			☑
Timber Operations				
Crown	Operations to end of 2015	☑		
	Operations to 2025			☑
	Operations to 2030			☑
	Operations to 2041 - predicted			☑
	Operations to 2056 - predicted			☑
Oil and Gas Operations				
Devon Canada Corporation	Multiwell Gas Battery 02-19-011-03 W5M	☑		
	Compressor Station 04-13-009-04 W5M	☑		
Harvest Operations Corp.	Burmis Gas Test Battery 12-19-007-02 W5M	☑		
HOC Energy Corp.	Single Well Gas Battery 10-07-006-02 W5M	☑		
Legacy Oil & Gas Inc.	Gas Single-Well Battery 13-35-007-03 W5M	☑		

Table CEAA 2-6 Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area and Grizzly Bear Regional Study Area

Company	Project	Existing & Approved Activity (Baseline Case)	Project (Application Case)	Planned Projects Cumulative effects/PDC Case
Nova Gas Transmission Ltd.	Interconnect 01-15-008-05 W5M	☑		
	Interconnect 09-11-008-05 W5M	☑		
Shell Canada Limited	Single Well Gas Battery 10-01-006-03 W5M	☑		
	Compressor Station 06-12-006-03 W5M	☑		
	Multiwell Gas Battery 02-20-006-03 W5M	☑		
	Gas Gathering System 16-07-007-02 W5M	☑		
Misc.	Wellsites	☑		
	Access Roads	☑		
	Pipelines	☑		
Rural Development				
MD of Crowsnest Pass	Community of Coleman	☑		
	Community of Blairmore	☑		
	Community of Frank	☑		
	Community of Bellevue	☑		
	Community of Hillcrest	☑		
	Roadways, Utility Corridors & Services	☑		
MD of Ranchlands	Roadways, Utility Corridors & Services	☑		
	Community of Maycroft	☑		
MD of Pincher Creek	Community of Burmis	☑		
	Community of Lundbreck	☑		

Table CEAA 2-6	**Project Inclusion List: Existing, Approved and Planned (Reasonably Foreseeable) Projects using/within the Wildlife Regional Study Area and Grizzly Bear Regional Study Area**			
Company	**Project**	**Existing & Approved Activity (Baseline Case)**	**Project (Application Case)**	**Planned Projects Cumulative effects/PDC Case**
	Community of Cowley	☑		
	Community of Beaver Mines	☑		
	Roadways, Utility Corridors & Services	☑		
Alberta Transportation	Roadways and Transportation Corridors	☑		
	Highway 3 Re-Alignment			☑
CP Rail	Rail Lines	☑		
Altalink	Castle Rock Ridge to Chapel Rock Transmission Project			☑
Various	Recreation and Tourism Facilities	☑		

Various sources of existing information were reviewed to obtain background information on the WLSA and RSAs. Further details can be found in the CR#9, Section 2.2. This includes but are not limited to:

- North American Breeding Bird Survey (BBS);
- Fish and Wildlife Management Information System (FWMIS);
- Alberta Conservation Association Aerial Ungulate Surveys;
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC);
- Federal recovery strategies for species at risk;
- Published species habitat use accounts and distribution maps;
- Hunting and trapping statistics; and
- Available Treaty 7 First Nations Traditional Use Reports, specific to the Grassy Mountain and the Project.

4.1.3.1 Existing anthropogenic disturbance in the WLSA and GBRSA

Wildlife Consultant Report (CR#9), Section 3.2 discusses elements of the current landscape that shape the conditions of many VCs. CR#9, Table 4.2-1 outlines the areal extent of a variety of anthropogenic disturbances that currently exist in the wildlife local study area. Anthropogenic disturbances associated with roads/highways, rail, clear cuts, pipelines, agricultural activity, and industrial and residential developments accounted for 18.2% of the WLSA.

Because of its varied landscapes and wildlife diversity, the Rocky Mountain Natural Region is also highly valued for the recreational opportunities it provides. Hiking, birding, wildlife watching, horse riding, hunting, mountain biking, skiing, and snowboarding are popular activities in the area and tourism is important to the economy of the region. Other land uses include cattle grazing, forestry, oil and gas exploration, and mining.

At the local level, the Project is located in the Crowsnest Pass region of southwestern Alberta. The Crowsnest Pass is a low-elevation mountain pass comprised of an east-west valley that passes through the Crowsnest Ridge. It contains the southernmost rail and highway route through the Canadian Rockies and the Project is approximately 7 km north of this important transportation corridor. The Crowsnest Valley also represents a major wildlife movement corridor and is an important overwintering ground for elk, and mule and white-tailed deer.

The Project falls within the area covered by the South Saskatchewan Regional plan and the South Saskatchewan River Basin Plan. It also includes lands that are subject to two different Integrated Resource Plan (IRP) areas, both of which aim to allow for multiple land uses while protecting the environment. These are the Livingstone-Porcupine Hills Sub-Regional IRP and the Crowsnest Corridor Local Sub-Regional IRP. Each IRP divides land into eight different Land Use Zones, each of which is subject to different management objectives (CR#9, page 13).

Cutblocks and other regenerating clearings (open regenerating herb, open regenerating shrub, and closed regenerating treed) were the most common anthropogenic disturbances in the WRSA at baseline (13.3%). Other important anthropogenic disturbances at the WRSA scale included agricultural land (5.4%) and linear anthropogenic disturbances (3.4%). Industry, including other mine operations, accounted for 0.6% of the WRSA (472.0 ha).

Cutblocks and other regenerating clearings (open regenerating herb, open regenerating shrub, and closed regenerating treed) were the most common anthropogenic disturbance in the GBRSA (13.3%; 17,991.2 ha). Agriculture accounted for an additional 9.5% of the landscape at the GBRSA scale and was relatively more abundant than in the WRSA. Linear anthropogenic disturbances accounted for

2.7% and industrial developments (including mines) accounted for 1.1% of the GBRSA (CR #9, Table 4.2-2).

4.1.3.2 Future Planned Physical Activities

Several projects and activities are expected to occur in the reasonably foreseeable future including TECK Coal Michel Creek Coking Coal Project, expansion at the TECK Coal Elkview Baldy Ridge Expansion site, timber harvesting up to 2030 and beyond, Altalink Castle Rock Ridge to Chapel Rock Transmission Line, and a realignment of Highway 3 (Table IR 2-7 below, and CR#9, Table 6.2.2). Including the Grassy Mountain Coal Project, planned developments will cover 11.1% (8,197.7 ha) of the WRSA (73,547.0 ha) and 6.8% (19,350.5 ha) of the GBRSA (284,024.7 ha). Most of the area affected by future projects in the WRSA and GBRSA will be associated with forestry activities at Year 14 and Year 27. The Grassy Mountain Coal Project accounts for 18.6% of planned development in the WRSA and 7.9% of planned development in the GBRSA (Table CEAA 2-7).

Table CEAA 2-7 Areal Extent of Planned Developments in the Wildlife Regional Study Area and the Grizzly Bear Regional Study Area

	WRSA		GBRSA	
Planned Development	**Area (ha)**	**% of Total Planned Area**	**Area (ha)**	**% of Total Planned Area**
Grassy Mountain Coal Project	1,520.7	18.6	1,520.7	1.9
Timber Harvest - Year 14	6,135.0	74.8	13,356.7	69.0
Timber Harvest - Year 27	369.5	4.5	3,155.1	16.3
TECK Coal Michel Creek Coking Coal Project – Year 14	-	-	966.5	5.0
TECK Coal Elkview Baldy Ridge Extension – Year 27[1]	-	-	-	-
Altalink Castle Rock Ridge to Chapel Rock Transmission Project[2] – Year 27	81.0	1.0	259.5	1.3
Highway 3 Realignment - Year 27	91.5	1.1	91.5	0.5
Total	**8,197.7**	**100**	**19,350.5**	**100**

[1] Within the already-disturbed Elkview Baldy Ridge Project area

[2] Based on assumed route length of xx m and ROW of 120 m (route was not selected at time of submission of this application)

4.1.3.3 Other Future Factors and Activities

4.1.3.3.1 Climate Change

Climate change has the potential to cumulatively affect wildlife habitat. The effects of climate change are expected to increase over time, gradually affecting more species as their thresholds to environmental change are reached. Climate warming can increase the spatial variability of precipitation, which will likely result in increased mean annual precipitation for most of Canada. Drier conditions are still liable to develop if precipitation levels remain too low to offset elevated evapotranspiration levels resulting from higher temperatures.

A warming trend will eventually lead to a higher elevation movement of the Montane and Subalpine Natural Subregions, leading to potential reduction/elimination of the Alpine Subregion. Climate change is expected to have species-specific effects. The changes to habitat may facilitate the range expansion of more generalist species like moose and deer. As predators such as wolves follow their expanding prey, increased predation on more sensitive species such as mountain goat can be expected (CR#9, Section 6.2.1).

4.1.3.3.2 Wildfires

Wildfire is an important natural disturbance that drives many processes within the forested Montane and Subalpine Natural Subregions. Although fire can negatively affect many species through direct mortality and habitat loss, it also has the effect of creating habitat for other species. Western toads, for example, will rapidly colonize recently burned habitat). The Montane Natural Subregion is expected to have a shorter fire return interval and great annual disturbance from fire than the Subalpine Natural Subregion. Within the GBRSA, the Alpine areas are expected to have the longest fire return intervals and least disturbance from fire. A continued warming trend may increase the frequency of wildfires in North America, including in the GBRSA. It is reasonable to anticipate that wildfires will occur within the GBRSA during the life of the Project (CR#9, Section 6.2.2).

4.1.3.3.3 Land Use and Recreational Activities

Various land use and recreational activities occur in the GBRSA and are likely to continue in the future, including hunting, fishing and trapping, golfing, downhill skiing, and recreational ATV and snowmobile use. Access management by various project proponents can limit access to the WLSA to authorized personnel and traditional land users, thereby reducing the hunting pressure on wildlife. Access management such as line blocking may reduce the likelihood of predators following access routes to ease their travel and increase the encounter rate with prey (CR#9, Section 6.2.3).

4.2 Analysis

Results from the cumulative effects assessment are summarized in Table CEAA 2-8 (CR#9, Table 6.3-1) and described in CR#9, Sections 6.3.2 to 6.3.6, which are copied here. Original references can be found in the applicable sections in CR#9.

Table CEAA 2-8 Changes in Habitat Availability between the Baseline and Cumulative Effects/PDC in the Wildlife Regional Study Area or Grizzly Bear Regional Study Area

Valued Component	Habitat Suitability Class	Baseline (ha)	Year 14			Year 27			Habitat Change Threshold (%)
			PDC (ha)	Change from Baseline		PDC (ha)	Change from Baseline		
				ha	%		ha	%	
Olive-sided flycatcher	High	3,868.1	5,393.6	1,525.5	39.4	5,338.2	1,470.1	38.0	-
	Moderate	18,415.5	16,836.1	-1,579.4	-8.6	16,713.6	-1,701.9	-9.2	-
	Low	19,080.0	12,816.1	-6,263.9	-32.8	12,586.5	-6,493.5	-34.0	-
	Nil	32,183.5	38,501.3	6,317.8	19.6	38,908.8	6,725.3	20.9	-
	Effective Habitat[1]	**22,283.6**	22,229.7	-53.9	-0.2	22,051.8	-231.8	-1.0	**-20**
Little brown myotis	High	2440.0	2420.5	-19.5	-0.8	2396.8	-43.2	-1.8	-
	Moderate	1151.4	1094.3	-57.0	-5.0	1064.1	-87.2	-7.6	-
	Low	37830.5	31718.4	-6112.2	-16.2	31319.7	-6510.8	-17.2	-
	Nil	32125.1	38313.8	6188.7	19.3	38766.4	6641.3	20.7	-
	Effective Habitat[1]	**3591.4**	3514.8	-76.5	-2.1	3460.9	-130.5	-3.6	**-20**
American marten	High	19,817.1	15,748.3	-4,068.8	-20.5	15,574.0	-4,243.1	-21.4	-
	Moderate-high	1,056.1	839.2	-216.9	-20.5	849.3	-206.8	-19.6	-
	Moderate	17,853.1	15,818.8	-2,034.2	-11.4	15,513.9	-2,339.2	-13.1	-
	Moderate-low	4,796.7	4,558.5	-238.2	-5.0	4,587.9	-208.8	-4.4	-
	Low	11,966.6	17,434.4	5,467.8	45.7	18,478.6	6,512.0	54.4	-
	Nil	18,057.5	19,147.9	1,090.3	6.0	18,543.3	485.8	2.7	-
	Effective Habitat[2]	**38,726.2**	32,406.3	**-6,319.9**	**-16.3**	31,937.1	-6,789.0	**-17.5**	**-20**
Canada lynx	High	19,827.9	15,721.8	-4,106.1	-20.7	15,602.2	-4,225.7	-21.3	-
	Moderate-high	10,115.6	8,718.1	-1,397.5	-13.8	8,573.6	-1,542.0	-15.2	-

Table CEAA 2-8 Changes in Habitat Availability between the Baseline and Cumulative Effects/PDC in the Wildlife Regional Study Area or Grizzly Bear Regional Study Area

Valued Component	Habitat Suitability Class	Baseline (ha)	Year 14			Year 27			Habitat Change Threshold (%)
			PDC (ha)	Change from Baseline		PDC (ha)	Change from Baseline		
				ha	%		ha	%	
	Moderate	1,087.3	992.4	-94.9	-8.7	986.0	-101.3	-9.3	-
	Moderate-low	13,703.1	12,777.9	-925.2	-6.8	12,629.2	-1,073.9	-7.8	-
	Low	5,511.1	5,379.2	-131.9	-2.4	5,351.1	-160.0	-2.9	-
	Nil	23,301.9	29,957.7	6,655.8	28.6	30,404.9	7,103.0	30.5	-
	Effective Habitat[2]	**31,030.8**	**25,432.2**	**-5,598.6**	**-18.0**	**25,161.8**	**-5,869.0**	**-18.9**	**-20**
Grizzly bear	Primary Sink	22,883.0	25,982.8	3,099.8	13.5	26,278.5	3,395.4	14.8	-
	Secondary Sink	18,683.9	15,472.4	-3,211.5	-17.2	15,221.6	-3,462.3	-18.5	-
	Non-critical Habitat	33,486.0	33,499.2	13.1	0.0	32,660.0	-826.0	-2.5	-
	Secondary Source	39,908.3	32,993.6	-6,914.8	-17.3	32,690.4	-7,217.9	-18.1	-
	Primary Source	35,078.6	42,106.1	7,027.6	20.0	43,189.2	8,110.6	23.1	-
	Effective Habitat[3]	**74,986.9**	**75,099.7**	**112.8**	**0.2**	**75,879.6**	**892.7**	**1.2**	**-20**

1. Effective Habitat = High plus moderate habitat suitability classes; WRSA

2. Effective Habitat = High plus moderate-high plus moderate habitat suitability classes; WRSA

3 Effective Habitat = Primary source plus secondary source habitat suitability classes; GBRSA

4.2.1 Olive-sided Flycatcher

4.2.1.1 Change in Habitat Availability

Cumulative effects on the area of effective habitat for olive-sided flycatchers in the WRSA will be minimal. In Year 14, approximately 53.9 ha (0.2%) of effective habitat will be lost, increasing to 231.8 ha (1%) by Year 27 (Table IR 2-8, CR#9, Figures 6.3-1 to 6.3-3). This is below the 20% habitat loss threshold adopted by Benga for this assessment (*i.e.* it is assumed that species can tolerate up to a 20% loss of habitat). Most effective habitat loss for olive-sided flycatchers will be of moderate-quality habitat. The predicted area of high-quality habitat will increase in the PDC as forestry activities increase the area of edge habitat (*i.e.,* where forested areas meet non-forested areas), which is often preferred by olive-sided flycatchers (CR#9, Appendix C, Section 2.4).

A temporary indirect loss of habitat may occur as a result of sensory disturbances (*e.g.*, vehicular traffic, heavy equipment, *etc*.) in the vicinity of the Project footprint and active forest cut blocks. These effects were incorporated into the olive-sided flycatcher habitat suitability model, as habitats surrounding noisy disturbances were rated as nil-quality.

The cumulative effects on olive-sided flycatcher habitat availability are predicted to be nil in magnitude and neutral, due to the increase in high-quality habitat (*i.e.* edge habitat) that will result from forestry activities. The confidence rating associated with these predictions is high, and the changes are predicted to be not significant at the regional level.

4.2.1.2 Change in Movement

As olive-sided flycatchers are highly mobile and are capable of migrating very long distances, neither Project development nor any of the planned projects in the WRSA are likely to present major barriers to movements. Olive-sided flycatchers do not rely on forest interior habitats, preferring to forage along habitat edges. Thus, forest fragmentation resulting from forestry activities is not predicted to negatively affect olive-sided flycatchers.

The magnitude of the cumulative effects on movement is predicted to be nil and the proposed Project contribution is predicted to be nil. The confidence rating associated with these predictions is high.

4.2.1.3 Change in Mortality Risk

After mitigation, the development of the proposed Project is unlikely to result in an increased mortality risk for olive-sided flycatchers (CR#9, Section 5.3.3.3). The same is true for the realignment of Highway 3. However, timber harvest may increase the risk of mortality for olive-sided flycatcher nestlings if trees are cut down before young birds have fledged from the nest. Recently harvested

areas can act as "ecological traps" for olive-sided flycatchers that nest adjacent to habitats that have been harvested and subsequently suffer from high rates of nest predation. Predators of olive-sided flycatcher nests and nestlings, such as common ravens and gray jays, may increase in abundance in harvested forests.

Cumulative effects for olive-sided flycatcher mortality risk are predicted to be regional in extent, long in duration, continuous in frequency, reversible in the long term, and low in magnitude. The probability of occurrence is predicted to be moderate and the changes are predicted to be not significant. Changes are predicted to be long term and continuous because of the potential increases in the population sizes of nest predators that may occur following forest harvest. The confidence rating associated with these predictions is moderate, as it is difficult to predict the magnitude of the predicted increase in nest predators and the magnitude of the effect it may have on olive-sided flycatcher populations. The contribution of the planned developments to changes in olive-sided flycatcher mortality risk will be negative.

4.2.1.4 Change in Abundance

Of the planned development activities for the WRSA, forestry will have the largest effect on olive-sided flycatcher abundance. It is difficult to predict the precise effects of forestry on olive-sided flycatcher populations because they often breed in selectively-harvested forests or in forests bordering clear cut areas and nest success is often lower in such habitats. Forestry activities may also result in the destruction of olive-sided flycatcher nests or nestlings, which will result in temporary decreases in the abundance of flycatchers.

The cumulative effects on olive-sided flycatcher abundance are predicted to be regional in extent, long in duration, continuous in frequency, reversible in the long term, low in magnitude, and not significant. The proposed Project contribution to these changes will be nil, although the contribution of other planned activities (primarily forestry) will be negative. The probability of occurrence is moderate and the confidence rating associated with these predictions is moderate, because although there will be an increase in high-quality habitat for olive-sided flycatchers, nest success may be low.

4.2.2 Little Brown Myotis

4.2.2.1 Change in Habitat Availability

Very little high or moderate-quality little brown myotis roosting habitat will be affected by the planned developments in the WRSA (Table IR 2-8 and CR#9, Figures 6.3-4 to 6.3-6). By Year 14, approximately 19.5 ha (0.8%) of high-quality and 57.0 ha (5%) of moderate-quality habitat will be lost in the WRSA. By Year 27, this will increase to a loss of 43.2 ha (1.8%) of high-quality habitat and

87.2 ha (7.6%) of moderate-quality habitat. Indirect habitat loss (*i.e.* bats avoiding areas where they may be disturbed by noise) was incorporated into the habitat suitability model.

The cumulative effects on roosting habitat availability for little brown myotis are predicted to be regional, extended in duration, continuous in frequency, reversible in the long term, and low in magnitude. The effects are predicted to be extended in duration because old deciduous trees are most likely to provide high-quality little brown myotis roosting habitat (CR#9, Appendix C, Section 2.6) and once such trees are removed, it can take many decades (and up to a century) for suitable roosting trees to regrow. The confidence rating associated with these predictions is moderate, because little brown myotis may also roost in abandoned buildings, the availability of which could not be modelled. The probability of occurrence is moderate and the changes are predicted to be not significant at the regional level, as less than 20% of effective roosting habitat will be affected by planned developments.

Benga undertook additional field studies for little brown myotis, the results of which can be found in the response to the Agency IR#1.

4.2.2.2 Change in Movement

Planned development activities in the WRSA are unlikely to negatively affect habitat connectivity and movement for little brown myotis. This species will frequently travel and forage along the edges of clear cuts and in forest gaps. Commuting bats may avoid areas with high levels of anthropogenic noise and artificial lights (such as highways or industrial sites). Little brown myotis are most active at night when levels of anthropogenic noise are generally lower.

The magnitude of cumulative effects on movement for little brown myotis is predicted to be nil, and the confidence rating associated with this prediction is high.

4.2.2.3 Change in Mortality Risk

Significant increases in mortality risk to little brown myotis are unlikely to occur as a result of the development of the proposed Project or the Highway 3 realignment. Timber harvesting is also unlikely to result in significant bat mortality, unless a tree being used as a maternity roost is removed. Mortality from this risk is expected to be low and infrequent.

Cumulative effects on mortality risk for little brown myotis are predicted to be regional in extent, short in duration, occasional in frequency, reversible in the short term, and low in magnitude. The cumulative effects are predicted to be negative, the probability of occurrence is low, and the effects are not significant. The confidence rating associated with this prediction is moderate because it is difficult to predict if and to what degree forestry activities will alter little brown myotis mortality risk.

4.2.2.4 Change in Abundance

Changes in abundance are most likely to be correlated with losses in roosting habitat. As a result, cumulative effects on abundance will be regional, extended in duration and long-term (due to a loss of suitable roosting trees), negative, and low in magnitude. The effects are predicted to be not significant at the regional level. The confidence level associated with these predictions is moderate and the probability of occurrence is moderate.

4.2.3 American Marten

4.2.3.1 Change in Habitat Availability

The primary effect to American marten is loss of preferred forest habitats. By Year 14, 6,319.9 (16.3%) of effective American marten habitat in the WRSA is predicted to be lost and by Year 27, 6,789 ha (17.5%) of effective habitat will be lost (Table CEAA 2-8 and CR#9, Figures 6.3-7 to 6.3-9). The habitat suitability model for American marten incorporated indirect habitat losses resulting from sensory disturbances. The majority of habitat loss (approximately 90.4%) is expected to be a result of planned forestry activities, which can be mitigated if patches of coarse woody debris are left on the landscape, and AEP recommends retaining some debris on a harvested landscape to enhance furbearer and microtine habitat.

The cumulative effects on habitat availability in the WRSA are predicted to be regional in extent, extended in duration, continuous in frequency, reversible in the long term, and low in magnitude. They are predicted to be extended and reversible in the long term because of the marten's preference for mature to old-growth forests, which will take many decades to regrow from reclaimed and reforested landscapes. Although American martens prefer mature to old-growth forests, they are sometimes found in recently harvested forests. The confidence rating associated with this prediction is high and the probability of occurrence is high, as numerous studies have demonstrated that American martens prefer mature, coniferous forests (CR#9, Appendix C, Section 2.7). As less than 20% of effective American marten habitat will be lost, the changes are predicted to be not significant.

4.2.3.2 Change in Movement

Planned development will result in increased fragmentation of American marten habitat, primarily because of forestry activities. Under baseline conditions, there is a large amount of contiguous high-quality American marten habitat in the north-central and southwest sections of the WRSA (CR#9, Figure 6.3-7). At Year 27, these areas of high-quality habitat will be interspersed with low-quality habitat patches (CR#9, Figure 6.3-9), primarily composed of recently harvested forests. American martens generally avoid moving through open habitats, such as recent cut blocks. As shrubs become re-established, martens are likely to begin moving through these areas again. It will take several decades for regenerating forests to develop into high-quality American marten habitat.

Highway 3 bisects the WLSA which may restrict north-south movements for American martens. Within the Cumulative Effects/PDC, there are plans to realign Highway 3 and wildlife crossing structures have been proposed as part of that development. Should the wildlife crossings be constructed, movement of marten populations between the north and south sides of Highway 3 may be improved under the Cumulative Effects/PDC.

The cumulative effects on American marten movement resulting from habitat fragmentation and Project effects on habitat connectivity are predicted to be regional in extent, extended in duration, continuous in frequency, reversible in the long term, and low in magnitude. They are predicted to be extended in duration and reversible in the long term because of the long periods of time required for reclaimed or reforested areas to re-mature into high-quality American marten habitat. The cumulative effects are predicted to be negative overall, and the probability of occurrence is high. The effects are predicted to be not significant and the confidence rating associated with these predictions is high.

4.2.3.3 Change in Mortality Risk

Significant cumulative effects on American marten mortality risk are unlikely to occur. American marten appear to avoid roads (CR#9, Appendix C, Section 2.7) and therefore the risk of collisions with vehicles is low. Various mitigation measures will be implemented by Benga to minimize wildlife mortality within the Project footprint (CR#9, Section 7.0). Isolated instances of mortality resulting from timber harvesting may occur if a tree containing non-mobile American marten kits is removed.

Increases in trapper effort and success may occur as access to previously remote areas increases from forestry and other planned developments that create linear access features such as cut lines, access roads, *etc*. Access to remote areas in the WRSA under baseline conditions is generally good due to the presence of existing trails and forestry roads and planned developments are therefore unlikely to result in significant increases in marten trapping mortality. Trapping in Alberta is regulated and marten trapping throughout the province is generally sustainable.

Cumulative effects on American marten mortality risk in the WRSA are predicted to be regional in extent, short in duration, isolated in frequency, reversible in the short term, low in magnitude, and negative in direction. The confidence rating associated with these predictions is high, the probability of occurrence is low, and any effects are likely to be not significant.

4.2.3.4 Change in Abundance

Cumulative effects on American marten abundance may result in small decreases because of the increased habitat fragmentation that will occur under the PDC scenario. Multiple studies have found negative correlations between American marten abundance and habitat fragmentation (CR#9,

Appendix C, Section 2.7). For example, sharp declines in marten abundance can occur when forest cover on a landscape falls below 75%. Under baseline conditions, 62.6% of the WRSA is forested, so marten populations may already be low in the region. The majority of further loss and fragmentation of American marten habitat (approximately 90%) will be a result of forestry activities.

Cumulative effects on American marten abundance in the WRSA are predicted to be regional in extent, extended in duration, continuous in frequency, reversible in the long term, low in magnitude and negative in direction. The confidence rating associated with these predictions is moderate, due to a lack of information on American marten density under baseline conditions, the probability of occurrence is moderate, and the effects are not significant.

4.2.4 Canada Lynx

4.2.4.1 Change in Habitat Availability

Cumulative effects in the WRSA are predicted to result in a net loss of effective winter habitat for Canada lynx (Table CEAA 2-8; CR#9, Figures 4.4-8, 6.3-10, and 6.3-11). By Year 14, approximately 5,598.6 ha (18%) of effective lynx winter habitat will be lost from the WRSA. Most of this loss will be high-quality (4,106.1 ha) habitat. By Year 27, 5,869 ha (18.9%) of effective Canada lynx winter habitat will be lost from the WRSA. Most of the habitat losses (90.4%) will be associated with planned forestry activities in the WRSA.

Benga Mining adopted a precautionary approach for assessing habitat change, and used a conservative threshold of 20% (*i.e.*, a species will tolerate up to a 20% loss of effective habitat) for valued species at the regional level. The area of effective winter habitat loss for Canada lynx by Year 27 is slightly below this threshold level. Canada lynx are expected to persist in the WRSA, although they may avoid highly disturbed areas, such as recently harvested forest blocks. Forest cut blocks are not expected to benefit lynx until approximately 20 years after clearing when snowshoe hare densities (their major prey species) are expected to increase in abundance. Habitat losses associated with forestry activities are expected to be temporary. Because of their ability to disperse long distances and their good reproductive potential, lynx in the region are likely to recolonize disturbed areas as they mature.

The cumulative effects on Canada lynx habitat availability are predicted to be regional in extent, extended in duration, continuous, reversible in the long-term, low in magnitude, and negative. The effects are considered reversible in the long term and extended in duration because harvested forests will regenerate and areas disturbed by the proposed Project will be reclaimed. However, it may take up to 20 years for cleared areas to mature into suitable lynx habitat. The confidence level associated with these predictions is high and the probability of occurrence is high, as forestry and mining activities will temporarily decrease the availability of Canada lynx habitat. As the area of effective

habitat lost will be lower than 20%, the cumulative effects on lynx habitat availability predicted to be not significant.

4.2.4.2 Change in Movement

Currently, the primary barrier to movement of Canada lynx in the WRSA is Highway 3 and this is not expected to change much under the PDC. Highway 3 is still likely to affect north-south connectivity for wildlife populations in the region. The planned realignment of Highway 3 has the potential to improve north-south connectivity for wildlife in the region if wildlife crossings are incorporated into the project. Biologists have proposed that crossing structures be added to Highway 3 in the Crowsnest Pass in order to reduce wildlife-vehicle collisions and improve connectivity between wildlife populations to the north and south of the highway.

Canada lynx are also likely to avoid other areas in the region where heavy equipment is active, such as areas where trees are being harvested. Lynx are likely to resume travel through cleared areas after harvesting has ceased. Recently harvested areas may also attract snowshoe hares, the lynx's primary prey, and may be used for hunting, particularly during summer. During winter, lynx prefer to hunt in coniferous forests.

Cumulative effects on Canada lynx movement as a result of planned development activities in the WRSA are predicted to be regional in extent, extended in duration, continuous, reversible in the long-term, low in magnitude, and negative. The effects are considered reversible, as Canada lynx are likely to begin to travel through the Project area upon closure and through harvested areas once work in them ceases. The confidence level associated with these predictions is high and the probability of occurrence is high, as Canada lynx are known to avoid areas with high levels of human activity. Changes in movement are predicted to be not significant although north-south connectivity may be improved by the inclusion of wildlife overpasses as part of the planned twinning of Highway 3.

4.2.4.3 Change in Mortality Risk

Significant cumulative effects on Canada lynx mortality risk are unlikely to occur. Canada lynx appear to avoid the area within approximately 5 km of Highway 3 and are therefore unlikely to be hit by vehicles travelling on the highway. Increases in mortality resulting from increases in trapper effort and success are also unlikely to occur under the Cumulative Effects/PDC (CR#9, Section 5.3.3.3). The magnitude of cumulative effects on Canada lynx mortality is nil, and the effects are predicted to be not significant. The confidence rating associated with this prediction is high.

4.2.4.4 Change in Abundance

As noted in CR#9, Section 6.3.4.1, Canada lynx are likely to persist in the WRSA along with the planned developments, although they may avoid recently disturbed areas, such as cut blocks and the

Project footprint during the construction and operations phases. At Year 27, there will be 25,161.8 ha of effective Canada lynx habitat in the WRSA, and 15,602.2 ha of this will be of high-quality habitat (Table IR 2-8; CR#9 Figures 4.4-8, 6.3-10, and 6.3-11). Large patches of high-quality habitat are located north and northwest of the Project footprint, and south of Highway 3. Canada lynx also have good dispersal abilities and are capable of recolonizing harvested and reclaimed areas as early seral stages mature and snowshoe hare populations increase.

The cumulative effects on Canada lynx abundance are predicted to be regional in extent, extended in duration, continuous in frequency, reversible in the long term, and of low magnitude. They are predicted to be extended and continuous because Canada lynx generally avoid recently harvested areas and open habitats. They will likely resume use of reclaimed areas after approximately 20 years. The changes are likely to be low in magnitude as less than 20% of lynx habitat will be affected and no significant changes in mortality risk are predicted. The confidence rating associated with these predictions is high, the probability of occurrence is moderate, and the changes are likely to be not significant.

4.2.5 Grizzly Bear

4.2.5.1 Change in Habitat Availability

Under the Cumulative Effects/PDC scenario, increases of 112.8 ha (0.2%) and 892.7 ha (1.2%) in effective grizzly bear habitat in the GBRSA are predicted for Year 14 and Year 27 compared to baseline conditions (Table CEAA 2-8). These increases will largely be related to reclamation of the Project footprint and forestry activities. Grizzly bears frequently forage in newly regenerating forests, including recent cut blocks since these habitats can provide abundant food including insects, berries, *Hedysarum* roots, and forbs.

The cumulative effects are likely to be short-term indirect habitat losses associated with sensory disturbances, as grizzly bears frequently avoid areas with high levels of human activities. Grizzly bears will likely avoid the Project footprint and active timber harvesting areas. It is expected that with the cessation of these activities, grizzly bears will likely begin to use the disturbed habitats again.

The cumulative effects on grizzly bear habitat availability in the GBRSA are predicted to be regional in extent, and positive because of a predicted increase in early seral-stage habitats. Since the increases are predicted to be relatively small, the magnitude of the change will be low. The duration of impact is predicted to be long, the frequency continuous, and not significant. As the cumulative effects are positive, no predictions regarding the ability for recovery are presented. The probability of occurrence of the changes is high and the confidence rating for these predictions is high.

4.2.5.2 Change in Movement

Long-term and significant cumulative effects on grizzly bear movements at the regional scale are unlikely to occur. Grizzly bears frequently avoid areas affected by high levels of human activity, and are likely to avoid active mine sites, Highway 3, and active forestry areas. Once mining and forestry activities have ceased, grizzly bears are likely to begin using the disturbed habitats again. Grizzly bears will often travel and forage in recently reclaimed areas (CR#9, Section 6.3.5.1). Benga will incorporate wildlife crossing structures to the proposed coal conveyor which will improve habitat connectivity in the area south of the active mine site (CR#9, Section 7.0). The north-south connectivity may also be improved by the inclusion of wildlife overpasses as part of the planned twinning of Highway 3 (CR#9, Section 6.3.3.2).

The magnitude of cumulative effects on habitat fragmentation and movement for grizzly bears is predicted to be nil in magnitude and not significant. The probability of effects occurring is low and the confidence rating is high.

4.2.5.3 Change in Mortality Risk

By Year 14 of the PDC scenario, there will be a 3,099.8 ha (13.5%) increase in grizzly bear primary sink habitat (high quality habitat with high human-caused mortality risk) and a 3,211.5 ha (17.2%) reduction in grizzly bear secondary sink habitat (moderate quality habitat with high mortality risk) (Table 8). By Year 27, it is predicted that primary and secondary sink habitats will increase by 3,395.4 ha (14.8%) and decrease by 3,462.3 ha (18.5%), respectively (Table CEAA 2-8). The increases in primary sink habitats indicate that there could be increased risk of grizzly bear human-caused mortalities in Years 14 and 27. These risks are expected to be related to an increased potential for human-grizzly bear encounters resulting from collisions with vehicles and trains, and perhaps from poaching.

At the local level, Benga will take several steps to reduce the mortality risk for grizzly bears in the area. These include enforcing a speed limit on the access road, limiting public access and prohibiting use of firearms within the Mine Permit Boundary, and decommissioning roads and trails (CR#9, Section 5.3.8.3 and Section 7.0). These and other best management practices appear to be effective in minimizing grizzly bear mortalities, as no grizzly bear mortality on mine permit lands have occurred in west-central Alberta (where there are numerous coal mines) over a period of 40 years.

The Alberta Grizzly Bear Recovery Plan (2008) also lists several best management practices that can be implemented at a regional scale to reduce the mortality risk to grizzly bears. Some of these include limiting intensive human activity to seasons when bears are inactive, decommissioning access roads when they are no longer used, and implementing "BearSmart" plans to reduce the risk of bear-human encounters.

The cumulative effects on grizzly bear mortality risk are predicted to be nil in magnitude, neutral, and not significant. As a result, no predictions regarding the geographic extent, duration, frequency, or ability for recovery will be presented here. The probability of cumulative effects occurring is low and the confidence rating is moderate, as these predictions rely on the assumption that foresters will follow practices intended to minimize grizzly bear mortality risk.

4.2.5.4 Change in Abundance

As no negative cumulative effects on grizzly bear habitat availability or mortality risk are anticipated to occur in the GBRSA, no significant changes in grizzly bear abundance are predicted to occur. The magnitude of the cumulative effects on grizzly bear mortality risk is predicted to be nil and the effects neutral. As a result, no predictions regarding the geographic extent, duration, frequency, or ability for recovery will be presented here. The probability of any effects occurring is low and the confidence rating is moderate, as these predictions rely on the assumption that regional mitigation measures outlined for the Project (CR#9, Section 7.0) and in the Alberta Grizzly Bear Recovery Plan (2008) are implemented successfully.

4.3 Mitigation

Mitigation measures to prevent or minimize Project effects on migratory birds and their habitats are incorporated into CR#9, Section 7.13 (habitat availability), Section 7.14 (habitat connectivity and movement), and Section 7.15 (mortality risk). Key measures include planning vegetation clearing outside of the breeding bird period (April 15 to August 31) characteristic of the region, conducting pre-disturbance nest searches, and implementing an effective conservation and reclamation plan (Section F - C&R Plan) that promotes the development of habitats required for migratory birds. Benga also acknowledges that Environment Canada encourages industry to develop Beneficial Management Practices guides to minimize potential Project-specific impacts on migratory birds and their habitat.

4.4 Significance

Cumulative effects ratings are summarized in Table CEAA 2-9 (CR#9, Table 6.4.1). Adverse effects on the persistence of wildlife populations (habitat loss, habitat fragmentation and connectivity, mortality risk, and abundance) during all phases of the Project will be minimized by implementing the Project design features and mitigation measures described in the Wildlife Mitigation and Monitoring (Section E.9.5 and CR#9, Section 7.0) and the Conservation & Reclamation Plan (Section F). The incremental effects of the Project to wildlife populations are small and no significant cumulative effects to wildlife population persistence are predicted (Table CEAA 2-9). Benga is committed to fulfilling their responsibilities to mitigate Project effects throughout the construction, development and reclamation phase and collaboratively participating in any regional initiatives with regulators,

stakeholders (*e.g.*, public, First Nations) and other industry partners to minimize the effects of resource development on wildlife.

Table CEAA 2-9 Summary of Residual Cumulative Effects Ratings for the Planned Development Case

Wildlife VC	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Direction[6]	Confidence Rating[7]	Probability of Occurence[8]	Significance[9]
Change in Habitat Availability									
Olive-sided flycatcher	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not significant
Little brown myotis	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not significant
Grizzly bear	Regional	Long	Continuous	N/A[11]	Low	Positive	High	High	Not significant
Change in Habitat Fragmentation/Connectivity									
Olive-sided flycatcher	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not significant
Little brown myotis	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	High	Not significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	Low	Not significant
Change in Mortality Risk									
Olive-sided flycatcher	Regional	Long	Continuous	Long term	Low	Negative	Moderate	Moderate	Not significant
Little brown myotis	Regional	Short	Occasional	Short term	Low	Negative	Moderate	Low	Not significant
American marten	Regional	Short	Isolated	Short term	Low	Negative	High	Low	Not significant
Canada lynx	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	High	N/A[10]	Not significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neutral	Moderate	Low	Not significant
Change in Abundance									

Table CEAA 2-9 Summary of Residual Cumulative Effects Ratings for the Planned Development Case

Wildlife VC	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Direction[6]	Confidence Rating[7]	Probability of Occurence[8]	Significance[9]
Olive-sided flycatcher	Regional	Long	Continuous	Long term	Low	Negative	Moderate	Moderate	Not significant
Little brown myotis	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not significant
American marten	Regional	Extended	Continuous	Long term	Low	Negative	Moderate	Moderate	Not significant
Canada lynx	Regional	Extended	Continuous	Long term	Low	Negative	High	Moderate	Not significant
Grizzly bear	N/A[10]	N/A[10]	N/A[10]	N/A[10]	Nil	Neural	Moderate	Low	Not significant

[1] Local, Regional, Provincial, National, Global

[2] Short, Long, Extended, Residual

[3] Continuous, Isolated, Periodic, Occasional

[4] Reversible in short term, Reversible in long term, Irreversible – rare

[5] Nil, Low, Moderate, High

[6] Neutral, Positive, Negative

[7] Low, Moderate, High

[8] Low, Moderate, High

[9] Not significant, Significant.

[10] No effects are predicted to occur.

[11] Predicted effects are positive in magnitude

4.5 Follow-Up

The scoping phase of the cumulative effects assessment eliminated any potential cumulative effects to the migratory bird related VCs, therefore no follow-up is required.

Project-specific follow-up and monitoring for the potential effects to the Wildlife VCs is provided in Section A.11.9.2 and CR#9 Section 7.2.

5.0 ABORIGINAL GROUPS CUMULATIVE EFFECTS ASSESSMENT

5.1 Scoping

5.1.1 Identifying Valued Components

The determination of which VCs are included in the assessment is based on input from Aboriginal groups and the residual effects assessment for the Aboriginal VCs and associated VCs. Pursuant to *CEAA 2012*, with respect to Aboriginal peoples, the cumulative effects assessment considers an effect occurring of any change that may be caused to the environment on:

- health and socio-economic conditions (Aboriginal Health and Aboriginal Socio-Economic Conditions VC);
- physical and cultural heritage (Aboriginal Physical and Cultural Heritage VC);
- the current use of lands and resources for traditional purposes (Current Use of Lands and Resources for Traditional Purposes VC); or
- any structure, site or things that is of historical, archaeological, paleontological or architectural significance (Aboriginal Physical and Cultural Heritage VC).

5.1.1.1 Aboriginal Health

The Aboriginal Health VC is scoped out and not carried forward to the cumulative effects assessment because the assessment of the Project effects on the Aboriginal Health VC concludes the Project will not have residual effects on this VC. Further details on this conclusion are provided in Section H – Aboriginal Consultation, Sections H.3 through H.13.

5.1.1.2 Aboriginal Socio-Economic Conditions

The Aboriginal Socio-Economic Conditions VC is scoped out and not carried forward to the cumulative effects assessment because the assessment shows there are no adverse residual effects on this VC. Further details on this conclusion are provided in Sections H.3 through H.13.

5.1.1.3 Aboriginal Physical and Cultural Heritage

The Aboriginal Physical and Cultural Heritage VC has been carried forward in scoping for the cumulative effects assessment because residual effects were identified for this VC for the following Nations: Kainai

Nation (Section H.3.4.4), Piikani Nation (H.4.4.4), Siksika Nation (H.5.4.4), Stoney Nakoda Nation (H.6.4.4), and Tsuut'ina Nation (H.7.4.4).

5.1.1.4 Current Use of Lands and Resources for Traditional Purposes

The Project effects on the Current Use of Lands and Resources for Traditional Purposes VC is carried forward in scoping for the cumulative effects assessment as there were residual effects identified for the following subcomponents: hunting, trapping, fishing, plant gathering, and trails and travel ways (Table CEAA 2-10).

Table CEAA 2-10 Residual Effects to Sub-components of the Current Use of Lands and Resources for Traditional Purposes VC

Aboriginal Group (EIA Section)	Residual Effects of the Project Identified				
	Hunting	Trapping	Fishing	Plant Gathering	Trails and Travel ways
Kainai Nation (H.3)	Yes	No	Yes	Yes	No
Piikani Nation (H.4)	Yes	No	Yes	Yes	Yes
Siksika Nation (H.5)	Yes	No	Yes	Yes	No
Stoney Nakoda Nation (H.6)	Yes	No	Yes	Yes	No
Tsuut'ina Nation (H.7)	Yes	No	No	Yes	No
Ktunaxa Nation (H.8)	No	No	No	No	No
Samson Cree Nation (H.9)	Yes	Yes	Yes	Yes	Yes
Shuswap Indian Band (H.10)	No	No	No	No	No
Foothills Ojibway First Nation (H.11)	No	No	No	No	No
Metis Nation of Alberta Region 3 (H.12)	Yes	No	No	Yes	No
Metis Nation of British Columbia Region 4 (H.13)	No	No	No	No	No

5.1.2 Determining Spatial and Temporal Boundaries

5.1.2.1 Spatial Boundaries

The spatial boundary for the local study area for Aboriginal VCs is the mine permit boundary (MPB), which is the area of direct disturbance by mining activities such as the open pit mine, coal handling and processing plant, overland conveyor and train load-out facility, and associated infrastructure (*e.g.*, rail system, equipment and explosives storage facilities, fueling station, water management structures, construction camp, coal conveyor and powerline, access roads). The RSA for Aboriginal VCs was defined

as the largest extent of potential effects identified in Section D - Methodology, which was for grizzly bears, and thus the RSA for Aboriginal cumulative effects assessment is the GBRSA.

5.1.2.2 Temporal Boundaries

The temporal boundaries for the Aboriginal Peoples cumulative assessment are:

- construction: the overall construction phase of the Project is anticipated to be two years pending all necessary approvals and permits;
- operation: The lifespan of the Project is anticipated to be approximately 24 years following the project initiation; and
- reclamation and closure: progressive reclamation will commence in Year 5 and extend to end of mine (EOM), which is at Year 24 of mine operations. The final closure phase will commence at the EOM and continue up to 41 years from project initiation.

5.1.3 Examining Past, Existing, and Future Physical Activities

To identify the source of potential cumulative effects, other projects or activities have been identified that have been or are likely to be carried out that could cause effects on the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs. Projects and activities listed in Section D Table D.2.4-2 (Table CEAA 2-1 of this document) and in the additional list provided in IR#2 were considered.

The inclusion of a project or activity is based on the following criteria:

1. the project or physical activity has spatial and temporal boundaries which overlap with the largest spatial and temporal boundaries of the Project (Aboriginal VC boundaries as described above); and
2. the project or physical activity could potentially interact with the Current Use of Lands and Resources for Traditional Purposes and/or Aboriginal Physical and Cultural Heritage VCs.

5.1.3.1 Projects or Physical Activities Which Occur within Aboriginal VC Boundaries

Projects or physical activities which overlap spatially and temporally with the Aboriginal VC boundaries are the same as those identified for the VC with the largest spatial boundaries, grizzly bears (Section E.9, Table 6.2-1):

- Teck Coal Baldy Ridge Extension;
- Teck Coal Michel Creek Coking Coal Project;
- Timber Operations (planned and predicted to 2056);
- Alberta Transportation Highway 3 Re-alignment; and
- AltaLink Castle Rock Ridge to Chapel Rock Transmission Project.

As a result, the five projects listed above are carried forward in scoping for the cumulative effects assessment.

5.1.3.2 Project or Physical Activity has a Potential Interaction with an Aboriginal VC

The five projects or physical activities carried forward from Section 4.1.3.1 above were screened for potential interaction with the Aboriginal VCs and sub-components carried forward from Section 4.1.1.

Each of these projects and activities have potential interactions with the above-mentioned VCs due to the identification of potential residual effects (Section 4.1.1) to the VCs and the identification of temporal and spatial overlap with the Project (Section 4.1.3.1). The projects and activities were therefore selected for the cumulative effects assessment of the Hunting, Trapping, Fishing, Plant Gathering, and Trails and Travel ways subcomponents of the Cultural Use of Lands and Resources for Traditional Purposes VC as well as the Aboriginal Physical and Cultural Heritage VC.

5.1.4 Consideration of the Views of Aboriginal Groups

This section describes how the views of Aboriginal groups related to cumulative effects assessment of the Project were considered in the scoping process.

5.1.4.1 Kainai Nation

Kainai Nation raised concerns related to the ability to practice their traditional way of life and exercise their aboriginal and Treaty rights due to Project development. In essence, this concern relates to all Aboriginal VCs described above. Kainai Nation also expressed a concern about direct and indirect effects to water quality imposing a cumulative effect to aquatic life. All Aboriginal VCs were carried through the scoping process as described above and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs were carried forward to the cumulative effects assessment below.

5.1.4.2 Piikani Nation

Piikani Nation raised concerns related to the Aboriginal Physical and Cultural Heritage VC. Piikani Nation also identified deficiencies in the cumulative impact assessment in the August 2016 EIA and asked for a detailed discussion of cumulative effects to all VCs. All Aboriginal VCs were carried through the scoping process as described above and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs were carried forward to the cumulative effects assessment.

5.1.4.3 Stoney Nakoda Nation

Stoney Nakoda Nation expressed the need to consider the South Saskatchewan Regional Plan and requested confirmation that current legislated standards and land use designations apply. The South Saskatchewan Regional Plan was considered for the cumulative effects assessment of Aboriginal VCs but was not included in the scope of cumulative effects assessment as described in the scoping process above.

5.1.4.4 Tsuut'ina Nation

Tsuut'ina Nation commented that the cumulative impact of the project should be considered in the regulatory review both from the perspective of the incremental effect on treaty rights and also in terms of lands available to First Nations for practicing traditional activities in Treaty 7 area. This concern relates to all Aboriginal VCs described above which were carried through the scoping process and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs were carried forward to the cumulative effects assessment below.

5.1.4.5 Siksika Nation

Siksika Nation raised concerns related to the ability to practice their traditional way of life and exercise their aboriginal and Treaty rights due to Project development. This concern relates to all Aboriginal VCs described above which were carried through the scoping process and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs were carried forward to the cumulative effects assessment below.

5.1.4.6 Ktunaxa Nation

Ktunaxa Nation raised concerns about aquatic issues and significant effects on their rights, titles and interests. All Aboriginal VCs were carried through the scoping process as described above and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs was carried forward to the cumulative effects assessment below.

5.1.4.7 Samson Cree Nation

Samson Cree Nation expressed a concern that the alienation of further Crown land would result in an effective infringement to their Aboriginal and Treaty rights. In essence, this concern relates to all Aboriginal VCs described above. All Aboriginal VCs were carried through the scoping process as described above and, subsequently, the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs was carried forward to the cumulative effects assessment below.

5.1.4.8 Other Aboriginal Groups

Shuswap Indian Band, Foothills Ojibway First Nation, Métis Nation of Alberta Region 3, and Métis Nation of British Columbia Region 4 did not raise any issues or concerns related to cumulative effects.

5.2 Analysis

The cumulative effects analysis for Aboriginal VCs involves review of the results of cumulative effects assessments of VCs associated with Aboriginal VCs (Table CEAA 2-11).

Table CEAA 2-11 Aboriginal VCs and Associated VCs

Aboriginal VCs (EIA Section H)		Associated VCs						
		Fish & Aquatic Resources	Vegetation & Wetlands	Wildlife	Land and Resource Use	Historical Resources	Human and Wildlife Health	Socio-Economic
Current Use of Lands and Resources for Traditional Purposes	Hunting			x	x		x	
	Trapping			x	x		x	
	Fishing	x			x		x	
	Plant Gathering		x		x		x	
	Trails and Trailways				x	x		
Physical and Cultural Heritage					x	x		

The cumulative effects assessment then takes into consideration any findings of cumulative effects related to projects or physical activities carried forward from the scoping process for the Project Aboriginal VCs (Section 4.1.3).

The following sections present cumulative effects assessment analyses for the Current Use of Lands for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs.

5.2.1 Current Use of Lands and Resources for Traditional Use

5.2.1.1 Hunting and Trapping

5.2.1.1.1 Associated VCs

5.2.1.1.1.1 Wildlife

The Wildlife VCs relevant to hunting and trapping for traditional purposes include grizzly bear, moose, and elk as these are of interest to Aboriginal groups (Sections H.3 to H.13). The assessment of effects to these VCs resulted in the identification of five projects or activities to be carried forward to a cumulative effects assessment for the grizzly bear VC (CR #9):

- Teck Coal Baldy Ridge Extension;
- Teck Coal Michel Creek Coking Coal Project;
- Timber Operations (planned and predicted to 2056);

- Alberta Transportation Highway 3 Re-alignment; and
- ATCO Castle Rock Ridge to Chapel Rock Transmission Project.

As described in the Wildlife VC cumulative effects assessment, it is unlikely that the incremental effects of the Project to cumulative effects on wildlife habitat availability, fragmentation/connectivity, mortality risk, and abundance would be significant, and no significant cumulative effects to wildlife population persistence are predicted.

5.2.1.1.1.2 Land and Resource Use

The assessment of effects to Land and Resource Use VCs did not identify any projects or activities with potential cumulative effects interactions, as it was determined that the cumulative effects assessment would be the same as for the Application Case and thus a cumulative effects assessment was not conducted (EIA Section E.10.4).

5.2.1.1.1.3 Human and Wildlife Health

The assessment of effects to Human and Wildlife Health VCs did not carry forward any project or activities with potential cumulative effects interactions because the Air Quality Assessment did not identify any planned projects in the area, and thus a Cumulative Effects/PDC was not required, and a cumulative effects assessment was not conducted (CR #12).

5.2.1.1.2 Projects or Physical Activities with Potential Interactions with the VC

None of the projects that are scoped into the cumulative effects assessment for Aboriginal VCs have identified residual effects to hunting and trapping.

5.2.1.2 Fishing

5.2.1.2.1 Associated VCs

5.2.1.2.1.1 Fish & Aquatic Resources

The assessment of effects to Fish & Aquatic Resources VCs did not carry forward any projects or activities to a cumulative effects assessment (Section 3 of this document).

5.2.1.2.1.2 Land and Resource Use

The assessment of effects to Land and Resource Use VCs did not carry forward any projects or activities to a cumulative effects assessment, as it was determined that the cumulative effects assessment would be the same as for the Application Case and thus a cumulative effects assessment was not conducted (Section E.10.4).

5.2.1.2.1.3 Human and Wildlife Health

The assessment of effects to Human and Wildlife Health VCs did not carry forward any project or activities to a cumulative effects assessment because the Air Quality Assessment did not identify any planned projects in the area, and thus a Planned Development Case was not required and a cumulative effects assessment was not conducted (CR #12).

5.2.1.2.2 Projects or Physical Activities with Potential Interactions with the VC

None of the projects that are scoped into the cumulative effects assessment for Aboriginal VCs have identified residual effects to fishing.

5.2.1.3 Plant Gathering

5.2.1.3.1 Associated VCs

5.2.1.3.1.1 Vegetation & Wetlands

The assessment of effects to three of the Vegetation & Wetlands VCs (Terrestrial Vegetation/Plant Communities or Ecosite Phases, Wetlands, and Biodiversity and Fragmentation) resulted in the identification of the following five projects or activities to be carried forward to a cumulative effects assessment (CR #8):

- Teck Coal Baldy Ridge Extension;
- Teck Coal Michel Creek Coking Coal Project;
- Timber Operations (planned and predicted to 2056);
- Alberta Transportation Highway 3 Re-alignment; and
- ATCO Castle Rock Ridge to Chapel Rock Transmission Project.

As described in Section E.8.4, while the Project will result in some loss of traditional use vegetation within the LSA, these losses represent very small proportions of the total amount of these vegetation communities within the RSA. Neither the project-specific residual effects, nor the Project's residual effects acting cumulatively with other projects, are likely to threaten the regional sustainability of traditional use plants or other vegetation resources, wetlands, biodiversity or fragmentation identified in this assessment.

5.2.1.3.1.2 Land and Resource Use

The assessment of effects to Land and Resource Use VCs did not carry forward any projects or activities to a cumulative effects assessment, as it was determined that the cumulative effects assessment would be the same as for the Application Case and thus a cumulative effects assessment was not conducted (Section E.10.4).

5.2.1.3.1.3 Human and Wildlife Health

The assessment of effects to Human and Wildlife Health VCs did not carry forward any project or activities to a cumulative effects assessment because the Air Quality Assessment did not identify any planned projects in the area, and thus a Planned Development Case was not required, and a cumulative effects assessment was not conducted (CR #12).

5.2.1.3.2 Projects or Physical Activities with Potential Interactions with the VC

None of the projects that are scoped into the cumulative effects assessment for Aboriginal VCs have identified residual effects to plant gathering.

5.2.1.4 Trails and Travelways

5.2.1.4.1 Associated VCs

5.2.1.4.1.1 Land and Resource Use

The assessment of effects to Land and Resource Use VCs did not carry forward any projects or activities to a cumulative effects assessment, as it was determined that the cumulative effects assessment would be the same as for the Application Case and thus a cumulative effects assessment was not conducted (Section E.10.4).

5.2.1.4.1.2 Historical Resources

The assessment of effects to Historical Resources VCs did not include the identification of projects or activities to be carried forward to a cumulative effects assessment, (Section E.13.4).

5.2.1.4.2 Projects or Physical Activities with Potential Interactions with the VC

None of the projects that are scoped into the cumulative effects assessment for Aboriginal VCs have identified residual effects to trails and travel ways.

5.2.1.5 Aboriginal Physical and Cultural Heritage

5.2.1.5.1 Associated VCs

5.2.1.5.1.1 Land and Resource Use

The assessment of effects to Land and Resource Use VCs did not carry forward any projects or activities to a cumulative effects assessment, as it was determined that the cumulative effects assessment would be the same as for the Application Case and thus a cumulative effects assessment was not conducted (Section E.10.4).

5.2.1.5.1.2 Historical Resources

The assessment of effects to Historical Resources VCs did not include the identification of projects or activities to be carried forward to a cumulative effects assessment (Section E.13.4).

5.2.1.5.2 Projects or Physical Activities with Potential Interactions with the VC

None of the projects that are scoped into the cumulative effects assessment for Aboriginal VCs have identified residual effects to Aboriginal physical and cultural heritage.

5.3 Results

Approximately one half of the Project footprint is located on privately held land. Combined with other private land ownership in the LSA and challenging terrain, it is unlikely that the Project will contribute to cumulative residual effects on traditional use locations and access routes. Benga has offered to work with affected Aboriginal groups on an Access Management Plan to both control access to authorized persons, and to facilitate access to traditional use locations where feasible.

Neither the project-specific residual effects, nor the Project's residual effects acting cumulatively with other projects are predicted to affect the Current Use of Land and Resources for Traditional Purposes or Aboriginal Physical and Cultural Heritage VCs. Therefore, the Project is unlikely to result in a cumulative adverse effect on the current use of lands and resources for traditional purposes or Aboriginal physical and cultural heritage.

5.4 Mitigation

The cumulative effects assessment did not identify any potential cumulative effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs, and therefore no mitigation is required for cumulative effects.

Project-specific mitigations for potential effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs are provided in Section H.3 to H.13.

5.5 Significance

The cumulative effects assessment did not identify any potential cumulative effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs, and therefore no significance characterization is required.

Project-specific significance findings for potential effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs are provided in Section H.

5.6 Follow-Up

The cumulative effects assessment did not identify any potential cumulative effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs, therefore no follow up is required.

Project-specific follow-up for the potential effects to the Current Use of Lands and Resources for Traditional Purposes and Aboriginal Physical and Cultural Heritage VCs is provided in Section H.

5.7 Consultation Summary – Issues and Concerns Related to Cumulative Effects

The following sections outline the views of First Nations as identified through publicly available documents, traditional use reports and the consultation process for the Project. While there are no cumulative effects predicted to the Aboriginal VCs, the issues raised below have been considered by Benga, and responses to the issues raised by the Aboriginal groups are included below.

5.7.1 Kainai Nation

Kainai Nation identified a potential cumulative effect to hunting due to the project rendering some land inaccessible for that use, and recommended mitigation by avoiding direct and indirect effects to plants and animals to the extent practicable.

> BENGA Response*: During the period of construction and operations, some of the lands will be rendered inaccessible for hunting. Benga will endeavour to minimize the extent of this temporary impact through progressive reclamation beginning as early as 5 years after project initiation. Final reclamation will return lands to a comparable level of productivity, including for lands that are currently disturbed and un-reclaimed from historical mining activities. After reclamation, there will be a net positive effect on habitat availability for moose, elk and grizzly.*

On June 23, 2015, Kainai Nation raised a concern about direct and indirect effects to water quality imposing a cumulative effect to aquatic life related to effects of nearby farming and sewage.

> BENGA Response*: As indicated in Section E.5.4, "Because no significant effects on surface water quality in the LSA and RSA are predicted for the Application Case, none of the effects of the Project on the same water quality variables will have the potential to overlap with potential effects from other planned developments.*

The July 2015 Grassy Mountain Coal Project Public Report on Kainai Nation Traditional Knowledge and Use of the Grassy Mountain Area stated the project will make some land inaccessible for hunting, imposing cumulative effects on Kainai Nation's land base.

> BENGA Response*: During the period of construction and operations, some of the lands will be rendered inaccessible for hunting. Benga will endeavour to minimize the extent of this temporary impact through progressive reclamation beginning as early as 5 years after project initiation. Final reclamation will return lands to a comparable level of productivity, including for lands that are currently disturbed and un-reclaimed*

from historical mining activities. After reclamation, there will be a net positive effect on habitat availability for moose, elk and grizzly.

On December 8, 2017, Kainai Nation submitted an addendum to its original statement of concern regarding the Project which included the following views on Cumulative Effects:

"As noted in our Original Statement of Concern, most of the lands which make up Treaty 7 have already been taken up for development or for other purposes. Given that there are fewer and fewer areas where Kainai can still practice its constitutionally protected Treaty rights, Kainai is becoming increasingly dependent on the few areas that can still support the practice of its Treaty rights. As stated by Kainai member Perry Day Chief:

> "We already have to go so far to hunt and exercise our Treaty rights and now this land is being limited, too. I worry there will soon be nowhere to go and we will have nowhere to exercise our rights. This is our livelihood."

The Project Area is one of the few remaining areas where Kainai members can still go to practice its Treaty rights, as much of the land in and around Grassy Mountain, including the Project Area, has never been developed. As such, Kainai is concerned by the permanent removal of 1520.7 ha of land for the Project. This land includes some of the last remaining areas where Kainai members can go to practice their traditional way of life and exercise their aboriginal and Treaty rights."

BENGA Response*: The response to this concern is similar to those above. The use of the land for a mining project is not permanent as indicated in the statement of concern but rather temporary for the life of the mine. After mining, the land will be reclaimed and will once again be suitable for pursuit of traditional activities.*

5.7.2 Piikani Nation

Piikani Nation conducted a review of the November 2015 EIA, and made the following requests related to cumulative effects assessment:

Piikani Nation requested that Benga:

i) Address what they believed were deficiencies in the cumulative impacts assessment in the upcoming Project Update (the August 2016 EIA), including explicit provision of pre- and post-development ecosite phases and reduction in quality. Piikani Nation identified that this information was critical both for the Project assessment and for discussion of biodiversity offsetting programs.

   BENGA Response*: The requested information was provided in the August 2016 EIA in the conceptual reclamation plan included in Section F*

ii) Commit in agreement to the development of a biodiversity-management plan in collaboration with Piikani Nation and other nations of the Blackfoot Confederacy.

BENGA Response*: An environmental management plan has been outlined in the EIA for the Project. This plan will be developed through the engineering phase and prior to construction in accordance with regulatory requirements. As part of this program development, Benga anticipates consulting with First Nations to obtain input and recommendations. Benga also anticipates developing an environmental stewardship program in collaboration with First Nations to allow for continued traditional monitoring of environmental effects of the Project.*

iii) Piikani Nation requested that Benga provide a cumulative impact assessment describing Project contributions to regional access issues and describing how public or Aboriginal land use would be affected and accommodated throughout the life of the Project.

BENGA Response*: An Access Management Plan is being developed and will incorporate input obtained through workshops with affected First Nations. One of the important purposes of this plan will be to identify regional access issues and ensure that suitable alternate access is available where the Project interferes with current access routes.*

iv) Piikani Nation requested that Benga provide a detailed discussion of how issues and concerns from Aboriginal communities in general, and Piikani Nation specifically, formed:

i) identifying local and regional issues of concern;
ii) the VCs;
iii) the study area boundaries; and
iv) potential Project and cumulative impacts.

Piikani Nation requested that Benga provide the above information for: air quality, visual aesthetics, noise, hydrogeology, hydrology, water quality, aquatic ecology, terrain and soils, vegetation and wetlands, wildlife, land and resource use, historical resources, human health, wildlife health and socio-economics in addition to Aboriginal traditional land use/valued components.

BENGA Response*: The 2016 EIA included the requested discussions in each subject as requested.*

v) Piikani Nation requested that Benga reassess the potential cumulative effects to Piikani Nation, for all applicable VCs.

BENGA Response*: The 2016 EIA included the requested discussions in each subject as requested.*

vi) Piikani Nation requested that Benga provide a cumulative impact assessment for land and resource issues, including access, and describe how public or Aboriginal land use will be affected and accommodated throughout the Project's life.

BENGA Response*: An Access Management Plan is being developed and will incorporate input obtained through workshops with affected First Nations. One of the important purposes of this plan will be to identify regional access issues and ensure that suitable alternate access is available where the Project interferes with current access routes.*

5.7.3 Siksika Nation

Siksika Nation did not identify any potential cumulative effects.

5.7.4 Stoney Nakoda Nation

On January 15, 2015 Stoney Nakoda Nation raised a concern emphasizing the need to consider the South Saskatchewan Regional Plan and wanted confirmation that current legislated standards and land use designations apply to the Grassy Mountain Project.

> BENGA Response*: The South Saskatchewan Regional Land Use Plan has been specifically considered in the EIA.*

5.7.5 Tsuut'ina Nation

Tsuut'ina Nation did not raise any issues or concerns related to potential cumulative effects.

5.7.6 Ktunaxa Nation

In the Teck Baldy Ridge report (Teck Coal Limited, November 2015), it states that considering the overall disturbance of lands and waters within the Elk Valley over time, and considering both quantitative percent disturbance, and more qualitative factors, a threshold of adverse, long term, high magnitude effect on the exercise of Ktunaxa rights in the RSA, as defined in Section C1 is understood to have already been surpassed. Additional residual Project effects, and effects from other reasonably foreseeable developments and changes in the environment, are anticipated to act together into the future. Synergistic, additive, or antagonistic interactions between multiple aquatic impacts are likely and poorly understood.

Based on existing information, and uncertainties related to mitigation and the EVWQP, the KNC anticipates that these cumulative effects will exacerbate already significant effects in the Elk Valley, and on KNC rights, title, and interests, for the foreseeable future.

> BENGA Response*: Benga does not foresee any interaction between the Elk Valley projects and the Grassy Mountain Project with respect to aquatic issues as the affected water systems are not connected. Furthermore, Benga has found that there are no significant impacts from the Grassy Mountain Project on surface water quality. With respect to traditional land use, during the period of construction and operations of the Grassy Mountain Project, some of the lands will be rendered inaccessible for hunting. Benga will endeavour to minimize the extent of this temporary impact through progressive reclamation beginning as early as 5 years after project initiation. Final reclamation will return lands to a comparable level of productivity, including for lands that are currently disturbed and un-reclaimed from historical mining activities. After reclamation, there will be a net positive effect on habitat availability for moose, elk and grizzly.*

5.7.7 Samson Cree Nation

Samson Cree Nation expressed a concern that the alienation of further Crown land would result in an effective infringement to Samson Cree Nation's Aboriginal and Treaty rights.

> BENGA Response: *The concern expressed by the Samson Cree FN is a legal position and does not reflect a concern about cumulative effects of the Grassy Mountain Project.*

5.7.8 Shuswap Indian Band

Shuswap Indian Band did not raise any issues or concerns related to cumulative effects.

5.7.9 Foothills Ojibway First Nation

Foothills Ojibway First Nation did not raise any issues or concerns related to cumulative effects.

5.7.10 Métis Nation of Alberta Region 3

Métis Nation of Alberta Region 3 did not raise any issues or concerns related to cumulative effects.

5.7.11 Métis Nation of British Columbia Region 4

Métis Nation of British Columbia Region 4 did not raise any issues or concerns related to cumulative effects.

6.0 REFERENCES

Alberta Environmental Protection and Enhancement Act. 2000. RSA 2000, c E-12.

Canadian Environmental Assessment Act [CEAA]. 2012. S.C. 2012, c.19, s.52

Alberta Environment. March 2013. Environmental Assessment Program: Guide to Preparing Environmental Impacts Assessment Reports in Alberta.

APPENDIX A-3: SUMMARY OF EFFECTS

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Air Quality														
Air emission general mitigation		Construction and operations		Air emissions will be mitigated though: • regular upgrading of the mine fleet upgraded and by Year 19, equipment will be newer and more efficient than assumed in emission estimation. • Exhaust emissions from the U.S. EPA Tier 4 (2010) standards were used in Project emission estimates and it is likely that off-road standards will be more stringent by Year 19.										
NO2	---	Construction and operations	Human health effects	Mitigation measures for NOx emissions include: • the use of Tier 4 engines in heavy duty mine equipment • Benga will investigate alternative ANFO formulations that reduce NOx emissions during blasting • minimizing diesel consumption through dispatch management	Moderate	Local	Medium	Continuous	Short-term	Negative	High	High	Not Significant	Yes (CR#1 Section 6.3)
SO2	---	Construction and operations	Human health and vegetation effects	Mitigation measures for SO2 emissions include: • use of low-sulphur diesel • minimizing diesel consumption through dispatch management	Moderate	Local	Medium	Continuous	Short-term	Negative	High	High	Not Significant	Yes (CR#1 Section 6.3)
PM2.5	---	Construction and operations	Human health effects and visibility impairment	Particulate matter will be mitigated through: • systemic application of water to haul roads and to the plant access road to minimize dust using a water truck dedicated to this purpose. An emission control efficiency of 80% during the summer months is expected from this measure • retaining snow cover on the road during the winter months, unless the cover would compromise the safety of vehicle operations. Winter ground is frozen and, since the soil and overburden have elevated moisture contents, there is a reduction of dust emissions at that time • gravel or crushed rock will be used on the haul roads. Gravel is observed to produce less dust than clay and sandy surfaces • use of a grader to maintain the active surface of the road. This procedure is expected to reduce the effective silt content of the portion of the road where the wheels of the haul trucks travel. The grader blade would tend to move the silt particles to the inactive portion (side) of the road or cover the active portion with coarser material • mined areas will be reclaimed promptly and backfilled with overburden and soil from pre-strip areas, and then covered by vegetation which reduces windblown fugitive dust emissions from exposed land • trees and bushes will be preserved around mines and plant, because they effectively trap dust emissions from mining activities and reduce dust concentrations farther from mining activities; • the coal processing plant module will be contained within an enclosed area and all coal material handling will be via covered conveyors • dust generation from transferring coal from the conveyor to the stock pile will be minimized by the use of luffing stackers (those that can lower and raise their boom) which will minimize the drop height and drop time of the coal • fugitive dust generation will be minimized at the rail load-out, with full cladding on the sides of the load-out structure to create a wind shelter, and with the movable discharge chute of the bin located as close as practical to the coal within the rail cars	Moderate	Local	Medium	Continuous	Short-term	Negative	Moderate	High	Not Significant	Yes (CR#1 Section 6.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
TSP	---	Construction and operations	Nuisance effects	Same as for PM, with the addition of: • the use of Tier 4 engines in heavy duty mine equipment • minimizing diesel consumption through dispatch management	High	Local	Medium	Continuous	Short-term	Negative	Low	High	Not Significant	Yes (CR#1 Section 6.3)
CO	---	Construction and operations	Human health effects	CO emissions will be mitigated by: • the use of Tier 4 engines in heavy duty mine equipment • minimizing diesel consumption through dispatch management	Moderate	Local	Medium	Continuous	Short-term	Negative	High	High	Not Significant	Yes (CR#1 Section 6.3)
PAI Deposition	---	Construction and operations	Acidification of sensitive soils, water bodies and vegetation	PAI is mitigated by mitigating SO2 and NOx emissions.	Low	Local	Medium	Continuous	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)
Nitrogen Deposition	---	Construction and operations	Eutrophication of sensitive ecosystems	N deposition is mitigated by mitigating NOx emissions.	Low	Local	Medium	Continuous	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)
Particulate Deposition	---	Construction and operations	Nuisance effects	Dust will be mitigated through: • systemic application of water to haul roads and to the plant access road to minimize dust using a water truck dedicated to this purpose. An emission control efficiency of 80% during the summer months is expected from this measure • retaining snow cover on the road during the winter months, unless the cover would compromise the safety of vehicle operations. Winter ground is frozen and, since the soil and overburden have elevated moisture contents, there is a reduction of dust emissions at that time • gravel or crushed rock will be used on the haul roads. Gravel is observed to produce less dust than clay and sandy surfaces • use of a grader to maintain the active surface of the road. This procedure is expected to reduce the effective silt content of the portion of the road where the wheels of the haul trucks travel. The grader blade would tend to move the silt particles to the inactive portion (side) of the road or cover the active portion with coarser material • mined areas will be reclaimed promptly and backfilled with overburden and soil from pre-strip areas, and then covered by vegetation which reduces windblown fugitive dust emissions from exposed land • trees and bushes will be preserved around mines and plant, because they effectively trap dust emissions from mining activities and reduce dust concentrations farther from mining activities • the coal processing plant module will be contained within an enclosed area and all coal material handling will be via covered conveyors • dust generation from transferring coal from the conveyor to the stock pile will be minimized by the use of luffing stackers (those that can lower and raise their boom) which will minimize the drop height and drop time of the coal • fugitive dust generation will be minimized at the rail load-out, with full cladding on the sides of the load-out structure to create a wind shelter, and with the movable discharge chute of the bin located as close as practical to	Moderate	Local	Medium	Continuous	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				the coal within the rail cars										
Ozone	---	Construction and operations	Human health effects	Secondary ozone production is managed by mitigating precursor emissions including NOx.	Low	Regional	Medium	Continuous	Short-term	Negative	High	High	Not Significant	Yes (CR#1 Section 6.3)
VOC, PAH, Metals	---	Construction and operations	Human health effects	Predicted concentrations of all VOCs, PAHs and metals were less than AAAQOs at and beyond the MPB in Baseline and Application cases. VOCs, metals, and PAHs are mitigated through: • minimizing diesel consumption through dispatch management • use of Tier 4 engines • investigating use of electric shovels Metals are also mitigated using the same techniques as managing TSP and PM2.5 emissions.	Low	Local	Medium	Continuous	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)
Odour	---	Construction and operations	Nuisance effects	The Project did not change predicted odour frequencies in the community, but added a new location with detectable odour on the MPB. Odour mitigation is managed through mitigation of NOx emissions.	High	Local	Medium	Continuous	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)
Greenhouse Gas	---	Construction and operations	Potential ecological effects	GHG emissions will be mitigated by: • minimizing diesel consumption through dispatch management • investigating use of lower GHG-intensity power sources • investigating sources of low-carbon diesel • investigating using electric shovels GHG sink losses are addressed by: • amending soil with woody debris or fertilizing and revegetating stockpiled soil • prompt reclamation and reforestation of the project disturbance and the historical mine disturbance • minimizing lifetime of soil stockpiles	Low	Regional	Long	Continuous	Long-term	Negative	Moderate	Medium	Not Significant	Yes (CR#1 Section 6.3)
Lighting	---	Construction and operations	Nuisance effects	Effects from Project lighting will be mitigated with the following measures: • use of low visibility spectrum lights on CHPP and rail loadout structures • use of low visibility spectrum lights in light stands, designed with directional shades to minimize illumination above the lights horizontal line and to direct light to the illuminated feature (e.g., the waste disposal area) • implementation of an on-demand and adaptive light management strategy (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during night time hours • where possible, minimize the amount of train loading during night time hours • light-duty vehicles along the access road will be kept to a minimum • the overland conveyor system will not be equipped with any additional lighting structures, as lighting would be provided by the associated access road lights • existing vegetation (mature trees) will not be cleared along areas requiring night-time illumination to reduce total viewshed	Low	Local	Medium	Periodic (night time)	Long-term	Negative	Moderate	High	Not Significant	Yes (CR#1 Section 6.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• mobile lighting set ups on the waste rock disposal area(s) would only be used when needed, and will be equipped with low visibility spectrum lights • mobile lighting set ups would be positioned (where possible) at the base of existing high points (such as the noise mitigation berm) to reduce their associated viewshed										
Noise														
Ambient noise	---	Construction and operations	Nuisance effects	Noise effects will be mitigated through: • routing the haul trucks (conveying waste rock and coal) along the western slope of the south disposal area such that the south disposal area itself provides noise shielding between the operating equipment and the residential receptors to the east • installing and maintaining a 15 m tall earthen berm along the eastern edge of the south disposal area. The earthen berm will be constructed and maintained during the day-time (when required) and the 15 m earthen berm will increase in overall elevation as the height of the south disposal area increases • blasting will occur only on weekdays during typical day-time hours; • minimizing blasting during cloud cover • limiting blasting to smaller more localized blasts, which reduces the amount of explosives used at any one time. • if, during active operations at the mine, concerns are raised by local residents, specific noise mitigation measures can be put in place (e.g., flashing light instead of backup alarm at night, directional backup alarms).	Moderate	Local	Long	Continuous	Short-tern	Negative	Moderate	Medium	Not Significant	Yes (Section E.2.4)
Hydrogeology														
Bedrock aquifers	---	Pit dewatering	Reduced water quantity	Effects to bedrock aquifers are predicted to be localized such that no mitigation measures are required. No impacts are predicted at the water wells; therefore, no mitigation is proposed.	Low	Local	Residual	Continuous	Irreversible	Negative	Moderate	High	Not Significant	Yes (CR#3, Section6.0)
	---	Mining operations	Reduced water quality		Low	Local	Long	Continuous	Long-term	Negative	Moderate	Medium	Not Significant	Yes (CR#3, Section 6.0)
	---	Surface facilities (operations)	Reduced water quality		Moderate	Local	Long	Occasional	Short-term	Negative	Moderate	Medium	Not Significant	Yes (CR#3, Section 6.0)
Discharge to surface water bodies	---	Pit dewatering	Reduced water quantity	Specific to watercourses' base flow reduction, effect assessment and mitigation options are discussed in the Hydrology, Surface Water Quality, and Aquatics Resources reports (CR #4, CR #5, Addendum CR #6, respectively).	Impacts presented in Hydrology and Surface Water Quality sections.									
	---	Mining operations	Reduced water quality											
Water wells	---	Pit dewatering	Reduced water quantity	Effects on water well water quality and quantity will be mitigated as followed: • mitigation measures on the effect of mine spoil on groundwater quality will include the development of a management plan as described in Sec. C and CR # 5.	Nil	Local	N/A	N/A	N/A	Neutral	High	Low	Not Significant	Yes (CR#3, Section 6.0)
	---	Mining operations	Reduced water quality		Nil	Local	N/A	N/A	N/A	Neutral	High	Low	Not Significant	Yes (CR#3, Section6.0)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• mitigation measures for minimizing or preventing adverse impacts on shallow groundwater quality include industry-standard operating practices, preparedness for upset conditions and the appropriate management of upset conditions.										
Hydrology														
Blairmore Creek streamflow	---	Operations, post-closure	Potential effects on high, average and low flows	Effects on flows will be mitigated though: • ensuring the coal handling and processing plant facilities will be aligned in such a way to minimize drainage diversions and runoff interception (*e.g.*, maintain natural vegetated buffers between active mine areas and undisturbed streams) • designing settling ponds according to the latest sizing methodology (1:10 year storm event and safely convey up to the 1:100 year flood event) • designing and constructing any potential watercourse crossings to meet or exceed the regulatory requirements for approval under the provincial *Water Act* • constructing clear span crossings over all watercourses identified as potential fish bearing streams • using appropriately sized culverts, as required, to maintain drainage along non-fish bearing headwater tributaries and/or ephemeral drainage draws • incorporating flow, such as ditch check structures	Low to Moderate	Local	Long	Continuous	Irreversible	Positive	Moderate	High	Not Significant	Yes (CR#4, Section 6.0)
Gold Creek streamflow	---	Operations, post-closure	Potential effects on high, average and low flows	Mitigation consists of: • measures outlined above for Blairmore Creek • routing of water from the End Pit Lake to the creek when it has filled	Low	Local	Long	Continuous	Irreversible	Negative	Moderate	High	Not Significant	Yes (CR#4, Section 6.0)
Blairmore Creek and Gold Creek sediment concentration	---	Operations, post-closure	Potential increase in sediment concentration	Increased sediment concentration in surface water will be mitigated by: • installing haul road berms to contain road runoff and direct it to designated runoff control works • incorporating erosion control measures, such as natural depressions or low areas to trap sediment, silt fences or exfiltration ditches in small, low gradient areas adjacent to soil and stockpiles areas • directing runoff from active mining areas, roads, and topsoil stockpiles to the water management sedimentation ponds for removal of suspended solids • maintain a 100 m minimum setback from the main stems of Blairmore Creek and Gold Creek, and a 30 m setback from associated headwater tributaries; • training personnel to minimize disturbances and use and maintain drainage and sediment controls	Low	Local	Long	Periodic	Short term	Positive/ Negative	Low	High	Not Significant	Yes (CR#4, Section 6.0)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Surface Water Quality														
Released process water	---	Construction, operations, closure, and post-closure	Increased turbidity, acid rock drainage, leaching, metals	A series of collection ditches, sumps, pumps and settling ponds will be established to manage all surface water on the mine site. A total of five settling ponds are proposed to treat total suspended solids and associated constituents in the water before release of water to the environment. Surface water runoff from mining areas, haul roads, overburden disposal areas and any other disturbed areas as well as groundwater runoff from the pit will be collected and directed to settling ponds for treatment and or will be pumped to the raw water pond for storage and use in the coal cleaning process. Once suspended solids are settled, water will be released to Blairmore Creek and Gold Creek. Slope grading and stabilization techniques will be adopted. Slopes will be contoured to produce moderate slope angles to reduce erosion risk. Other stabilization techniques used to control erosion include: ditching above the cutslope to channel surface runoff away from the cutslope, leaving buffer (vegetation) strips between the construction site and a watercourse, and placing large rock rip rap to stabilize slopes. Mitigations to reduce effects from erosion/sedimentation include: • construction techniques will be employed that protect the integrity of the streams as well as the quality of water • where necessary, interim erosion/sediment control measures will be utilized until long-term protection can be effectively implemented • progressive reclamation to reduce the amount of disturbed area at any given time. During reclamation, permanent plant cover and revegetation will be established. Soil erosion will be reduced by minimizing the time that reclaimed surfaces are left bare • temporary measures to control erosion before vegetation cover is re-established, including: diversion ditches, drainage control, check dams, sediment ponds, sumps, and mulches • whenever possible, construction activities in close proximity to watercourses will be carried out during periods of lowest potential impact, typically during the winter months. A 100 m undisturbed buffer zone, maintaining existing vegetation, strip will be left between development activities and Blairmore Creek to the west and Gold Creek to the east • the design and construction of all stream crossings will be done in compliance with the Alberta Code of Practice for Watercourse Crossings and associated guidelines. This means that all stream crossings constructed by the Project will meet regulatory requirements for protection of fish resources and aquatic habitat, which also will effectively mitigate against effects on surface water quality Selenium-specific mitigations include: • implementing a water management plan to address selenium management and augmentation of potentially impacted tributaries for the Project • utilizing saturated backfill to remove selenium from enriched waters	Low / Moderate (sulphate)	Local	Short / Residual (sulphate)	Occasional	Short-term / Irreversible (sulphate)	Neutral/ Negative (sulphate in Blairmore Creek) [2]	Moderate	---[3]	Not Significant	Yes (CR#5, Section 4.1.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• directing runoff from the north and south waste rock disposal areas to the surge ponds for selenium treatment • implementing specific mitigation measures to attenuate selenium concentrations in process water before release to the receiving environment (discussed further in CR #5)									
Nitrogen-based explosives	---	Blasting during mine operations	Higher concentrations of ammonia, nitrite and nitrate	Nitrogen-specific mitigation includes: • implementing specific mitigation measures to attenuate nitrite and nitrate concentrations in process water before release to the receiving environment (discussed further in CR #5) • surge ponds will receive all potentially mine-affected water draining from external rock-disposal areas. From there, water will be directed to the various anaerobic saturated zones for treatment.	Low	Local	Short	Low	Short-term	Negative[5]	High	High	Not Significant	Yes (CR#5, Section 4.2.3)
Accidental leaks and spills	---	Construction and operations	Elevated concentrations of hydrocarbons, chemicals and waste products	Spill mitigation includes: • the Project will incorporate design features, management practices and mitigation plans to minimize the potential for spills that might adversely affect surface water quality. Appropriate design features (*e.g.*, berms and containment areas around potential sources), best management practices and emergency spill response plan will be followed • spills of produced water or other potentially hazardous substances will be cleaned up according to emergency response procedures and regulations (Section C.7). Leaks and spills will be reported to AER and AEP as required and cleaned up in a timely manner	Moderate	Local	Short	Low	Short-term	Negative[5]	High	Medium	Not Significant	Yes (CR#5, 4.3.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Domestic wastewater	---	Construction, operations and closure	Elevated concentrations of nutrients resulting in increased primary productivity and oxygen depletion	Mitigations include: • domestic wastewater will be collected in storage tanks and transferred to the wastewater treatment facility • facility sewage will be collected and treated in a sewage treatment package plant located on the MIA pad (Section C.6.13). Treated effluent will be tested to ensure that its quality meets or exceeds the limits for treated wastewater discharge as be specified in the EPEA approval	Low	Local	Short	Low	Short-term	Negative[5]	High	Medium	Not Significant	Yes (CR#5, Section 4.4.3)
Acidification and air emissions	---	Construction and operations	Increase in acidity	Effects from acid-generating materials will be mitigated by: • during operations, neutralizing the acid-generating material by blending with non-acid generating materials or sub-aqueous disposal will be performed (Section C.8.3.2) • during mine closure, all acid-generating pit walls will be actively managed by blending with non-acid-generating materials Expected acid deposition due to Project air emissions is less than the monitoring level for moderately sensitive ecosystems; therefore, acidification effects are not expected to occur from aerial emissions of the Project and no mitigations are required.	Low	Local	Medium	Continuous	Short-term	Negative[5]	Moderate	Medium	Not Significant	Yes (CR#5, Section 4.5.2)
Aquatic Resources														
Fish - westslope cutthroat trout	**CEAA 5(1)(a)(i) 5(1)(a)(ii) / SARA 79**	Construction, operations and closure Construction, operations and closure	Changes to habitat	Effects on westslope cutthroat trout habitat loss will be mitigated through the following measures: • size of the Project's physical footprint has been minimized through proactive mine design • existing infrastructure, rather than new infrastructure, will be used or upgraded where feasible and sustainable • separate Fisheries Act Authorizations and/or SARA Approval, will be obtained prior to construction • Project footprint will be minimized to the extent possible through storing of waste rock in existing disturbed locations and making best use of existing facilities, including through backfilling mined-out pits • offsetting measures will be implemented to counterbalance any permanent loss of fish habitat where serious harm to fish and fish (critical) habitat cannot be avoided	Moderate	Local	Long	Continuous	Reversible in long-term	Positive (with application of mitigation and offsetting)	Moderate	High	Not Significant	Yes (CR#6, Section 4.4)
			Changes in flow regime within LSA	Effects on westslope cutthroat trout habitat alteration will be mitigated through the following measures: • offsetting measures will be implemented to counterbalance any permanent alteration to, or destruction of, fish (critical) habitat, where serious harm cannot be avoided • water will be pumped to the upper reaches of Gold Creek (above Caudron Creek confluence) to mitigate potential incremental reductions in flows in Gold Creek during low flow periods (e.g. 1:10, 1:20) during operations, as deemed necessary • monitoring of groundwater-surface water interactions and contributions to	Moderate	Local	Extended	Continuous	Reversible in Long-term	Positive (with application of mitigation and offsetting)	Moderate	High	Not Significant	Yes (CR#6, Section 4.4)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				Gold Creek as on-site water management features are implemented										
			Changes in flow regime within RSA	Same as above for LSA changes	Low	Regional	Short	Continuous	Reversible in short-term	Neutral	High	High	Not Significant	Yes (CR#6, Section 4.4)
Terrain & Soils														
Soil Quality (Soil profile disturbance)	---	Construction, operations and closure	Reduced soil quality	Mitigations to reduce the extent and severity of surface disturbance include: • upland surface soil and sufficient subsoil and suitable overburden materials (coversoil) will be salvaged using best management practices. Supervision of salvage operations, stockpiling, and placement of materials during reclamation (including direct placement) by qualified individuals is recommended • soil handling activities should be suspended under wet or windy conditions when the degradation of soil quality is a potential; • organic soil material will be salvaged for later use in reclamation • placement of coversoil material will require that it is stored in a manner to minimize material loss or degradation of quality and located in areas that are accessible and retrievable • varying thicknesses of coversoil will be replaced, with a target of 20 cm average thickness, to assist in creating diversity in the reclaimed landscapes • decompaction of the replaced materials will be done; • all reclaimed lands will be initially vegetated using a cover crop upon completion of soil placement to minimize soil loss via erosion	Moderate	Local	Extended	Continuous, diminish with time	Long-term	Initially – Negative; Over time - Neutral	High	High	Not Significant	Yes (CR #7 Section 7.1)
Soil Quality (Erosion)	---	Construction, operations and closure	Soil loss	Mitigations to reduce wind and water erosion potential include: • when stockpiling reclamation material, piles will be placed in strategic locations, to minimize exposure to wind or water • stockpiles will be seeded with a non-invasive and weed free seed mix that establishes quickly • erosion control materials (mats, netting, mulches, straw) will be used to reduce soil surface exposure, as required • reclaimed landscapes will be reseeded with a quick establishing; non-invasive cover crop to minimize the length of time bare soil is exposed to potential wind and water erosion. In addition, reclaimed landscapes that have a moderate to high water erosion risk (i.e., steep side slopes) will have soil stabilizers or other measures implemented (where necessary) to minimize the potential of erosion (i.e., rough mounding, check bales, silt fences, tackifiers, and/or mulch).	Initially - Moderate, Low - with veg. establishment	Local	Short	Occasional (unplanned)	Irreversible	Negative	Moderate	Initially High decreasing to Low	Not Significant	Yes (CR #7 Section 7.1)
Soil Quality (Accidental releases)	---	Construction, operations and closure	Soil loss or degradation of soil quality	To mitigate and/or minimize the potential for accidental releases of operational-related chemicals, liquids, or solids: • proper handling and containment of these substances will be implemented. • containment and waste storage facilities and processes will be based on regulatory requirements and a spill response plan implemented by Benga to address the various operating processes required for the Project. In the Project Application, Section C.7, detailed spill response, pollution	Low	Local	Long	Occasional (unplanned)	Short-term	Neutral	High	Medium to Low	Not Significant	Yes (CR #7 Section 7.1)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				prevention and waste disposal plans for the Project are provided.										
Soil biodiversity & ecological integrity	---	Construction, operations and closure	Reduced soil biodiversity & ecological integrity	Effects will be mitigated by progressive reclamation that includes: • appropriate soil salvage and replacement (see mitigations for soil profile disturbance, above) • site re-contouring (see mitigations for impacts to terrain, below) • revegetation for establishing target end land uses	Low	Local	Extended – diminish with time	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR #7 Section 7.2)
Alteration of terrain	---	Construction, operations and closure	Removal of natural terrain types	Impacts to terrain will be mitigated through: • appropriate re-contouring of reclaimed landscapes to provide topography and surface forms that provide appropriate surface drainage, blend with the adjacent undisturbed terrain (i.e., drainage, aspect), remain stable, provide suitable habitat for the formation of diverse reclaimed soil and vegetation patterns in the reclaimed landscape, and meet the desired end land use objectives. In instances where the reclaimed landscape is expected to differ from the original terrain type (i.e., end pit lake or wetland), the landscape will be designed to ensure that end land use objectives are met. • a reclamation plan that includes the development of various ecosystem features (wetlands, surface drain ways (swales), and end pit lakes that will function as wetlands) to ensure that a range of diverse terrain and terrain features are created post development. Final re-contouring of depleted mine blocks and appropriate soil replacement will create soil landscape patterns appropriate for the desired end land uses. The landscapes will provide surface water drainage to ensure water movement across disturbed lands, provide surface runoff for constructed wetlands and end pit lakes, as well as establishment of ecosystem patterns appropriate for desired end land uses.	Moderate	Local	Residual	Continuous	Irreversible	Neutral	High	High	Not Significant	Yes (CR #7 Section 7.3)
Land Capability Effects (Reclaimed overburden materials)	---	Construction, operations and closure	Increased time to equivalent land capability	Effects to reclaimed overburden materials will be mitigated through: • implementing appropriate soil salvage activities such that sufficient volumes of reclamation material are salvaged for placement • sufficient suitable overburden material will be available for placement over unsuitable overburden • upon backfilling and re-contouring of mine blocks, unsuitable overburden will be identified to ensure that sufficient reclamation material is replaced to meet regulatory requirements over all reclaimed lands Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. Benga will: • reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement • utilize best management practices currently used in the industry as well as adaptive management to promote effective reclamation practices	Low	Local	Residual	Continuous, diminish with time	Long-term	Neutral	High	Low	Not Significant	Yes (CR #7 Section 7.4)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Land capability Effects	---	Construction, operations and closure	Altered land capability distribution and delay in achieving equivalent land capability	Effects will be mitigated with a C&R Plan (Section F) that will result in reclaimed landscapes providing a range of capabilities that will be spatially unique to pre-disturbance conditions Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. Benga will: • reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement • utilize best management practices currently used in the industry as well as adaptive management to promote effective reclamation practices	Moderate	Local	Extended – diminish with time	Continuous	Irreversible	Neutral	High	High	Not Significant	Yes (CR #7 Section 7.4)
Vegetation														
Terrestrial vegetation	---	Construction, operations and closure	Potential reduction in plant community types and area	Terrestrial vegetation mitigation measures will include: • implementation of a re-vegetation program which aims at the establishment of target vegetation with equivalent capability • develop a reclamation plan that includes the establishment of communities that are locally and regionally limited in distribution where conditions allow • preservation of adjacent vegetation communities by limiting disturbance to areas required for development of the Project; • use of an appropriate soil substrate where re-vegetated areas can establish • seed coversoil stockpiles with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment • the use of coarse woody debris and direct soil placement techniques • the use of direct placement of soil for provision of propagules to enhance opportunity for re- establishment of native species composition and enhanced species richness • implement a weed management and control program • incorporate traditional use plants into the reclamation program • establish multiple layers of native vegetation (e.g., trees, shrubs and graminoids) to provide initial structure for wildlife habitat and to enhance biodiversity	High	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8 Section 4.1)
Rare plants	---	Construction, operations and closure	Removal of rare plant potential	Effects on rare plant potential will be mitigated through measures implemented to also mitigate for effects on: • terrestrial vegetation (above) • biodiversity (below) • wetlands (below) • forest resources (below) • rangeland resources (below) • rare plants (below)	High	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8, Section 4.2)
			Removal of rare plants	The Fescue Grassland Community Mitigation Plan (CR #8 Section 4.3.4.1) includes the following mitigations: • minimize overall project disturbance and avoid fescue where possible • identify potential areas on hill crests and southern aspects suitable for re-establishment of native fescue grasslands	High	Local	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#8, Section 4,2)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• direct reclamation material placement from grassland areas, when opportunities exist • collect native foothills rough fescue seed from across the site • use wild harvested certified weed-free native seed as a monoculture and as part of a certified, weed-free native seed mix; • seed and grow foothills rough fescue plugs in a greenhouse for transplanting onto reclaimed areas of the site; • promote seeding of foothills rough fescue on the rough areas of the golf course to increase overall distribution of fescue grasslands									
	SARA 79		Removal of whitebark (and limber pine)	The Whitebark Pine and Limber Pine Mitigation Plans (CR #8 Section 4.2.6.3) include the following mitigations: • minimizing the Project footprint to avoid populations of whitebark pine where possible • adhering to the mitigation approaches outlined in the Alberta Whitebark Pine Recovery Plan • introducing white pine blister rust resistant strains during reclamation phases • conserving genetic diversity, by collecting cones from whitebark pine trees within the disturbance Footprint that are healthy and free of disease after harvesting is completed. The cones will be provided to a greenhouse and seed will be extracted and stored until needed for the reclamation program • planting according to the following strategies: • identification of high light, low competition sites; • planting in pure stands or patches to avoid competition from other trees • avoidance of potential swales and frost pockets • creation of microsites for seedling establishment (rocks, stumps or other coarse woody debris) • use of recommended spacing to avoid interspecies competition •preferentially planting seedlings in the fall to avoid hot dry summer conditions.	High	Local	Extended	Continuous	Long-term	Positive (neutral)	High	High	Not Significant	Yes (CR#8, Section 4.2)
Rangeland resources	---	Construction, operations and closure	Removal of rangelands	Effects on rangeland resources will be mitigated with the Fescue Grassland Community Mitigation Plan (provided above for rare plant mitigation)	High	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8, Section 4.3)
Forest resources	---	Construction, operations and closure	Removal of forested stands	Mitigation for effects on forest resources includes: • salvaging merchantable timber, both coniferous and deciduous • collecting locally available cones and seed for future reforestation programs • planting seedlings on areas where reclamation and revegetation have been completed.	Low	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8, Section 4.4)
Old growth forests	---	Construction, operations and closure	Removal of old growth forests	Mitigation for effects on old growth forest will include: • reclamation using tree species capable of achieving of old growth conditions with equivalent capabilities prior to development • preserving adjacent vegetation communities by minimizing the area required for construction and operation of the Project.	Low	Local	Extended	Continuous	Long-term	Positive	High	High	Not Significant	Yes (CR#8, Section 4.5)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Traditionally use plants	---	Construction, operations and closure	Removal of TEK species	Mitigation measures for TEK vegetation will include: • on-going consultation with Aboriginal Groups for designing mitigation measures for sustainable management of TEK vegetation • implementing a re-vegetation program that will aim at re-establishing vegetation communities that are common to the pre-disturbed landscape and that will support TEK vegetation • implementing a re-vegetation program that includes native vegetation species and does not include agronomic invasive species • providing opportunities to identify and collect suitable lodgepole pine for traditional use ceremonies • re-vegetate with locally collected seed to preserve the legacy of species and of place, where practicable	High	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8, Section 4.6)
Wetlands	---	Construction, operations and closure	Reduced types and area	Wetland mitigation measures will include: • using wetland construction best practices to maintain the hydrologic regime of mineral soil wetlands • creating transition areas between re-vegetated ecological units to the treed swamps • re-vegetating appropriate depression wetland areas to mineral soil wetlands, where possible • re-vegetating mineral soil wetlands with wetland riparian, emergent, and submergent vegetation species • during construction, salvage and store wetland soil and propagule materials from existing (baseline) wetlands within the Footprint for replacement during wetland reclamation and reconstruction activities • directly place wetland soil materials (soils and propagules) from adjacent wetlands, to provide a soil substrate with a propagule source for wetlands • placing culverts within wetlands that may be divided by roads, to enable water flow between wetlands, where applicable	Moderate	Local	Extended	Continuous	Long-term	Positive	High	High	Not Significant	Yes (CR#8, Section 4.7)
Biodiversity	---	Construction, operations and closure	Reduction inspecies diversity	Mitigation measures for biodiversity will include: • direct placement of soil salvaged (with propagules) from new mining areas as much as is practicable • re-establishing native species by planting native trees, native shrubs, and native graminoids to provide structural diversity, wildlife habitat. and wildlife browse • implementing an adaptive re-vegetation strategy to take advantage of opportunities present on the re-contoured lands for establishment of a variety of target vegetation communities and wetlands as outlined in the reclamation plan or other vegetation communities that may become more appropriate with knowledge gained from adaptive management	Moderate	Local	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#8 Section 4.8)
			Reduction incommunity diversity		High	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#8 Section 4.8)
			Reduction in landscape diversity		Moderate	Regional	Residual	Continuous	Irreversible	Positive	High	High	Not Significant	Yes (CR#8 Section 4.8)
Noxious vegetation	---	Construction, operations and closure	Spread of invasive and noxious species	Mitigation measures to prevent/minimize the spread of noxious and invasive species will include: • controlling noxious weed populations identified during baseline field sampling (hand-pulling, cultivation, and/or spot-spraying of herbicide) prior to site disturbance and mine operation • conducting ongoing inspections during each growing season to identify the presence of noxious weeds, throughout the lifetime of the Project • minimizing areas of bare ground during Project construction and operation	Low	Local	Extended	Periodic	Long-term	Neutral	High	High	Not Significant	No

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• promptly reclaiming and re-vegetating bare ground upon completion of mining • using a non-invasive certified seed mix for erosion control, and using approved re-vegetation species that are compatible with the target vegetation communities • implementing a noxious and invasive species control program prior to and during construction and operation of the Project, and during reclamation phases • cleaning equipment arriving from offsite to remove soil and vegetative material before accessing the Project • using recommended re-vegetation techniques and species that will limit the establishment and spread of noxious and invasive species during reclamation										
Potential acid input and nitrogen deposition	---	Construction and operations	Potential acid input and nitrogen deposition	No mitigation measures are thought to be necessary for PAI and nitrogen deposition.	Low	Local	Extended	Continuous	Long-term	Neutral	Moderate	High	Not Significant	Yes (CR#8, Section 4.10)
Wildlife														
Wildlife General Mitigation		Construction and operations	Reduced habitat availability	Effects on wildlife habitat will mitigated with the following measures: • a C&R Plan that aims to establish suitable wildlife habitat • avoiding habitat destruction and alteration outside of the defined Project footprint to the best extent possible • pre-disturbance surveys will be conducted along the edges of all areas to be cleared during Project development to determine the occurrence of any important wildlife habitat features • in areas of suitable wildlife habitat (on the edge of the Project footprint boundary) appropriate setback distances (or buffer zones) will be considered • clearing and equipment use/storage/cleaning in undisturbed areas within and adjacent to the Project footprint will be avoided • where appropriate, vegetated buffer zones (100 m or minimum of 30 m; pending topography constraints) will be maintained between Project infrastructure and wetlands, creeks, and streams to the best extent possible • retain slash and large woody debris in the salvaged soil to provide microsites for perches for migratory birds • ensuring reclaimed areas promote the re-establishment of woody species and are on a trajectory for reforestation • minimizing loss of mature and old-growth forest habitat and avoid complex, multi-story mixedwood forest where possible Sensory disturbances that may reduce habitat quality and effective habitat quantity will be mitigated by: • vegetation adjacent to high-activity linear corridors (*e.g.*, access roads, coal conveyor) will be retained to reduce the extent of noise and visual sensory disturbances to the extent possible •Benga has developed a visual impact mitigation plan that reduces stray and non-essential artificial lighting to minimize wildlife effects and that will comply with OH&S safety requirements • to mitigate the potential effects of sensory disturbance (acoustic and visual) on effective habitat availability in the southeast portion of the Gold Creek valley, Benga will install and maintain a 15-m tall earth berm along the eastern edge of the south disposal area • noise mitigation (see Noise CR #2a)										
			Reduced movement ability	Measures to mitigate effects on wildlife movement include: • a minimum of six wildlife crossings (underpasses and overpasses) will be incorporated into the design of the coal conveyor (the conveyor route is approximately 5.4 km in length); • where appropriate, vegetated buffer zones (100 m or minimum of 30 m; pending topography constraints) will be maintained between Project infrastructure and wetlands, creeks, and streams to the best extent possible; • surface water management ponds and ditches located in undisturbed areas of the Project footprint will be designed to allow wildlife to move around or cross safely; • road plowing and grading will be conducted in a manner that does not restrict wildlife from crossing access roads or accessing wildlife crossings • a C&R Plan that aims to establish suitable wildlife habitat, including: • minimize the overall disturbance footprint through the mine planning process • preserve remnant forest patches in the development areas to provide essential habitat, habitat connectivity, and hide cover for wildlife species • retain slash and large woody debris in the replaced soil landscape • plant native shrubs early in the reclamation process to initiate hiding cover										

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• establish mixed wood forest stands and high density coniferous tree stands • provide understory complexity in the reclaimed forests by planting native shrubs such as alder and willow to provide security cover for the carnivores and their prey • maximize the amount of ungulate habitat; • prior to final reclamation, disrupt linear disturbances and sight lines by mounding surface soils, piling brush limit sight lines by maintaining mature forest stands or by planting high density coniferous stands to act as buffers between roads, project disturbance boundaries and the reclaimed mine areas										
			Increased mortality	Mitigations for effects on wildlife mortality risk include: • timing vegetation site clearing activities are to occur outside the April 15 to August 31 period to avoid disrupting nesting migratory and resident songbirds and raptors • in the event that vegetation clearing must occur within the restricted activity period, pre-disturbance nesting surveys will be conducted by experienced avian biologists according to established sensitive species inventory guidelines (Government of Alberta 2013b) • surface water management ponds and ditches located in undisturbed areas of the Project footprint will be designed to allow wildlife to move around or cross safely • retaining slash and large woody debris in the salvaged soil to provide hide cover • all access to the Mine Permit will be controlled; no uncontrolled access will be permitted. Common operational practices will include: prohibiting use of snowmobiles and ATVs; prohibiting hunting, harassment, or feeding of wildlife; and implementing a strictly enforced zero tolerance policy on the use of firearms; • design water management ponds and drainage ditches, and pit lakes to minimize potential entrapment of wildlife • bird collisions with buildings will be mitigated by placing visual markers on windows, and collisions with the proposed power line will be mitigated by installing large 'floats' or other markers • enforce speed limits (≤50 km/hr) along the main access road and utility corridors, and place signs at identified wildlife crossings to increase driver diligence to minimize wildlife-vehicle collisions. Vehicles will yield to all wildlife crossing the main access road. • a detailed Waste Management Plan will be developed and implemented prior to construction and operational activities to minimize the attraction of wildlife. Benga will follow the Best Management Practices for camps, fences, and barriers as described in Bear Smart: Best Management Practices for Camps (ASRD 2011), and ensure all waste is stored in wildlife-proof containers and disposed of properly. • implementing an Emergency Spill Response Plan to limit the effect of accidental spills. Spills will be minimized by restricting fuel storage and filling to designated areas that are at least 100 m from wetlands and watercourses as well as Project drainage ditches, sediment control ponds, and pit lakes. • storing all hazardous materials, including those used for blasting, in secure areas that are inaccessible to wildlife (e.g. buildings, storage areas surrounded by wildlife-proof fencing). In addition, proper handling and storage of industrial materials and debris within the Project footprint will be maintained to minimize potential risks to wildlife. • developing procedures to clear blasting areas of large mammals or birds prior to blasting. • developing a strategy to minimize changes in water quality upstream of the mine in conjunction with a water-quality monitoring program.										
			Reduced abundance	Effects on wildlife abundance are mitigated through the measures implemented to mitigate habitat loss, movement, and mortality risk (above).										
Columbia spotted frog / Western toad	---	Construction and operations	Reduced habitat availability	In addition to mitigations for wildlife in general (above), mitigations for effects on Columbia spotted frog and western toad include: • conducting monitoring to identify other habitable ponds and to identify habitat requirements and constraints • constructing trial breeding ponds • reclaiming upland habitat adjacent to reconstructed breeding ponds	Low	Local	Long	Continuous	Long-term	Negative	Moderate	High	Not Significant	Yes[4]
			Reduced movement ability		Low	Local	Long	Continuous	Short-term	Negative	Moderate	High	Not Significant	Yes[4]
			Increased mortality		Low	Local	Extended	Continuous	Long-term	Negative	Moderate	Moderate	Not Significant	Yes[4]
			Reduced abundance		Low	Local	Extended	Continuous	Long-term	Negative	Moderate	High	Not Significant	Yes[4]
Olive-sided flycatcher	SARA 79	Construction and operations	Reduced habitat availability	For olive-sided flycatcher, additional (from those listed above for wildlife in general) relevant mitigations include: • should Environment and Climate Change Canada (ECCC) have other requirements (*e.g.*, beneficial management practices), Benga will work with ECCC to ensure those mitigation measures are also implemented	Moderate	Local	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#9 Section 6.3)
			Reduced		Low	Local	Long	Continuous	Short-term	Negative	High	High	Not	Yes (CR#9

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
			movement ability										Significant	Section 6.3)
			Increased mortality		Low	Local	Long	Isolated	Short-term	Neutral	High	High	Not Significant	Yes (CR#9 Section 6.3)
			Reduced abundance		Low	Local	Long	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#9 Section 6.3)
Great gray owl	---	Construction and operations	Reduced habitat availability	For great gray owl and other raptors, additional relevant mitigations include: • retain residual patches of essential habitat and habitat features within and adjacent to the mine footprint (i.e. mature poplar trees, tall conifer trees) to provide perches, nest sites, and hide cover • minimize loss of mature and old-growth forest habitat and avoid complex, multi-story mixedwood forest where possible • maintain a 100 m buffer of undisturbed forest around Blairmore Creek, Gold Creek and other riparian corridors • planning vegetation clearing outside of the great gray owl nesting period (March 1 to April 30) characteristic of the region	Low	Local	Long	Continuous	Long-term	Neutral	High	High	Not Significant	Yes[4]
			Reduced movement ability		Low	Local	Long	Continuous	Short-term	Neutral	High	High	Not Significant	Yes[4]
			Increased mortality		Low	Local	Long	Occasional	Short-term	Neutral	High	High	Not Significant	Yes[4]
			Reduced abundance		Low	Local	Long	Continuous	Short-term	Negative	Moderate	Moderate	Not Significant	Yes[4]
Little brown myotis	SARA 79	Construction and operations	Reduced habitat availability	Mitigation measures specific to little brown myotis and other bat species include: • avoiding direct and indirect impacts to known, primary maternity roosts should any such roosts be located/identified • consulting with ECCC and AEP should hibernacula, fall swarming sites, or maternity roosts be observed during operations • implementing a reclamation plan to promote the re-establishment of woody species and wetland vegetation • preserving remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and roost sites for bat species	Moderate	Local	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#9 Section 6.3)
			Reduced movement ability	Effects on habitat connectivity and movement will be mitigated by: • implementing a reclamation plan to promote the re-establishment of woody species and wetland vegetation • preserving remnant forest patches within the development areas where feasible to provide habitat connectivity for bat species	Low	Local	Long	Continuous	Short-term	Neutral	High	Moderate	Not Significant	Yes (CR#9 Section 6.3)
			Increased mortality	Effects on mortality will be mitigated by: • timing clearing outside of the summer breeding/rearing window (falls into the breeding bird window) • avoiding direct and indirect impacts to known, primary maternity roosts should any such roosts be located/identified	Low	Local	Long	Occasional	Short-term	Neutral	High	Low	Not Significant	Yes (CR#9 Section 6.3)
			Reduced abundance	Effects on abundance will be mitigated by mitigating for effects on habitat loss and mortality, as described above.	Low	Local	Long	Continuous	Long-term	Negative	High	Moderate	Not Significant	Yes (CR#9 Section 6.3)
American marten	---	Construction and operations	Reduced habitat availability	Mitigations are the same as for wildlife general mitigation (above)	Moderate	Local	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#9 Section 6.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
			Reduced movement ability		Low	Local	Extended	Continuous	Long-term	Negative	Moderate	Low	Not Significant	Yes (CR#9 Section 6.3)
			Increased mortality		Low	Local	Short	Occasional	Short-term	Negative	Moderate	Low	Not Significant	Yes (CR#9 Section 6.3)
			Reduced abundance		Low	Local	Extended	Continuous	Long-term	Negative	Moderate	Moderate	Not Significant	Yes (CR#9 Section 6.3)
Canada lynx	---	Construction and operations	Reduced habitat availability	Mitigations are the same as for wildlife general mitigation (above)	Moderate	Regional	Extended	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#9 Section 6.3)
			Reduced movement ability		Low	Regional	Long	Continuous	Long-term	Negative	Moderate	Moderate	Not Significant	Yes (CR#9 Section 6.3)
			Increased mortality		Low	Local	Long	Occasional	Short-term	Negative	Moderate	Low	Not Significant	Yes (CR#9 Section 6.3)
			Reduced abundance		Low	Local	Extended	Continuous	Short-term	Negative	Moderate	Low	Not Significant	Yes (CR#9 Section 6.3)
Grizzly bear	---	Construction and operations	Reduced habitat availability	Additional mitigations that are specifically targeted to grizzly bears and grizzly bear habitat will also support other carnivores and migratory birds, and include: • maintain a 100 m undisturbed forested buffer around Blairmore Creek and other riparian corridors • leave patches of residual forest within and adjacent to the mine footprint • commence reclamation early on in mine operations by seeding reclaimable areas with plant species favourable to grizzly bear forage, and by planting shrub and tree species that provide suitable cover (e.g. willow, alder, coniferous trees).	Low	Regional	Extended	Continuous	Long-term	Positive	High	Moderate	Not Significant	Yes (CR#9 Section 6.3)
			Reduced movement ability	Mitigations are the same as for wildlife general mitigation (above)	Low	Regional	Long	Isolated	Long-term	Negative	High	Moderate	Not Significant	Yes (CR#9 Section 6.3)
			Increased mortality	To mitigate effects on grizzly bear mortality (in addition to mitigations for wildlife in general): • Benga commits to supporting active bear management plans associated with the Project. If a site specific plan is required, it will be developed in consultation with AEP personnel as part of the Wildlife Mitigation and Monitoring Plan.	Low	Local	Residual	Occasional	Long-term	Negative	High	Moderate	Not Significant	Yes (CR#9 Section 6.3)
			Reduced abundance	Effects on abundance will be mitigated by mitigating for effects on habitat loss and mortality, as described above.	Low	Local	Extended	Continuous	Long-term	Positive	Moderate	Moderate	Not Significant	Yes (CR#9 Section 6.3)
Moose		Construction and operations	Reduced habitat availability	Mitigations are the same as for wildlife in general (above)	Low	Regional	Residual	Continuous	Long-term	Positive	Moderate	Moderate	Not Significant	Yes[4]

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
			Reduced movement ability		Low	Regional	Long	Continuous	Long-term	Negative	Moderate	Moderate	Not Significant	Yes[4]
			Increased mortality		Low	Local	Long	Occasional	Long-term	Negative	High	Moderate	Not Significant	Yes[4]
			Reduced abundance		Low	Local	Residual	Continuous	Long-term	Neutral	Moderate	Moderate	Not Significant	Yes[4]
Elk	---	Construction and operations	Reduced habitat availability	Mitigations are the same as for wildlife in general (above)	Low	Regional	Residual	Continuous	Long-term	Positive	High	High	Not Significant	Yes[4]
			Reduced movement ability		Low	Regional	Long	Continuous	Long-term	Negative	Moderate	Moderate	Not Significant	Yes[4]
			Increased mortality		Low	Local	Long	Occasional	Long-term	Negative	High	Moderate	Not Significant	Yes[4]
			Reduced abundance		Low	Local	Residual	Continuous	Long-term	Positive	Moderate	Moderate	Not Significant	Yes[4]
Migratory Birds	CEAA 5(1)(a)(iii)	Land clearing and physical disturbance of landscape	Habitat availability	Key measures include: • planning vegetation clearing outside of the breeding bird period (April 15 to August 31) characteristic of the region, • conducting pre-disturbance nest searches • implementing an effective conservation and reclamation plan that promotes the development of habitats required for migratory birds. • should Environment Canada have other requirements (*e.g.*, in beneficial management practices or species recovery strategies), Benga will work with Environment Canada to ensure those mitigation measures are also implemented Many of the Project effects associated with wildlife habitat loss will be minimized through implementation of the Project's reclamation plan. The summary of the reclamation plan mitigation recommendations for wildlife and wildlife habitat reclamation was provided in CR#9 Wildlife Sections 7.1.3 and 7.1.4. • Noise mitigation • Speed limit enforcement • planning vegetation clearing outside of the breeding bird period (April 15 to August 31) characteristic of the region • as the presence of artificial lighting can potentially affect bird use of nearby habitats, Benga has developed a visual impact mitigation plan that reduces stray and non-essential artificial lighting to minimize wildlife effects and that will comply with OH&S safety requirements • develop and implement procedures to clear blasting areas of birds prior to	Moderate/nil-low[5]	Local	Extended/residual/ long[5]	Continuous	Long-term/ short-term[5]	Negative/ positive[5]	High	High	Not significant	Yes[4]
			Habitat fragmentation and connectivity		Low	Local	Long	Continuous	Short-term	Negative	High	High	Not significant	Yes[4]
			Mortality		Low	Local	Long	Isolated	Short-term	Neutral	High	High	Not significant	Yes[4]
			Reduced abundance		Low	Local	Long	Continuous	Long-term	Negative	High	High	Not significant	Yes[4]

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
		Operations (sensory disturbance)	Habitat availability	blasting • to mitigate the potential effects of sensory disturbance (acoustic and visual) on effective habitat availability in the southeast portion of the Gold Creek valley, Benga will install and maintain a 15-m tall earth berm along the eastern edge of the south disposal area • should Environment Canada have other requirements (e.g., in beneficial management practices or species recovery strategies), Benga will work with Environment Canada to ensure those mitigation measures are also implemented • develop and implement procedures to clear blasting areas of birds prior to blasting • Speed limit enforcement • bird collisions with buildings will be mitigated by placing visual markers on windows, and collisions with the proposed power line will be mitigated by installing large 'floats' or other markers	Moderate/nil-low[4]	Local	Extended/residual/ long[4]	Continuous	Long-term/ short-term[4]	Negative/ positive[4]	High	High	Not significant	Yes[4]
			Reduced abundance		Low	Local	Long	Continuous	Long-term	Negative	High	High	Not significant	Yes[4]
		Operations - blasting	Mortality		Low	Local	Long	Isolated	Short-term	Neutral	High	High	Not significant	Yes[4]
			Reduced abundance		Low	Local	Long	Continuous	Long-term	Negative	High	High	Not significant	Yes[4]
		Construction & operations - vehicle & building collisions	Mortality		Low	Local	Long	Isolated	Short-term	Neutral	High	High	Not significant	Yes[4]
			Reduced abundance		Low	Local	Long	Continuous	Long-term	Negative	High	High	Not significant	Yes[4]

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Common nighthawk	SARA 79	Land clearing and physical disturbance of landscape Operations (sensory disturbance)	Overall impact	• all relevant mitigation measures stated for migratory birds, above, • implement a visual impact mitigation plan that reduces stray and non-essential artificial lighting to minimize wildlife effects and that will comply with OH&S safety requirements; • in light of the final Recovery Strategy for this species having been released in 2016, Benga will consult with Environment Canada to develop a beneficial management practice for this species in the LSA	Low	Local	Long	Continuous	Short-term	Negative	Moderate	High	Not significant	Yes[4]
Short-eared owl	SARA 79	Land clearing and physical disturbance of landscape Operations (sensory disturbance)	Overall impact	• all relevant mitigation measures stated for migratory birds, above, • implement a visual impact mitigation plan that reduces stray and non-essential artificial lighting to minimize wildlife effects and that will comply with OH&S safety requirements; • Benga will consult with Environment Canada to determine whether a beneficial management practice or other strategy is recommended for this species in the LSA	Low	Local	Long	Continuous	Short-term	Negative	Low	Low	Not significant	Yes[4]
Land & Resource Use														
Land use policies and resource management initiatives	---	Construction, operations and closure	Conflict with intent of policies	Effects on land and resource will be mitigated by: • continuing to consult with local stakeholders, through the life of the Project, in order to identify concerns and proactively address issues when they arise • undertaking progressive reclamation, and reclaiming the area to a landscape that includes provisions for a variety of land uses, including forestry, wildlife habitat, grazing, recreational use, etc.	Nil	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)
Resource development	---	Construction, operations and closure	Reduced access		Nil	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)
Hunting and trapping	---	Construction, operations and closure	Reduced access and availability		Nil	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)
Access and utilities	---	Construction, operations and closure	Reduced access		Nil	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)
Tourism and outdoor recreation	---	Construction, operations and closure	Reduced access / opportunity		Nil	Local	Extended	Continuous	Long-term	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)
Unique sites and special features	---	Construction, operations and closure	Damage	Damage to unique sites and special features will be mitigated as follows: • Benga will continue work to fully document these resources as directed by Alberta Culture and Tourism and will obtain clearance under the *Historical Resources Act* prior to undertaking any development that may impact these known historic resources • to mitigate potential rail yard impacts, pertinent best management	Nil	Local	Extended	Continuous	Irreversible – Rare	Neutral	High	High	Not Significant	Yes (CR#10 Section 7)

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Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				practices, as outlined in the Guidelines for the New Development in Proximity to Railway Operations, will be adhered to • disturbance of any further remains located within the proposed rail load out footprint, will be mitigated with controlled excavations to remove the remains • a mitigation excavation of approximately 80 m^2 will occur in the CHPP footprint in advance of Project development to remove all remaining historical resources or representative samples • historic mine remains will be completely documents and recorded • historic mining camp remains will be documented in a 20 m^2 excavation • additional field surveys and documentation, where required									
Socio-economics														
Income	---	Construction, operations, closure, and post-closure	Increased income	Project contribution is positive during both construction and operation as the Project will contribute to increased incomes to individuals, households, and businesses in the region. No mitigations required.	Low	Regional/ Provincial	Long	Continuous	Long-term	Positive	High	High	Not Significant	No
Government revenue	---	Construction, operations, closure, and post-closure	Increased revenue	Project contribution is positive as the Project will contribute increased government revenue to all three levels of government. No mitigations required.	Low to Moderate	Regional/ Provincial/ National	Long	Continuous	Long-term	Positive	High	High	Not Significant	No
Employment	---	Construction, operations, closure, and post-closure	Increased opportunities	Project contribution is positive during both construction and operation as the Project will create employment opportunities at both the regional and provincial level. No mitigations required.	Low	Regional/ Provincial	Long	Continuous	Long-term	Positive	High	High	Not Significant	No
Population	---	Construction, operations, closure, and post-closure	Increased population	Effects of increased population will be mitigated with the following measures: • support the hiring of a municipal planner for Crowsnest Pass to assist with community planning • support local municipalities in discussions with the province to acquire additional funding for services and infrastructure • work with the municipalities in the region to keep them informed of its development plans and their timing so that the affected municipalities have sufficient time to plan for changes in the demand for services	Low	Regional	Long	Continuous	Long-term	Mixed	High	High	Not Significant	Yes (CR#12 Section 5.3.1.3)
Housing	---	Construction, operations, closure, and post-closure	Increased demand for housing	Increased demand for housing will be mitigated as follows: • house construction workers in a temporary camp, which has the ancillary effect of reducing the resident population effect of the Project and the anticipated demand for housing • work with local governments to facilitate the timely development of residential land and dwellings	Moderate	Regional	Long	Continuous	Long-term	Positive	High	High	Not Significant	Yes (CR#12 Section 6.3.3)
Social infrastructure	---	Construction, operations, closure, and post-closure	Increased demand on social infrastructure	Benga will: • put in place project-related measures to mitigate effects on regional social infrastructure, including: - developing and implementing specific policies regarding employee health and safety and emergency response;	Low	Regional	Long	Occasional to Periodic	Long-term	Negative	High	High	Not Significant	Yes (CR#12 Section 7.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				- maintaining explicit and enforced workplace policies with regards to alcohol and drug use, and illegal activities; and - providing employees with access to the company's confidential employee assistance plan, which provides support for families and individuals who may experience difficulty dealing with personal, family, or work-life issues that can affect one's health and well-being. • continue supporting local programs and initiatives through both financial and in-kind contributions, where appropriate. • cooperate with service providers (e.g. health, social, education), government, and other industrial operators in the region to assist in addressing effects of its project and resource development in general by: - communicating its development and operational plans with the appropriate agencies; and - working with the provincial and municipal governments on the implementation of relevant planning initiatives and coordination of emergency response procedures, where appropriate.									
Municipal Infrastructure and Services	---	Construction, operations, closure, and post-closure	Increased demand on municipal infrastructure	Benga is committed to working with the municipalities in the region to keep them informed of its development plans and their timing so that the affected municipalities have sufficient time to plan for changes in the demand for services. Additionally: • Benga has offered to support the hiring of a municipal planner for Crowsnest Pass to assist with community planning. • the use of an on-site camp and workforce transportation strategy will serve to limit the demands placed on local municipal infrastructure by the mobile construction workforce.	Moderate	Regional	Long	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#12 Section 8.3.3)
Traditional Land Use and Culture	---	Construction, operations, closure, and post-closure	Increased income / reduced access to traditional land use	To mitigate these effects, Benga will: • undertake progressive reclamation, giving consideration to traditional land use, where possible • provide access to traditional users across the lease • compensate trappers directly affected by the Project, according to industry standards • promote cultural diversity awareness to Benga's employees and contractors regarding respect for traditional resource users • support specific community projects, such as elder and youth programs • continue working with Aboriginal communities in the region to ensure that their concerns with respect to traditional land use and culture are continually considered during Project planning and operation	Low	Regional	Extended	Continuous	Long-term	Mixed	High	High	Not Significant	See Aboriginal effects section
Transportation	---	Construction, operations, closure, and post-closure	Increased traffic	Transportation effects will be mitigated with the following measures: • improvements to the left turn lane storage at intersections within Blairmore, and additional signalization at the 129th Street intersection will be completed by 2021 to accommodate projected increases in background traffic volumes. • the existing gravel access road to the Project will need to be upgraded to accommodate Project-related traffic. • During both construction and operations, Benga and its contractors will	Moderate	Regional	Long	Continuous	Long-term	Negative	High	High	Not Significant	Yes (CR#12 Section 10.3.3)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				use buses and multi-passenger vans to transport personnel to site in order to reduce the total number of vehicles traveling on local roads. Benga will also endeavour to schedule construction deliveries during off-peak hours. •Benga is committed to maintaining an open dialogue and communicating its development and operational plans, including traffic management plans, with the appropriate agencies such as Alberta Transportation and B.C. Transportation and Infrastructure.										
Human Health (Parameters)														
NO_2 HQ	---	Construction and operations	Health effects - acute		Low	Local	Long	Periodic	Short-term	Negative	High	Low	Not Significant	No
$PM_{2.5}$ HQ	---	Construction and operations	Health effects - acute		Low	Local	Short	Periodic	Short-term	Negative	High	Low	Not Significant	No
	----		Health effects - chronic		Low	Local	Long	Continuous	Irreversible	Negative	High	Low	Not Significant	No
PM_{10} HQ - MPOI	---	Construction and operations	Health effects - acute		Moderate	Local	Short	Periodic	Short-term	Negative	High	Low	Not Significant	No
	---		Health effects - chronic	Assuming public access within the Mine Permit Boundary is restricted and the mitigation measures assumed by the other disciplines are implemented (Section A.11), there is no need for further mitigation of emissions based on the results of the HHRA.	Low	Local	Short	Continuous	Irreversible	Negative	High	Low	Not Significant	No
PM_{10} HQ -at R10	---	Construction and operations	Health effects - acute		Low	Local	Short	Periodic	Short-term	Negative	High	Low	Not Significant	No
	---		Health effects - chronic		Low	Local	Short	Continuous	Irreversible	Negative	High	Low	Not Significant	No
PM_{10} HQ – at R6	---	Construction and operations	Health effects - chronic		Low	Local	Long	Continuous	Irreversible	Negative	High	Moderate	Not Significant	No
PM_{10} HQ- at R8 and R14	---	Construction and operations	Health effects - chronic		Low	Local	Long	Continuous	Irreversible	Negative	High	Moderate	Not Significant	No
Historical Resources														
Archaeological and paleontological resources	---	Construction and operations	Removal/ damage of historical resources	Effects to historical resources will be mitigated as follows: • to mitigate potential rail yard impacts, pertinent best management practices, as outlined in the Guidelines for the New Development in Proximity to Railway Operations, will be adhered to. For public access structures on the inside of the rail loop will be fenced off and will be accessible to the public via request. For structures outside of the rail loop, a roadside interpretive pull off will be developed • disturbance of any further remains located within the proposed rail load out footprint, will be mitigated with controlled excavations to remove the remains • a mitigation excavation of approximately 80 m^2 will occur in the CHPP	Low	Local	Long	Occasional	Irreversible	Neutral	Moderate	Certain	Not Significant	Yes (Section E.13.4)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				footprint in advance of Project development to remove all remaining historical resources or representative samples • historic mine remains will be completely documents and recorded • historic mining camp remains will be documented in a 20 m^2 excavation • additional field surveys and documentation, where required										
Aboriginal Peoples														
Aboriginal health and socio-economics	CEAA 5(1)(c)(i)	Construction and operations	Health – air quality	• The mine fleet is regularly upgraded and by Year 14, equipment will be newer and more efficient than assumed in emission estimation. Exhaust emissions from the U.S. EPA Tier 4 (2010) standards were used in Project emission estimates and it is likely that off-road standards will be more stringent by Year 14. • water is systematically applied to haul roads and to the plant access road to minimize dust using a water truck dedicated to this purpose. An emission control efficiency of 80% during the summer months is expected from this measure. • Snow cover is retained on the road as a mitigative measure during the winter months, unless the cover would compromise the safety of vehicle operations. Winter ground is frozen and, since the soil and overburden have elevated moisture contents, there is a reduction of dust emissions at that time. • Gravel or crushed rock is used on the haul roads. Gravel is observed to produce less dust than clay and sandy surfaces. • Use of a grader to maintain the active surface of the road. This procedure is expected to reduce the effective silt content of the portion of the road where the wheels of the haul trucks travel. The grader blade would tend to move the silt particles to the inactive portion (side) of the road. • The mined areas are reclaimed promptly and backfilled with overburden and soil from pre-strip areas, and then covered by vegetation which reduces windblown fugitive dust emissions from the barren land. • Trees and bushes will be preserved around mines and plant, effectively trapping dust emissions from mining activities and reducing dust concentrations further from mining activities. • The two coal processing plant (CPP) modules will be contained within an enclosed area and all coal material handling will be via covered conveyors. • Dust generation from transferring coal from the conveyor to the stock pile will be minimized by the use of luffing stackers (those that can lower and raise their boom) which will minimize the drop height and drop time of the coal. • Fugitive dust generation will be minimized at the rail load-out, with full cladding on the sides of the load-out structure to create a wind shelter, and with the movable discharge chute of the bin located as close as practical to the coal within the rail cars. Benga commits to developing a more detailed monitoring program when the mine plan is more advanced than it is now, and commits to reviewing its adequacy periodically in future. Benga will provide the draft monitoring plan to AER 6 months before planned start-up and to implement the	Nil	NA	NA	NA	NA	Neutral	NA	NA	Not significant	No

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				program 3 months or more prior to the beginning of construction.										
		Construction and operations	Health – water quality	Benga will develop and implement a water management plan, environmental management plan, and Gold Creek Stewardship Program to effectively prevent Project effects on turbidity and associated water quality constituents or reduce them to acceptable levels. Benga will: • establish a series of collection ditches, sumps, pumps and settling ponds to manage all surface water on the mine site. Surface water runoff from mining areas, haul roads, overburden disposal areas and any other disturbed areas as well as groundwater runoff from the pit will be collected and directed to settling ponds for treatment and or will be pumped to the raw water pond for storage and use in the coal cleaning process. Once suspended solids are settled, water will be released to Blairmore Creek and Gold Creek; • implement appropriate slope grading and stabilization techniques to reduce erosion risk. Slopes will be contoured to produce moderate slope angles to reduce erosion risk. Other stabilization techniques used to control erosion include: ditching above the cutslope to channel surface runoff away from the cutslope, leaving buffer (vegetation) strips between the construction site and a watercourse, and placing large rock rip rap to stabilize slopes; • implement temporary measures to control erosion before vegetation cover is re-established, including: diversion ditches, drainage control, check dams, sediment ponds, sumps, and mulches; • progressively reclaim to reduce the amount of disturbed area at any given time. • whenever possible, construction activities in close proximity to watercourses will be carried out during periods of lowest potential impact, typically during the winter months. A 10- m undisturbed buffer zone, maintaining existing vegetation, will be left between development activities and Blairmore Creek to the west and Gold Creek to the east; • comply with the Alberta Code of Practice for Watercourse Crossings and associated guidelines; • implement construction techniques that protect the integrity of the streams as well as the quality of water; • where necessary, interim erosion/sediment control measures will be utilized until long-term protection can be effectively implemented. • implement a plan to attenuate selenium and nitrite and nitrate concentrations in process water before release to the receiving environment • develop and implement appropriate design features (*e.g.*, berms and containment areas around potential sources), best management practices, and spill response plan to minimize potential for spills that might adversely affect surface water quality • collect domestic wastewater in storage tanks and transferred to the wastewater treatment facility, test treated effluent to ensure that its quality meets or exceeds the limits for treated, and discharge wastewater as	Nil	NA	NA	NA	NA	Neutral	NA	NA	Not significant	No

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				specified in the EPEA approval.										
		Construction and operations	Health – country foods	Mitigations relevant to country foods include: • mitigations for air quality (above) • mitigations for surface water quality (above) • access control policy	Nil	NA	NA	NA	NA	Neutral	NA	NA	Not significant	No
		Construction and operations	Health – noise	Mitigations relevant to noise include: • route the haul trucks (conveying waste rock and coal) along the western slope of the south disposal area such that the south disposal area itself provides noise shielding between the operating equipment and the residential receptors to the east; and, • install and maintain a 15 m tall earthen berm along the eastern edge of the south disposal area. The earthen berm will be constructed and maintained during the day-time (when required) and the 15 m earthen berm will increase in overall elevation as the height of the south disposal area increases. • blasting to occur only on weekdays during typical day-time hours; • minimal blasting during cloud cover; and • blasting to be limited to smaller more localized blasts, which reduces the amount of explosives used at any one time. • If, during active operations at the mine, concerns are raised by local residents, specific noise mitigation measures can be put in place for light duty vehicle back-up alarms. For example, the alarm noise can be replaced during night-time activities with a flashing light, which provides the necessary safety warning while eliminating the noise. During the day-time there are directional back-up alarms available that focus the noise to areas directly behind the vehicle and minimize the omni-directional noise radiation or back-up alarms with varying tones which provide the necessary safety warnings while minimizing the impact on receptors further away. • There will be on-site maintenance shops to ensure that equipment is kept in good repair, to mitigate operational sound levels. When new equipment is purchased, the noise levels of the equipment will be considered during the procurement process. • monitoring low frequency tonal noise (e.g., from mining equipment and rail loadout activity) during Project operations, and following up as required by AER *Directive 038*.	Nil	NA	NA	NA	NA	Neutral	NA	NA	Not significant	No
		Construction and operations	Socio-economics – commercial activity, forestry and logging, recreational use	Benga recognizes the effects of resource development on traditional land use and culture. The proponent will therefore carry out the following actions to enhance the positive and minimize the adverse effects of its Project: • Provision of employment and economic opportunities • Aboriginal Access Management Plan and access control policy • progressive reclamation, giving consideration to traditional land use, where possible; • compensate trappers directly affected by the Project, according to industry standards;	NA	NA	NA	NA	NA	Positive	NA	NA	Not significant	No

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
				• promote cultural diversity awareness to Benga's employees and contractors regarding respect for traditional resource users; • support specific community projects, such as elder and youth programs, where appropriate; and • ongoing consultation with Aboriginal communities in the region to ensure their concerns with respect to traditional land use and culture are continually considered during Project planning and operation. • all relevant mitigations proposed to reduce the effects on wildlife and wildlife habitat / fragmentation • all relevant mitigations for air quality (above) • implementation of a re-vegetation program which will aim at the re-establishment of vegetation communities, such as closed conifer forests, mature mixed forests, native upland herbaceous grasslands and treed swamps, common to the pre-disturbed landscape that will support valued vegetation • implementation of a re-vegetation program that utilizes native vegetation species and does not include agronomic invasive species • provision of opportunities to identify and collect suitable lodge pole pine for TU ceremonies • where practicable, utilize locally collected seed to preserve the legacy of species and of place									
Aboriginal physical and cultural heritage	CEAA 5(1)(c)(ii)	Land clearing and physical disturbance of landscape.	Damage or disturbance of valued sites; access to valued sites; cultural value	• Site-specific mitigations for historical resources identified in the Historical Resources Impact Assessment; • Aboriginal Access Management Plan; • Cultural Site Discovery Contingency Plan; • ongoing Aboriginal consultation	Low	Local	Long-term	Regular	Not reversible (if not mitigated)	Negative	----[3]	---[3]	Not significant	Yes (Section H)
Traditional land and resource use [1]	CEAA 5(1)(c)(iii)	Land clearing and physical disturbance of landscape	Hunting (KN, PN, SN, SNN, TTN, SCN)[6] – species, habitats, access	• Aboriginal Access Management Plan and access control policy • progressive reclamation, giving consideration to traditional land use, where possible; • compensate trappers directly affected by the Project, according to industry standards; • ongoing consultation with Aboriginal communities • all relevant mitigations proposed to reduce the effects on wildlife and wildlife habitat / fragmentation • all relevant mitigations for air quality (above) • all relevant mitigations for surface water quality (above) • all relevant mitigations for noise (above) • implementation of a re-vegetation program which will aim at the re-establishment of vegetation communities, such as closed conifer forests, mature mixed forests, native upland herbaceous grasslands and treed swamps, common to the pre-disturbed landscape that will support valued vegetation	Low	Local	Short-term	Continuous	Reversible	Negative	---[3]	---[3]	Not significant	Yes (Section H)
			Trapping (SCN)[6] – species, habitats, access											
			Plant gathering (KN, PN, SN,	• Aboriginal Access Management Plan and access control policy • provision of opportunities to identify and collect suitable lodge pole pine for TU ceremonies	Moderate	Local	Long-term	Continuous	Reversible	Negative	---[3]	---[3]	Not significant	Yes (Section H)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
			SNN, TTN, SCN)[6] – use, access, harvesting	• progressive reclamation, giving consideration to traditional land use, where possible; • ongoing consultation with Aboriginal communities in the region to ensure their concerns with respect to traditional land use and culture are continually considered during Project planning and operation. • all relevant mitigations proposed to reduce the effects on wildlife habitat • implementation of a re-vegetation program that will aim to re-establish vegetation communities, such as closed conifer forests, mature mixed forests, native upland herbaceous grasslands and treed swamps, common to the pre-disturbed landscape that will support valued vegetation • implementation of a re-vegetation program that utilizes native vegetation species and does not include agronomic invasive species • where practicable, utilize locally collected seed to preserve the legacy of species and of place									
			Trails and travelways (PN, SCN)[6] – use and access, disturbance	• Aboriginal Access Management Plan and access control policy • ongoing Aboriginal consultation • relevant site-specific mitigations stated in the Historical Resources Impact Assessment • all relevant mitigations indicated in the Conservation and Reclamation Plan • promote cultural diversity awareness to Benga's employees and contractors regarding respect for traditional resource users;	Moderate	Local	Long-term	Continuous	Long-term	Negative	---[3]	---[3]	Not significant	Yes (Section H)
		Construction and operations	Hunting (KN, PN, SN, SNN, TTN, SCN)[6] – species, habitats, access	Same mitigations as for land clearance and physical disturbance - hunting and trapping, above	Low	Local	Short-term	Continuous	Reversible	Negative	---[3]	---[3]	Not significant	Yes (Section H)
			Trapping (SCN) [6]– species, habitats, access											
			Fishing (SCN)[6] – species, habitats, access	• refer to fish and fish habitat mitigations, above • refer to Aboriginal health - water quality mitigations, above • Aboriginal Access Management Plan • access control policy • ongoing Aboriginal consultation	Low	Local	Short-term	Continuous	Reversible	Negative	---[3]	---[3]	Not significant	Yes (Section H)
			Trails and travelways (PN, SCN)[6] – use and access, disturbance	• Aboriginal Access Management Plan and access control policy • ongoing Aboriginal consultation • relevant site-specific mitigations stated in the Historical Resources Impact Assessment • all relevant mitigations indicated in the Conservation and Reclamation Plan • promote cultural diversity awareness to Benga's employees and contractors regarding respect for traditional resource users;	Nil	Local	Extended	Continuous	Long-term	Neutral	---[3]	---[3]	Not significant	Yes (Section H)

Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components

Valued Component	Federal Jurisdiction	Project Activity	Potential Effects	Proposed Mitigation	Magnitude	Extent	Duration	Frequency	Reversibility	Ecological/ Social Context	Confidence Rating	Probability of Occurrence	Significance	Valued Component carried forward to CE/PDC[1] case
Structure, site or thing of historical, archaeological, paleontological, architectural significance	CEAA 5(1)(c)(iv)	Land clearing and physical disturbance of landscape	Disturbance, damage, loss of sites	• access control policy • ongoing Aboriginal consultation • relevant site-specific mitigations stated in the Historical Resources Impact Assessment • promote cultural diversity awareness to Benga's employees and contractors regarding respect for structures, sites, or other features with traditional significance	Nil	NA	NA	NA	NA	Neutral	---[3]	---[3]	Not significant	No

[1] **CE/PDC Case = Cumulative Effects/Planned Development Case**

[2] **The following update to the surface water residual effects ratings is provided as an errata to Section E.5.6, Table E.5.6-1**

[3] **--- This criteria was not used as part of the determination of significance for this VC**

[4] **Cumulative effects assessment was conducted for 5 of the 10 Wildlife VCs which are representative of all wildlife VCs. Wetland VC cumulative effects assessment can also be used to help evaluate habitat for some wildlife VCs.**

[5] **Migratory birds significance assessment results vary depending on type of birds and their habitat.**

[6] **KN - Kainai Nation, PN – Piikani Nation, SN – Siksika Nation, SNN – Stoney Nakoda Nation, TTN – Tsuu T'ina Nation, SCN – Samson Cree Nation**

APPENDIX A-4: PROJECT SCHEDULE – UPDATED APRIL 2018

Appendix D - Project Schedule - Updated April 2018

Phase	Activity	Purpose	Frequency*	Application Reference Section	Mine Year: 0				1				2				3				4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Year 2046-20XX
					2018				2019				2020				2021				2022				Year 20XX																				
					Regulatory				Construction				Operations																																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	46 - XX
nstructio	**Infrastructure Corridor**																																												
	Main Access Road Construction	Access from Hwy 3 to CHPP and mine site	Isolated	Section C.4.1																																									
	Transmission Line Installation	Power from 25kV line to site	Isolated	Section C.6.15																																									
	Telecommunications Line Installation	Telecommunications and internet to CHPP	Isolated	Section C.6.15																																									
	Overland Conveyor Installation	To convey product coal from CHPP to Loadout	Isolated	Section C.2.7																																									
	Mine Infrastructure																																											
	Topsoil Salvage & On-site Storage	For progressive reclamation purposes	Isolated	Section C.1.5.1																																									
	Temporary Camp Construction	Residence for first year of construction	Isolated	Section C.6.17																																									
	Mine Infrastructure Building Construction	To support operations & maintenance	Isolated	Sections C.2 and C.6																																									
	Coal Processing Plant Construction	For coal product development	Isolated	Sections C.2 and C.2.8																																									
	Clean Coal Pile Area Construction	For clean product storage	Isolated	Section C.2.6.6																																									
	Rail Loop Construction	Will tie in to CP line to ship product	Isolated	Section C.3																																									
	Blairmore Creek Rail Bridge Crossing	Required to tie into CP line	Isolated	Section C.5.3.2																																									
	Rail Loadout Building Construction	Terminal end of conveyor to load train cars	Isolated	Section C.3																																									
	Explosives Plant Construction	Mine explosives storage	Isolated	Agency IR 02/28/18 NRCan IR3																																									
	Open Pit Development																																											
	Geotechnical Assessment	Mine Engineering requirement	Isolated	Section C.1.5.3																																									
	Topsoil Salvage & On-site Storage	For progressive reclamation purposes	Isolated	Section C.1.5.1																																									
	South Rock Disposal Area Preparation	For processing waste rock storage	Isolated	Section C.1.5.3, Figures C.1.3-1																																									
	Mine rock Pre-stripping	Opearations requirement	Isolated	Section C.1.5.3, Figures C.1.3-1																																									
	Mine rock placement (external)	For processing waste rock storage	Isolated	Section C.1.5, Figures C.1.3-2																																									
	Water Management Infrastructure*																																											
	Loadout Sediment Pond Construction	Collect water for TSS treatment and release	Isolated	Section C.5.5.1 and Table C.5.6-1																																									
	Raw Water Surge Pond Construction	Collect water for selenium treatment	Isolated	Section C.5.5.2 and Table C.5.6-1																																									
	Southwest Surge Pond Construction	Collect water for selenium treatment	Isolated	Section C.5.5.2 and Table C.5.6-1																																									
	Southeast Surge Pond Construction	Collect water for selenium treatment	Isolated	Section C.5.5.2 and Table C.5.6-1																																									
	West Sediment Pond Construction	Collect water for TSS treatment and release	Isolated	Section C.5.5.1 and Table C.5.6-1																																									
	Plant Site Sediment Pond Construction	Collect water for TSS treatment and release	Isolated	Section C.5.5.1 and Table C.5.6-1																																									
peratior	**Open Pit Mining**																																											
	Geotechnical Assessment	Mine Engineering requirement	Periodic	Section C.1.5.3																																									
	Topsoil Salvage & On-site Storage	For progressive reclamation purposes	Isolated	Section C.1.5.1																																									
	Mine Rock Removal	For resource extraction requirements	Comtinuous	Sections C.1.5.2 and C.1.5.3																																									
	Coal Mining	Resource extraction	Comtinuous	Sec. C.1.5.4, Figures C.1.3-1 to 36																																									
	Coal Processing	Resource product development	Comtinuous	Section C.2																																									
	Mine Rock Placement (External)	For processing waste rock storage	Periodic	Sec. C.1.5, Figures C.1.3-1 to 36																																									
	Mine Rock Placement (Backfill)	For processing waste rock storage	Periodic	Sec. C.1.5, Figures C.1.3-1 to 36																																									
	Rock disposal area re-sloping	For progressive reclamation purposes	Periodic	Section F.1 and Table F.4.1-1																																									
	Rock disposal area topsoil replacement	For progressive reclamation purposes	Periodic	Section F.1 and Table F.4.1-1																																									
	Water Management																																											
	East Sediment Pond Construction	Collect water for TSS treatment and release	Isolated	Section C.5.5.1 and Table C.5.6-1																																									
	Northwest Surge Pond Construction	Collect water for selenium treatment	Isolated	Section C.5.5.2 and Table C.5.6-1																																									
	Northeast Sediment Pond Construction	Collect water for TSS treatment and release	Isolated	Section C.5.5.1 and Table C.5.6-1																																									
	Saturated Zone 1 (SZ1465) Construction	For selenium attenuation	Periodic	Section C.5.3.4.2, Figure C.5.3-3																																									
	Saturated Zone 2 (SZ1636) Construction	For selenium attenuation	Periodic	Section C.5.3.4.2, Figure C.5.3-4																																									
	Saturated Zone 3 (SZ1700) Construction	For selenium attenuation	Isolated	Section C.5.3.4.2, Figure C.5.3-5																																									
Closure	**Open Pit Closure**																																											
	Rock disposal area re-sloping	For progressive reclamation purposes	Isolated	Sections C.1.3.4 and F.4.5.6																																									
	Rock disposal area topsoil replacement	For progressive reclamation purposes	Isolated	Sections C.1.3.4 and F.3.6.2																																									
	End Pit Lake	Based on final mining topography	Isolated	Section F.4.5.7																																									
	Mine Infrastructure Removal																																											
	Coal Handling Plant Dismantling	For progressive reclamation purposes	Isolated	Section F.4.5.2																																									
	Mine Infrastructure Area Removal	For progressive reclamation purposes	Isolated	Section F.4.5.2																																									
	Rail Loop Closure	For progressive reclamation purposes	Isolated	Sections C.3.2.3 and F.4.5.5																																									
	Water Management																																											
	Close Northeast Sediment Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close East Sediment Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close West Sediment Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Southwest Surge Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Plant Site Sediment Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Loadout Sediment Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Southeast Surge Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Northwest Surge Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									
	Close Raw Water Surge Pond	For progressive reclamation purposes	Isolated	Sections F.3.6.2 and F.4.4																																									

Notes Water Management Infrastructure includes all petinent features: pond, dam, connecting ditches, pump installation, etc.

APPENDIX C-1: PIIKANI TECHNICAL REVIEW

Appendix C

Piikani Technical Review of the Environmental Impact Assessment (EIA) document issued November 2015. That EIA document was since updated in August 2016.

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
EIS Review [35]	Piikani Nation requests that Benga: i) outlines a contingency plan for the mine-site water releases when sedimentation pond or saturated backfill zone releases do not meet permitted guidelines for TSS; ii) describes the potential downstream hydrologic impacts to Blairmore and Gold creeks if water must be withheld rather than released as planned;	Water Management	Water treatment for total suspended solids is very well tested technology and Benga does not anticipate a difficulty achieving required water quality objectives. Any periodic or incident based deviations will be dealt with through the adaptive management process and would include addition of water treatment technologies to ensure consistent water quality is achieved.
EIS Review [36]	Piikani Nation requests that Benga provides a plan to augment low flows on Gold Creek, perhaps by intercepting some flows directed to Blairmore Creek, so that no reduced flows occur that can be detrimental to fish or fish habitat.	Water Management	Benga has developed a revised hydrological model and instream flow needs study to protect fish and fish habitat which was submitted in an addendum in January 2017. The result of this study indicate that there will be some loss of fish habitat due to reduced flows in Gold Creek. Benga is discussing with Fisheries and Oceans Canada (DFO) an offset plan to more than compensate for any habitat loss due to the project. Benga will consider the Piikani Nation proposal as it advances with these discussions and will consult with Piikani Nation on the fisheries offset plan prior to its finalization.

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
EIS Review [41]	Piikani Nation requests that Benga provides for Blairmore and Gold creeks: i) quantification of the anticipated fish habitat that will be lost due to the Project Footprint (lost tributaries), considering flows, lost food supply, effect of climate change, and potential contamination; ii) plans or potential options for more equitably dividing flows between the two rivers so that fish habitat in Gold Creek can be sustained under low flow conditions; and iii) details of the Offset, Recovery Plan and Stewardship Program suggested as mitigation in the assessment.	Fish	A revised Aquatic Ecology report was filed by Benga in January 2017 which includes results from extensive fish and fish habitat research that was conducted in the project area from 2014 to 2017. As a result, more is known today than ever before about these creeks. This section now contains information to describe: • the quality, composition, and distribution of fish habitats throughout the mainstem and tributaries of Gold Creek and Blairmore Creek; • barriers to fish passage; • fish presence, distribution and habitat use (including overwintering and spawning) within the study area to characterize fish species composition, distribution and abundance; • the fluvial geomorphology of the creeks, which included a land use change analysis to characterize recent and current conditions of the Blairmore Creek and Gold Creek watersheds to assess the impacts associated with the alteration of flow regimes; and • the baseline hydrology to support the Instream Flow Assessment for the Project, which was designed to evaluate the potential for flow related effects on westslope cutthroat trout and their habitat. A preliminary offset recovery plan is also included in Appendix A4 of the addendum.

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
EIS Review [42]	Piikani Nation requests that Benga i) consults with regulators (AEP and DFO), WCT experts (perhaps that were involved in the Recovery Plan design), and Piikani Nation to determine the most appropriate mitigation aimed at protecting critical habitat of this threatened species in the Project area; and ii) describes how it addressed or plans to address the requirements of the DFO Habitat Protection Order.	Fish	Benga are working with the appropriate fish biologist regulators including Fisheries and Oceans Canada (DFO) to develop appropriate mitigations and offsets for the associated watercourses. Although the fish habitat protection order was not issued at the time of the submission of the 2016 EIA (DFO issued it after the 2016 EIA was submitted), Benga have met with DFO on a number of occasions to discuss the impacts of the Protection Order. The fisheries offset plan will be discussed with Piikani Nation as it being developed and before it is finalized.
EIS Review [44]	Piikani Nation requests that Benga provides an assessment of the potential impact to fish and aquatic habitat that might be caused by using explosives in the vicinity of fish-bearing waters – including the types and weights of explosives, and measures taken to ensure that vibration and noise will not disturb aquatic habitat and fish. Further, Piikani Nation requests that this assessment is completed as part of the forthcoming Project Update.	Blasting	The following is an excerpt from the updated Section 6.3.1.1 contained in the January 2017 addendum: The Project intends to use explosives in the process of mining and this has the potential for creating instantaneous pressure changes (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish Wright and Hopky (1998). In addition, vibrations from the detonation of explosives may cause damage to incubating eggs. As well, blasts generate both seismic and surface waves (Rayleigh waves). Benga is committed to developing and using a blasting regime that will meet the blasting guidelines contained in Wright and Hopky (1998). Implementation of mitigation actions is expected to effectively manage and

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
			reduce the likelihood and extent of direct mortality to westslope cutthroat trout (WSCT) that inhabit both Gold and Blairmore creek watersheds. Thus, no detectable changes in WSCT relative abundance due to blasting activities, proportional to baseline conditions, is expected. Thus, this pathway was determined to have no linkage to effects on WSCT.
EIS Review [45]	Piikani Nation requests that, for Blairmore and Gold creeks, Benga provides measurements of baseline: i) sediment quality parameters (notably Se) in pool or depositional zones in the creeks, within representative reaches and tributaries, for comparison to planned operational monitoring data; and ii) calcite ($CaCO_3$) buildup in spawning areas or other non-depositional zones, within representative reaches and tributaries, for comparison to planned operational monitoring data. Piikani Nation also requests that this information is provided before the application is deemed complete	Water Management	i) A table of sediment quality parameters including Se can be found in the Application Volume 5, Consultant Report #5, Table 11, ii) The presence of calcite precipitate was not observed in either Gold or Blairmore creeks during characterization of baseline conditions of fish and fish habitat

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
EIS Review [47]	Piikani Nation requests that Benga: i) develops a monitoring plan designed to validate EIA assessment predictions for water quality and aquatic resources and evaluates the effectiveness of mitigation; and ii) consults with Piikani Nation prior to developing aquatic monitoring plans and prior to any approvals being issued for the Project.	Management Plans	Water quality compliance monitoring will be an integral component of the Project operations, and Benga expects certain ambient aquatic monitoring conditions to be contained in the Environmental Protection and Enhancement Act approval with respect to water quality sampling. This monitoring program will be developed and put in place prior to construction. Benga is beginning to develop monitoring plans and will continue to work with Piikani Nation to identify ways in which community members can contribute to and participate in monitoring. Benga plans to hold workshop with Piikani Nation prior to the start of construction to request further input into the water monitoring program. Benga has committed to develop a system or set of protocols with Piikani Nation to deal with environmental communications. Environmental matters can be managed through this communication system. Benga and Piikani Nation have discussed the establishment of a joint committee that will provide a forum for reviewing concerns related to water quality and aquatic resources regularly.
EIS Review [157]	Piikani Nation requests that Benga discusses the significance of any impacts on water quality and	Environmental Assessment	Benga has developed a water management strategy that facilitates both the management and use of water for the

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
	implications to aquatic resources (e.g., biota, biodiversity and habitat) and related implications for Piikani Nation's traditional and current use of these resources.	– Aquatic Ecology	Project with the intent to prevent any impact to water quality and quantity on aquatic resources. The collection of surface runoff water and the management of pit water are required for the removal of total suspended solids (TSS). The main objective is to control TSS levels to meet wastewater guidelines and objectives. Three sedimentation ponds will be located downstream of the active mining areas during the operating life of the mine to receive and treat dewatering flows for TSS prior to release into Blairmore and Gold Creeks. A fourth sedimentation pond will be located in the vicinity of the processing plant to manage storm water runoff from the plants access roads, the clean coal stockpile, the Mine Infrastructure Area and the run-of-mine pad. Water from the sedimentation ponds is intended to be captured and treated (via settling or flocculant, as necessary) prior to being released. Since the source of the water directed to the sedimentation ponds will be from surface runoff and groundwater interception and will not be exposed to the mining process, it will not require further treatment. Based on the results of geology testing it is expected that selenium concentrations will increase in water that percolates through the external (to the pit) waste rock

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
			dumps. This particular volume of water will be directed to the selenium management ponds, which have been strategically located to accept water that will be impacted by the external rock disposal areas. These selenium management ponds will collect water with selenium and nitrate concentrations and pump it to specific zones within the mine pit for treatment. Water exiting these zones will be tested and if suitable, be returned to the environment.
EIS Review [262]	Piikani Nation requests that Benga provides opportunities for Piikani Nation to provide input into, and opportunities for the community to participate in, the monitoring of any and all groundwater and surface water (including in association with wetlands) monitoring programs (this might include developing community-based monitoring programs).	Groundwater and Surface Water	A groundwater monitoring program will be implemented to detect any impacts on shallow groundwater quality resulting from mining operations. Monitoring will focus primarily on areas in the vicinity of the ex-situ rock disposal areas and surge ponds that store captured water from mine waste rock run-off. Further details are presented in Consultant Report #3, Section 7.0 for the groundwater monitoring program and in Consultant Report #5, Section 5.0 – Water Quality. (Consultant Report #3, Section 5.4.3.2, Page 53). The groundwater monitoring program will be reviewed and approved by the regulator prior to the start of operations. Benga will also seek Piikani Nation input to the program through a meeting or workshop on the subject.

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
			Benga has committed to develop a system or set of protocols with Piikani Nation to deal with environmental communications. Environmental matters can be managed through this communication system. Benga and Piikani Nation have discussed the establishment of a joint committee that will provide a forum for discussing groundwater and surface water monitoring on a regular basis.
EIS Review [264]	Piikani Nation requests that Benga develops a 'No Fishing' policy for Project staff and contractors.	Groundwater and Surface Water	Benga will include a mitigation measure that includes a 'no fishing' policy for Project staff.
EIS Review [266]	Piikani Nation requests that Benga discusses how Piikani Nation's traditional and cultural use information and concerns and issues expressed during consultation formed the aquatic resources assessment.	Use of TK Information	The Piikani Nation TK/TU report clearly indicates that there is a concern about surface water quality, ground water quality and quantity and protection of aquatic resources - especially fisheries. These concerns are perfectly aligned with Benga and the various regulators overseeing the Project application.
EIS Review [267]	Piikani Nation requests that Benga supports collecting culturally important fish and aquatic species information to be included in the Project Update assessment on aquatic resources.	Fish	From 2014 to 2016, Benga has conducted field surveys to quantify the fisheries resources on Gold and Blairmore Creeks and has through these studies contributed significantly to the information base available. Findings can be found in the January 2017 Addendum.

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
EIS Review [268]	Piikani Nation requests that Benga assesses the potential impact to fish and aquatic habitat that might be caused by using explosives in the vicinity of fish-bearing waters. Further, Piikani Nation requests that this information is provided in the anticipated Project Update prior to the application being deemed complete.	Fish	The following is an excerpt from the updated Section 6.3.1.1 contained in the January 2017 addendum: The Project intends to use explosives in the process of mining and this has the potential for creating instantaneous pressure changes (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish Wright and Hopky (1998). In addition, vibrations from the detonation of explosives may cause damage to incubating eggs. As well, blasts generate both seismic and surface waves (Rayleigh waves). Benga is committed to developing and using a blasting regime that will meet the blasting guidelines contained in Wright and Hopky (1998). Implementation of mitigation actions is expected to effectively manage and reduce the likelihood and extent of direct mortality to westslope cutthroat trout (WSCT) that inhabit both Gold and Blairmore creek watersheds. Thus, no detectable changes in WSCT relative abundance due to blasting activities, proportional to baseline conditions, is expected. Thus, this pathway was determined to have no linkage to effects on WSCT.
EIS Review [269]	Piikani Nation requests that Benga engages Piikani Nation in developing the Project's conceptual Offset, Recovery Plan and Stewardship Program. Further,	Fish	Benga is discussing with Fisheries and Oceans Canada (DFO) an offset plan to more than compensate for any fish habitat loss due to the project. Benga will consider the Piikani Nation proposal as it advances with these

Document Reference	Specific Concern Expressed	Project Specific Aspect of the Concern Expressed	Proponent Response or Effort to Avoid or Mitigate Concern
	Piikani Nation requests that Benga considers, in consultation with Piikani Nation, alternative fish offsetting options, if necessary.		discussions and will consult with Piikani Nation on the fisheries offset plan prior to its finalization.
EIS Review [270]	Piikani Nation requests that Benga engages with Piikani Nation on developing fish habitat, fish abundance and diversity and fish health management, mitigation and monitoring plans with a goal to achieve a net positive impact on aquatic resources (this might include developing community-based monitoring programs).	Fish	Benga is discussing with Fisheries and Oceans Canada (DFO) an offset plan to more than compensate for any fish habitat loss due to the project. Benga will consider the Piikani Nation proposal as it advances with these discussions and will consult with Piikani Nation on the fisheries offset plan prior to its finalization.

APPENDIX C-2: WATER BALANCE TABLES

Table 33-1 Annual Water Balance Summary for the Grassy Mine Site

		Inflow				Outflow			Change in Water Storage on Site				
Year	Precipitation	Total Site Catchment Yield	Net Groundwater Flow, Seepage to Mine Pit and Overburden	Total Inflow	Evaporation and Evapotranspiration	Flow to Creeks	Moisture in Product Coal to Market	Total Outflow	Water in Ponds	Water in Saturated Zones	Water in End Pit Lake	Waste Rock and Coal Reject Pore Water	Total Storage Change
2018	9,120,000	4,520,000	0	4,520,000	4,600,000	4,520,000	0	4,520,000	0	0	0	0	0
2019	9,120,000	4,690,000	352,000	5,040,000	4,430,000	4,520,000	429,000	4,949,000	230,000	0	0	165,000	395,000
2020	9,120,000	4,690,000	352,000	5,040,000	4,430,000	4,696,000	429,000	5,125,000	21,000	0	0	417,000	438,000
2021	9,120,000	4,910,000	352,000	5,260,000	4,210,000	4,647,000	429,000	5,076,000	20,000	0	0	575,000	595,000
2022	9,120,000	4,910,000	352,000	5,260,000	4,210,000	4,542,000	429,000	4,971,000	0	70,000	0	636,000	706,000
2023	9,120,000	5,050,000	372,000	5,420,000	4,070,000	4,616,000	429,000	5,045,000	227,000	193,468	0	336,000	756,468
2024	9,120,000	5,170,000	391,000	5,560,000	3,950,000	4,616,000	429,000	5,045,000	-90,000	386,532	0	612,000	908,532
2025	9,120,000	5,290,000	411,000	5,700,000	3,830,000	4,616,000	429,000	5,045,000	103,000	300,000	0	633,000	1,036,000
2026	9,120,000	5,390,000	430,000	5,820,000	3,730,000	4,616,000	429,000	5,045,000	14,000	300,000	0	808,000	1,122,000
2027	9,120,000	5,490,000	450,000	5,940,000	3,630,000	4,395,000	429,000	4,824,000	-26,000	300,000	0	999,000	1,273,000
2028	9,120,000	5,560,000	470,000	6,030,000	3,560,000	4,395,000	429,000	4,824,000	-51,000	476,600	0	1,069,000	1,494,600
2029	9,120,000	5,580,000	489,000	6,070,000	3,540,000	4,395,000	429,000	4,824,000	-79,000	476,600	0	1,183,000	1,580,600
2030	9,120,000	5,610,000	509,000	6,120,000	3,510,000	4,395,000	429,000	4,824,000	19,000	476,600	0	905,000	1,400,600
2031	9,120,000	5,640,000	528,000	6,170,000	3,480,000	4,700,000	429,000	5,129,000	-26,000	476,600	0	1,091,000	1,541,600
2032	9,120,000	5,670,000	548,000	6,220,000	3,450,000	4,154,000	429,000	4,583,000	-26,000	476,600	0	1,143,000	1,593,600
2033	9,120,000	5,680,000	567,000	6,250,000	3,440,000	4,154,000	429,000	4,583,000	-13,000	457,000	0	1,023,000	1,467,000
2034	9,120,000	5,700,000	587,000	6,290,000	3,420,000	4,154,000	429,000	4,583,000	-12,000	520,000	0	850,000	1,358,000
2035	9,120,000	5,690,000	607,000	6,300,000	3,430,000	4,154,000	429,000	4,583,000	-1,000	520,000	0	834,000	1,353,000
2036	9,120,000	5,650,000	626,000	6,280,000	3,470,000	4,866,000	429,000	5,295,000	-1,000	520,000	0	866,000	1,385,000
2037	9,120,000	5,600,000	646,000	6,250,000	3,520,000	4,856,000	429,000	5,285,000	22,000	520,000	0	845,000	1,387,000
2038	9,120,000	5,570,000	665,000	6,240,000	3,550,000	4,483,000	429,000	4,912,000	243,000	520,000	0	85,000	848,000
2039	9,120,000	5,520,000	685,000	6,210,000	3,600,000	4,483,000	429,000	4,912,000	1,000	644,000	0	39,000	684,000
2040	9,120,000	5,480,000	704,000	6,180,000	3,640,000	4,483,000	429,000	4,912,000	1,000	644,000	0	28,000	673,000
2041	9,120,000	5,430,000	724,000	6,150,000	3,690,000	4,483,000	429,000	4,912,000	8,000	644,000	0	1,000	653,000
2042	9,120,000	5,380,000	744,000	6,120,000	3,740,000	5,254,000	429,000	5,683,000	0	644,000	0	0	644,000
2043	9,120,000	5,300,000	763,000	6,060,000	3,820,000	4,203,000	429,000	4,632,000	234,000	644,000	555,622	0	1,433,622
2044	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,203,000	429,000	4,632,000	0	0	542,378	0	542,378
2045	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,203,000	429,000	4,632,000	0	0	533,000	0	533,000
2046	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,203,000	429,000	4,632,000	0	0	527,000	0	527,000
2047	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	520,000	0	520,000
2048	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,778,000	429,000	5,207,000	0	0	512,000	0	512,000

Table 33-1 Annual Water Balance Summary for the Grassy Mine Site

		Inflow				Outflow			Change in Water Storage on Site				
Year	Precipitation	Total Site Catchment Yield	Net Groundwater Flow, Seepage to Mine Pit and Overburden	Total Inflow	Evaporation and Evapotranspiration	Flow to Creeks	Moisture in Product Coal to Market	Total Outflow	Water in Ponds	Water in Saturated Zones	Water in End Pit Lake	Waste Rock and Coal Reject Pore Water	Total Storage Change
2049	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	506,000	0	506,000
2050	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	498,000	0	498,000
2051	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	490,000	0	490,000
2052	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,778,000	429,000	5,207,000	0	0	482,000	0	482,000
2053	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	476,000	0	476,000
2054	9,120,000	5,240,000	783,000	6,020,000	3,880,000	4,810,000	429,000	5,239,000	0	0	469,000	0	469,000

Table 33-2 Annual Water Budget for Model Nodes on Gold Creek

	Gold Creek Nodes - Upstream to Downstream													
	GC13			GC10			GC04			GC02			GC01	
Year	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC10	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC04	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC02	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC01	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to Downstream
	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
2017	3984	0	3984	12254	0	16238	18985	0	35223	3786	0	39009	28304	0	67313
2018	3984	0	3984	12254	0	16238	18985	0	35223	3786	0	39009	28304	0	67313
2019	3984	0	3984	12254	0	16238	18985	0	35223	2912	0	38135	28304	0	66439
2020	3974	0	3974	12220	0	16194	18933	0	35127	1953	0	37081	28226	0	65307
2021	3984	0	3984	12242	0	16226	18950	0	35176	1959	0	37135	28304	0	65438
2022	3984	0	3984	12217	0	16201	18876	0	35077	1959	0	37036	28304	0	65340
2023	3984	0	3984	12191	0	16176	18802	0	34978	1959	0	36937	28304	0	65241
2024	3974	0	3974	12132	0	16106	18650	0	34756	1953	0	36710	28226	0	64936
2025	3984	0	3984	12139	0	16123	18572	0	34695	1959	0	36654	28304	0	64957
2026	3984	0	3984	12112	0	16097	18442	0	34538	1959	0	36497	28304	0	64801
2027	3983	0	3983	12082	0	16065	18357	0	34422	1959	0	36381	28304	0	64684
2028	3969	0	3969	12014	0	15983	18272	0	34254	1953	0	36208	28226	0	64434
2029	3976	0	3976	12013	0	15989	18286	0	34275	1959	0	36234	28304	0	64537
2030	3973	0	3973	11978	0	15951	18251	0	34202	1959	0	36161	28304	0	64464
2031	3960	0	3960	11902	0	15862	18222	0	34083	1959	0	36042	28304	0	64346

Table 33-2 Annual Water Budget for Model Nodes on Gold Creek

	Gold Creek Nodes - Upstream to Downstream														
	GC13			GC10			GC04			GC02			GC01		
	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC10	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC04	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC02	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to GC01	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to Downstream
Year	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
2032	3926	0	3926	11747	0	15673	18150	0	33823	1953	0	35776	28226	0	64002
2033	3913	0	3913	11658	0	15571	18177	0	33748	1959	0	35707	28304	0	64010
2034	3894	0	3894	11534	0	15428	18165	0	33594	1959	0	35552	28304	0	63856
2035	3878	0	3878	11410	0	15289	18165	0	33454	1959	0	35413	28304	0	63716
2036	3852	0	3852	11255	0	15107	18116	0	33223	1953	0	35176	28226	0	63403
2037	3847	0	3847	11162	0	15009	18165	0	33174	1959	1.64	35135	28304	0	63438
2038	3832	0	3832	11037	0	14869	18165	0	33035	1959	29.69	35023	28304	0	63327
2039	3824	0	3824	10972	0	14796	18165	0	32961	1959	29.55	34950	28304	0	63253
2040	3814	0	3814	10940	0	14754	18116	0	32870	1953	29.47	34853	28226	0	63079
2041	3824	0	3824	10967	0	14791	18165	0	32957	1959	29.55	34945	28304	0	63249
2042	3824	0	3824	10965	0	14789	18165	0	32954	1959	29.54	34942	28304	0	63246
2043	3824	0	3824	10965	383.5	15172	18165	0	33337	1959	29.53	35326	28304	0	63629
2044	3814	0	3814	10935	692.2	15440	18116	0	33556	1953	29.45	35539	28226	0	63765
2045	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2046	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2047	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2048	3814	0	3814	10935	692.2	15440	18116	0	33556	1953	29.45	35539	28226	0	63765
2049	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2050	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2051	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2052	3814	0	3814	10935	692.2	15440	18116	0	33556	1953	29.45	35539	28226	0	63765
2053	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2054	3824	0	3824	10965	693.8	15482	18165	0	33648	1959	29.53	35636	28304	0	63940
2055	3824	0	3824	10965	1495	16283	18165	0	34449	1959	29.53	36437	28304	0	64740
2056	3814	0	3814	10935	1958	16706	18116	0	34822	1953	29.45	36805	28226	0	65031
2057	3824	0	3824	10965	1964	16752	18165	0	34917	1959	29.53	36906	28304	0	65209
2058	3824	0	3824	10965	1964	16752	18165	0	34917	1959	29.53	36906	28304	0	65209
2059	3824	0	3824	10965	1964	16752	18165	0	34917	1959	29.53	36906	28304	0	65209
2060	3820	0	3820	10954	1961	16736	18148	0	34884	1957	29.5	36870	28276	0	65147

Table 33-3 Annual Water Budget for Model Nodes on Blairmore Creek

	Blairmore Creek Nodes - Upstream to Downstream														
	BL03			BC07			BL02			BC03			BC01		
	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC07	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BL02	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC03	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC01	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to Downstream
Year	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
2017	15512	0	15512	6784	0	22296	2823	0	25119	17044	0	42163	10205	0	52367
2018	15512	0	15512	6784	0	22296	2823	0	25119	17044	0	42163	10205	0	52367
2019	15512	0	15512	6758	1712	23982	2590	216.8	26789	16362	1309	44460	10205	0	54665
2020	15470	0	15470	4536	3467	23474	2299	439	26212	15438	2651	44301	10177	0	54478
2021	15512	0	15512	2197	6185	23894	2194	469	26557	15191	2678	44426	10205	0	54633
2022	15512	0	15512	2197	7018	24728	2031	389.7	27148	14899	2103	44149	10205	0	54358
2023	15512	0	15512	2197	7001	24711	1867	401.8	26979	14606	2182	43768	10205	0	53977
2024	15470	0	15470	2191	7494	25155	1736	500.4	27392	14408	2776	44576	10177	0	54757
2025	15512	0	15512	2197	7389	25099	1657	542.9	27299	14433	3035	44766	10205	0	54975
2026	15512	0	15512	2197	7137	24847	1573	568	26988	14418	3187	44592	10205	0	54801
2027	15512	0	15512	2197	5658	23368	1517	428.9	25313	14401	2346	42061	10205	0	52270
2028	15470	0	15470	2191	6817	24478	1488	615.1	26582	14344	3471	44397	10177	0	54578
2029	15512	0	15512	2197	6762	24472	1468	646	26586	14365	3656	44607	10205	0	54816
2030	15512	0	15512	2197	7050	24760	1444	720.6	26924	14347	4108	45379	10205	0	55588
2031	15512	0	15512	2197	6775	24485	1431	726.1	26642	14337	4142	45120	10205	0	55329
2032	15470	0	15470	2191	3217	20878	1427	317.8	22623	14297	1676	38596	10177	0	48777
2033	15512	0	15512	2197	6200	23910	1430	736.8	26077	14336	4206	44618	10205	0	54827
2034	15512	0	15512	2197	7069	24779	1430	872	27081	14335	5022	46438	10205	0	56647
2035	15512	0	15512	2197	7076	24786	1430	880.7	27096	14335	5075	46506	10205	0	56715
2036	15470	0	15470	2191	6998	24659	1426	878.8	26964	14296	5064	46324	10177	0	56505
2037	15512	0	15512	2197	6996	24706	1430	886.5	27022	14335	5110	46467	10205	0	56676
2038	15512	0	15512	2197	3693	21402	1430	475.5	23308	14335	2628	40271	10205	0	50480
2039	15512	0	15512	2197	7450	25159	1430	955.3	27545	14335	5525	47405	10205	0	57614
2040	15470	0	15470	2191	7365	25026	1426	944.5	27397	14296	5461	47154	10177	0	57334
2041	15512	0	15512	2197	7303	25013	1430	936.9	27380	14335	5414	47129	10205	0	57338
2042	15512	0	15512	2197	7179	24889	1430	921.2	27240	14335	5319	46894	10205	0	57103
2043	15512	0	15512	2197	3165	20874	1430	398.1	22702	14335	2322	39360	10205	0	49576
2044	15470	0	15470	2191	6615	24276	1426	834.9	26537	14296	4961	45794	10177	0	55982
2045	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2046	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2047	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2048	15470	0	15470	2191	6615	24276	1426	834.9	26537	14296	4961	45794	10177	0	55982
2049	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2050	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2051	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2052	15470	0	15470	2191	6615	24276	1426	834.9	26537	14296	4961	45794	10177	0	55982
2053	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2054	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2055	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2056	15470	0	15470	2191	6615	24276	1426	834.9	26537	14296	4961	45794	10177	0	55982
2057	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2058	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135

Table 33-3 Annual Water Budget for Model Nodes on Blairmore Creek

	Blairmore Creek Nodes - Upstream to Downstream														
	BL03			BC07			BL02			BC03			BC01		
	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC07	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BL02	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC03	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to BC01	Undisturbed Catchment (Surface and Groundwater	From Site (Seepage + Discharge)	Total to Downstream
Year	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
2059	15512	0	15512	2197	6633	24343	1430	837.2	26610	14335	4974	45919	10205	0	56135
2060	15497	0	15497	2195	6626	24319	1429	836.4	26584	14321	4969	45875	10195	0	56081

APPENDIX E-1: TERRAIN ASSESSMENT

1. Terrain Hazards

It is NRCan's view that the proponent should evaluate the landslide potential beyond the immediate vicinity of infrastructures (e.g., pit walls and storage dumps). NRCan recommends that the evaluation of landslide risk needs to include steep ground above infrastructure.

NRCan requests information on landslide potential that exists in the LSA that could impact project activities and infrastructure. Please include the methodology followed to evaluate the landslide risk in the area.

Response

1.0 INTRODUCTION

There have been no federally adopted landslide safety criteria in Canada; however, landslide potential assessments can be performed using best engineering and geological practices by evaluating the landslide risk hazard based on the local conditions and circumstances of the Project site, utilizing available geological and historical data.

The Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction (Porter and Morgenstern, 2013) suggests that the risk evaluation approach and landslide safety criteria used in an evaluation varies depending on the scenario; selecting the appropriate method for local conditions and circumstances. Given the low number of recorded landslides in the area, a magnitude-frequency relationship analysis was not deemed a practical method of assessment.

NRCan describes an appropriate method of evaluating landslide safety called *Partial Risk (Encounter Probability*) whereby the project area is located downslope or behind a potential landslide area. Partial risk criteria can be used when it can be demonstrated that landslide risk is very low; or that the probability of occurring and reaching the development area is unlikely or very unlikely (Porter and Morgenstern, 2013).

A modified likelihood of failure approach has been selected to assess the level of landslide potential across the Project region and identify areas of potential concern where additional ground control monitoring might be necessary.

2.0 METHODOLOGY

To assess landslide potential of the Project area and upper slopes qualitative and semi-quantitative approach elements were used based on a combined factor analysis of conditions and circumstances inherent to the existing slopes above and around the Project infrastructure.

The LSA and upper slopes were grouped into regions (A, B, C, D, E, F, G, H, I and J) with similar spatial and physiographic characteristics in order to identify areas having lower and greater landslide potential in the consultation zone, primarily in the upper slopes of the Project area (Figure 1-1). *The consultation zone* includes the area of proposed development within the maximum credible extent of potential landslides (Hungr and Wong, 2007). The consultation zone in this landslide evaluation consists of the LSA and areas where the steeper mountainous slopes beyond the proposed pit and dump limits could have landslide potential impacting the Project development and infrastructure.

Each region within the consultation zone was assessed according to factors affecting landslide susceptibility: slope gradient, bedrock attitude, presence of structural discontinuities, nature of soil cover, vegetation cover, precipitation influences and frequency of previous instability events. Existing data sets used in the combined factor analysis are listed in Table NRCan 1-1.

Table NRCan 1-1 Datasets for Combined Factor Analysis

Data Set	Information Source
Slope Angle/Grade	• Slope Classes Within the RSA; 2016 EIS Figure 3.3-1 by Millennium EMS Solutions Ltd. Dated June 13, 2016 • Calculations from topo data
Bedrock	• Bedrock Geology evaluated from 2016 EIS, Section B – Geology and Geotechnical, Figures B.1.1-0, B1.1-3, B1.1- • Bedrock attitude evaluated from Cross Sections in 2016 EIS, Section B – Geology and Geotechnical, Figures B.2.0-1 to B.2.0-7 by Riversdale Resources Limited. Dated May 2, 2016
Soil Cover	• Soil cover evaluated from excerpts from the Grassy Mountain Coal Project Baseline Soil Survey and Impact Assessment, prepared for Benga Mining Limited, by Millennium EMS Solutions Ltd., June 2016. Including Figure 4.1-1 Thicknesses of Soil Layers within the RSA, Dated June 13, 2016. • Bobrowsky, P.T. & Dominguez, M.J. 2012. Landslide Susceptibility Map of Canada; Geological Survey of Canada, Open File 7228, scale 1:6 million. doi:10.4095/291902 • Surficial Mapping Program, Alberta Geological Survey. Retrieved April 3, 2018 from http://ags-aer.maps.arcgis.com/apps/webappviewer/index.html?id=d85fd3dd5daa424488bd82dfd9033846 • Borehole data from 2016 EIS, Section B – Geology and Geotechnical

Table NRCan 1-1 Datasets for Combined Factor Analysis	
Data Set	**Information Source**
	by Riversdale Resources Limited. Dated May 2, 2016
Vegetation Cover	• Air photos • Excerpts from the Grassy Mountain Coal Project Baseline Soil Survey and Impact Assessment, prepared for Benga Mining Limited, by Millennium EMS Solutions Ltd., June 2016. • Vegetation and Wetlands Assessment Grassy Mountain Coal Project Assessment, prepared for Benga Mining Limited, by Millennium EMS Solutions Ltd., July 2016.
Event Frequency	• Historical landslides that have resulted in fatalities in Canada (1771–2014); Geological Survey of Canada, Open File 7836 • Imagery 2018 S. Alberta MDs and Counties, DigitalGlobe, Map Data 2018 • Air photos • Modified from Multi-hazard Risk Evaluation Matrix, Porter & Morgenstern 2016
Precipitation	• SRK Consulting (Canada) Inc. 2016. Grassy Mountain – Raw Water Pond Inflow Design Flood Memo. November 21, 2016. • Benga Mining Ltd. – Grassy Mountain Coal Project Conformity Information Requests, Nov. 2017. Appendix 25A. • Environment Canada. Meteorological Service of Canada. Canadian Climate Normals. 1981-2010 Climate Normals & Averages.

The landslide susceptibility factors for each region in the consultation zone were assessed. Ratings were assigned to the susceptibility factors (A to I) and, when totaled, result in a combined susceptibility rating. The combined ratings were colour coded and applied to the consultation zone regions to produce a landslide susceptibility map (Figure 1-2). This method also allowed for identification of areas of potential concern; specific areas within the regions that contain a number of the higher landslide susceptibility attributes. These areas have been marked with a flag on Figure 1-2. Evaluation criteria used for the combined factor analysis are presented in Table NRCan 1-2 and the landslide susceptibility combined factor analysis is presented in Table NRCan 1-3. The combined susceptibility ratings for each region are recorded in Table NRCan 1-4.

Fall lines were calculated within the consultation zone to determine rock fall shadows for potential landslide movement. The spatial relationship of the areas of potential concern, fall

lines and existing and future infrastructure were assessed to identify areas having higher risk for potential impact due to landslides.

Table NRCan 1-2 Landslide Susceptibility Criteria for Combined Factor Analysis

Risk Rating	Susceptibility Rating	Slope		Bedrock Attitude	Soil Cover (m)	Soil Type	Vegetation Cover	Annual Precipitation (mm)	Historical Landslide Frequency*
		Slope Percent	Approx. Degrees						
Negligible	0	0-10	0-6.3^0	<10^0 bedding dips/no discontinuities	<1.0	no soil	>90%	0-100	Event is possible but expected to occur less than once every 10,000 years
Low	1	10-30	6.3-16.7^0	bedding dips into slope/fault planes dip into slope	1.0 - 2.0	Alluvial/Glacial Deposits	70-90%	>100-400	Event expected to occur 1,000 to 10,000 years
Moderate	2	30-45	16.7-24.2^0	bedding dips downslope/fault planes dip into slope	2.0-3.0	Glaciofluvial	50-70%	>400-600	Event expected to occur 100 to 1000 years
Mod-High	3	45-70	24.2-35^0	bedding dips into slope/fault planes dip downslope	3.0-5.0	Colluvial	30-50%	>600-1000	Event expected to occur 10 to 100 years
High	4	70-100	35-45^0	bedding dips downslope/fault planes dip downslope (≤45^0)	5.0 - 10.0	Glaciolacustrine/Lacustrine	10-30%	>1000-1500	Event typically occurs every few years
Extremely High	5	>100	>45^0	bedding dips downslope/fault planes dip downslope (>45^0)	>10.0	Lacustrine/Marine	<10%	>1500	Event typically occurs once per year

*Modified from Multi-hazard Risk Evaluation Matrix, Porter & Morgenstern 2016

3.0 COMBINED FACTOR ANALYSIS

The factors listed below comprise the physical characteristics evaluated for each region in the Combined Factor Analysis. These factors were selected because of their relevance to landslide susceptibility and the availability of the associated datasets.

3.1 Slope Angle

Structural conditions of the slopes susceptible to potential landslides (rockfall) "include terrain with overhanging rock or fractured or jointed rock along steep slopes, particularly in areas subject to frequent freeze-thaw cycles" (Highland and Bobrowsky, 2008. P.7). Slope angle is a critical element influencing landslide potential and thus was selected as a primary factor in establishing the regions in the consultation zone for the combined factor analysis. This approach will ensure that the evaluation of landslide risk will include steep ground above infrastructure. Boundaries of regions A to J were defined primarily on dominant slope angle in order to delineate areas having a higher degree of landslide susceptibility if additional conditions prevail. The locations of regions A to J are illustrated in Figure 1-1.

3.2 Bedrock

The upper slopes of the consultation zone and outside the proposed pit limits are composed primarily of Cretaceous aged sediments of the Blairmore Group. Both the Cadomin and Gladstone Formations are represented, the former consisting of a green alluvial conglomerate and the latter consisting of a fining upward sequence of sandstones, siltstones and claystones. The units are assumed to have intact rock strength.

The dominant bedrock composition was assigned to each region; however, no hazard rating was assigned to rock type as most of the bedrock sediments in the area are lithified and very resistant to erosion. Bedding planes, shear zones and structural discontinuities in the bedrock could influence landslide potential. Zones where the bedrock bedding planes dip downslope and structural discontinuities present also dip downslope have been classified as having a higher landslide potential.

Shear zones are considered a critical triggering element for deep seated landslides, which can increase potential threat to the Project infrastructures. Information about weak shear zones within the upper rock slopes is not available and therefore evaluation of the likelihood of deep seated landslides to occur within the consultation zone is beyond our current assessment.

3.3 Soil Cover

Soil cover was assigned a hazard rating based on soil type (Bobrowsky & Dominguez, 2012). The consultation zone consists predominantly of colluvial and moraine sediments overlying bedrock with some fluvial/glaciofluvial sediments in low lying areas near streams/rivers. Soil depth for each region was highly variable based on borehole results from resource and geotechnical drilling programs. Generally, it can be said that the thicker packages of Quaternary sediments can be found near the base of valleys and stream/river beds. The surficial geology deposits thin out to < 1.0 m at higher elevations and on steeper slopes, including several higher altitude locations having exposed bedrock with no soil cover.

3.4 Vegetation Cover

Vegetation cover for each region was evaluated from air photo and satellite imagery with estimates of tree coverage being the primary discretionary feature. Most areas devoid of tree growth were observed to be on steep terrain or in areas where clearcutting occurred. The clearcut locations were included as having no cover, although most of these areas displayed signs of regrowth (*e.g.* reforested or populated by small shrubs and grass).

3.5 Precipitation

The precipitation hazard ratings for most of the regions were evaluated as low to moderate based on average annual precipitation in the region relative to low and high precipitation regions in Canada (Environment Canada). The consultation zone has been categorized as having a Montane and Sub-alpine Natural Sub-region characteristics, which coincide with historical annual precipitation values for the region. It is recognized that extreme precipitation events could increase landslide potential in some areas; however, it is estimated that a significant percentage of the upper steep slopes in the consultation zone has minimal cover to withhold water saturation (<1m).

3.6 Historical Landslide Frequency

There were three recorded landslides in the region that resulted in fatalities (Blais-Stevens, Castagner and Behnia, 2015) and there have been documentation of older coal mine pit collapses in the region as stated in Benga's Attachment 2: Response to CEAA's Request for Additional Information, p. 2-95. Landslide occurrences in the upper slopes of the Project consultation area have not been noted; however, it was estimated that the potential for frequency would increase in areas where slope angle was greatest. Future foot surveys and detailed air photo assessments can further augment the accuracy of this dataset.

Table NRCan 1-2 Landslide Susceptibility Combined Factor Analysis

Region	Slope %	Slope Height (m)	Slope Face Direction	Infrastructure in Fall Line (Commissioning Yr)	Dominant Bedrock Fm	Bedrock Attitude	Fault Planes	Soil Cover Depth (m)	Dominant Soil Type	Vegetation Cover	Annual Precipitation (mm)	Frequency of Event
A	*30-45	110	East	n/a	Gladstone	*West 40-45°	None	0-4	Colluvial (Moraine)	70% (~30% clearcut but new growth established)	400-600	1,000 to 10,000 years
B	*45-70	170	East/West	NW Surge Pond (6)	Gladstone	West 25-55°	1 major - west dip various minor 50-70°	0-10	Colluvial	50% forest on sloped areas	400-600	100 to 1000 years
C	*30-45	550	East/West	North Rock Disposal Area (year 6)	Gladstone	*West 20-30°	1 major - west dip (Turtle Mountain Thrust Fault) various minor 65-70°	0-2	Colluvial	80% forest w/ new growth on clearcut areas	400-600	1,000 to 10,000 years
D	45-70	150	East	NE Sediment Pond (13); East Sediment Pond (6)	Fernie, Gladstone, Cadomin, Kootenay, Moose Mountain*	West 30-45° East 60-85°	2 major - west dip (Turtle Mountain Thrust Fault); various minor west 40-70°	0-9	Colluvial	25% forest predominantly on base of slopes	400-600	100 to 1000 years
E	*10-30	200	West/East	NE Sediment Pond (13)	Gladstone	East 40-50° Anticline close to west edge	1 major - west dip various minor 40-50°	<2-11	Moraine	90% treed to the North; 10-20% to the south	400-600	10,000 years
F	*45-70	360	SW/NE	NE Sediment Pond (13)	Gladstone	*East 50-60°	1 major - west dip	No Data	Colluvial	75-85% forest	400-600	100 to 1000 years
G	*30-45	150	West	Power Line (0)	Gladstone	*West 20-30°	1 major - west dip	0-5	Moraine (Colluvial)	80 % forest	400-600	1,000 to 10,000 years
H	30-70	260	NW/West	Raw Water Pond (0); Power Line (0); Overland Conveyor (0); Mine Road (0); Camp (0)	Fernie	*West 20-30°	1 major - west dip (Turtle Mountain Thrust Fault)	0-7	Colluvial (Moraine)	90-95% forest on N slope facing CHPP	400-600	100 to 1000 years
I	30-45	140	West	SE Surge Pond (1); East Sediment Pond (6); Power Line (0)	Gladstone	East up to 70° on limbs of anticline	various minor 40-60° west	<3-10	Fluvial/Colluvial	35% on West facing slopes; 90% on slopes in S lobe	400-600	1,000 to 10,000 years
J	45-70	420	West/East	Power line (0)	Fernie	*West 40-45°	2 major - west dip (Turtle Mountain Thrust Fault) various minor 50-80°	No Data	Colluvial	80% forest with ~20% on steep W facing slopes	400-600	100 to 1000 years

*Extrapolated from partial dataset: i.e. Part of the region was outside the dataset limits.

4.0 DISCUSSION OF ASSESSMENT RESULTS

Table NRCan 1-3 Landslide Susceptibility Combined Factor Analysis shows the assessment of the susceptibility factors for each region of the consultation zone. The evaluation provided a basis to assign a susceptibility rating for six of the factors. In addition to information presented in Table NRCan 1-3, the following list summarizes the key characteristics of each region, highlighting areas having potential risk on Project infrastructure:

Region A – Region A was assessed as having lower risk because most of the region lies outside the consultation zone, with the exception of the southernmost lobe. Although the lobe has a moderate slope gradient facing towards the NW Surge Pond, the fall line would not extend past the base of the valley to the currently proposed pond location.

Region B – A large percentage of Region B has slope grades between 45-70%. Much of the northern portion of the region is outside the consultation zone, as the mountainous terrain is beyond influence of the Project. The North Rock Disposal Area (NRDA) footprint and pit crest transect the region, which have been studied in previous stability assessments. Areas of concern lie directly above the NW Surge Pond and the West Sedimentation Pond. The west facing slope above the West Sediment Pond is of particular concern as the bedrock bedding and local discontinuities dip downslope to the west. However, the slopes are densely forested and boreholes in the area show less than 1 m of soil cover.

Region C – The dominant slope grade in the region is 30-45% with the northern half lying outside the consultation zone. The southern half of the region has slopes with a wide range of orientations (*e.g.* south facing, west facing, NE facing, NW facing) all defining an area within the proposed NRDA footprint. Upper slopes beyond the dump footprint have no influence on potential landslide impact to the Project.

Region D – This region contains high slope angles, diverse bedrock formations, regional discontinuities and a low percentage of vegetation cover. Region D contains the proposed pit area and the stability concerns have been addressed in other submissions; however, areas of potential concern have been flagged on Figure 1-2: Landslide Susceptibility Map.

Region E – This region is defined by the lower grade slopes and valley floor containing Gold Creek in the northern half of the study area. The region has been assessed as having a low landslide susceptibility rating, largely due to shallower slopes where bedding and structural discontinuities dip into the east facing slopes.

Region F – The majority of this region has been evaluated as having moderate landslide susceptibility risk. The steep west facing slopes on the east side have been flagged as an area of potential concern, especially in the location directly upslope of the proposed NE Sediment Pond.

Region G – Slopes in the region are predominantly 30-40% facing east and south. There are steeper slopes in the northern portion of the region, but the landslide risk areas are facing away from the Project area towards highway 40 and are technically beyond the consultation zone.

Region H – Although ~80% of the slopes in this region have been mapped at a 30-45% grade, there are areas having up to 70% grade in the upper elevations. Region H includes a large number of infrastructure elements including the mine road, overland conveyor, CHPP, SW Surge Pond, Raw Water Plant and the Plant Site Sediment Pond. The west facing slope above the overland conveyor and mine road has been flagged as an area of potential concern due to the bedding and structural features dipping downslope; however, the critical slope is heavily treed and the main structural discontinuity defines the valley at the base of the slope.

Region I – The region was assessed as having low landslide susceptibility, largely due to the gentle slopes defining the west half of the terrain. Slope grade increases on the west facing slopes of the region's east half, which contributes to an area of potential concern being identified directly upslope of the East Sediment Pond.

Region J – Located in the southernmost region of the study area, a large percentage of the terrain is beyond the consultation zone limits. The region contains major structural elements, including the Turtle Mountain Thrust Fault, as well as steep slope gradients and areas with little to no soil cover. Areas of potential concern have been identified in this region and the northernmost lobe of the terrain has been flagged as a higher risk area due to its juxtaposition with the power line.

The susceptibility ratings for the factors in each region are scored on Table NRCan 1-4, with the same colour coding scale depicted on the associated Landslide Susceptibility Map shown in Figure 1-2.

Table NRCan 1-3 Landslide Susceptibility Rating by Region

Region	Slope %	Bedrock Attitude	Dominant Soil Type	Vegetation Cover	Precipitation	Frequency of Event	Combined Hazard Rating
A	2	1	3	1	2	1	10
B	3	5	3	2	2	2	17
C	2	5	3	1	2	1	14
D	3	5	3	4	2	2	19
E	1	3	3	2	2	0	11
F	3	3	3	1	2	2	14
G	2	5	3	1	2	1	14
H	3	5	3	0	2	2	15
I	2	1	2	3	2	1	11
J	3	5	3	4	2	2	19

Susceptibility Rating

Landslide Susceptibility	Rating	Combined Rating
Negligible	0	0-5
Low	1	6-11
Moderate	2	12-17
Mod-High	3	18-23
High	4	24-27
Extremely High	5	28-30

5.0 LANDSLIDE POTENTIAL INTERSECTS PROJECT INFRASTRUCTURE

A number of the Project's infrastructure elements are located in areas nearby steep upper slopes; however, most of the elements are outside the fall shadows of locations flagged as having a higher landslide susceptibility rating. Infrastructure elements estimated to be in the fall line of areas having higher landslide susceptibility have been noted with red flags on Figure 1-2 and include the following:

1. Proposed NE Sediment Pond below steeply dipping east and west facing slopes in Regions D and F; both slopes having bedding and structural elements dipping downslope (Flags #1, #2).
2. Proposed East Sediment Pond below fall line of west and east facing slopes in Regions D and I; both have steeply dipping upper slopes and bedding/structural elements dipping downslope (Flags #3, #4).
3. Existing power line below steep northeast and east facing slope in Region J (Flag #5).
4. Proposed West Sediment Pond below steeply dipping upper slopes with bedrock bedding and regional discontinuities dipping out of slope (Flag #6).
5. Existing overland conveyor and mine road access below steeply dipping west facing slopes in Region H; bedding and local structure dipping out of slope (Flag #7).

Other areas of potential concern but with no direct impact on the mine infrastructure are shown in Figure 1-2 Flags 8 to 11. It should be noted that these are areas of potential concern and should be reassessed by conducting a detailed site reconnaissance to evaluate ground conditions and ensure the susceptibility factors have been accurately evaluated.

6.0 MITIGATION MEASURES

The following measures will be implemented to improve understanding of the ground conditions in the upper slopes within the consultation area:

- Perform foot survey of geomorphic features diagnostic of landslides in areas of potential concern, for example; tension cracks, crescent-shaped or curved scarps or depressions; shallow, linear depressions, step-like benches or small scarps; fresh rock or soil surfaces; groups of toppled, leaning, or split trees; disturbed linear features (fences, roads, powerlines); revegetated scars or partially revegetated strips; linear strips of even-aged vegetation or trees, etc. (Jackson, Bobrowsky & Bichler 2012). A field survey will confirm or negate areas categorized with a higher landslide susceptibility rating during the study.

- Perform field mapping exercise to identify overhangs and areas having evidence of previous rockfalls/slides and any areas displaying shear zones at surface. Locations where these features are noted would become key observational areas for annual inspections.
- Include annual ground condition inspections with increased frequency after major precipitation events.
- Incorporate confirmed areas of potential concern (red flags in Figure 1-2) into comprehensive ground monitoring program planned for the Project area. Recommended slope monitoring methods have been listed in response to question 184: Volume 3, Appendix 9C, Section 8.0, Page 15. The selected monitoring program should incorporate elements that capture slope movement in the areas having higher landslide susceptibility identified in this study.

7.0 CONCLUSION

Based on the landslide susceptibility evaluation, with particular focus on the steep upper slopes in and around the Project area, there are areas in the consultation zone exhibiting moderate-high landslide susceptibility. Areas of potential concern have been identified; however, most of these areas are not in locations where project development and infrastructure would be adversely affected. The landslide susceptibility map has flagged areas of potential concern that should be incorporated into an annual ground inspection and slope monitoring plan. The observational approach as a mitigation measure will ensure any changes in the ground conditions are identified in areas having higher landslide susceptibility.

The landslide evaluation of the Grassy Mountain consultation zone, with focus on the upper slopes surrounding the project area, was executed as a preliminary desktop study to identify areas of potential risk. Terracon highly recommends that the landslide susceptibility assumptions made during the evaluation are confirmed with detailed site reconnaissance and physical mapping exercises.

8.0 LIMITATIONS

This assessment was conducted in accordance with generally accepted geological and engineering principles and practices, and based on information provided by Benga, and our recommendations may not be appropriate if site conditions differ than those reported herein. Terracon shall not be liable if different surface or subsurface conditions encountered at the study area other than conditions relied on in our assessment. Terracon reserves the right to re-evaluate the recommendations presented in this report should new information become available.

All recommendations, conclusions, specifications and drawings presented in this report are prepared on the assumption that all information supplied by Benga, or by others on behalf of or on the instructions of Benga, and by public sources is correct and accurate, and Terracon shall not be liable for any reason, including, but not limited to, any loss, cost expense or damage arising from or as a result of the incorrectness or inaccuracy of such information. Benga shall, upon such incorrectness or inaccuracy coming to its attention, notify Terracon thereof and Terracon shall be entitled to make any corrections, alterations or changes in the plans, specifications, drawings or designs, prepared on the basis of such incorrect or inaccurate information, at Benga's expense.

9.0 REFERENCES

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5512500.0000 5510000.0000 5507500.0000 5505000.0000 5502500.0000 5500000.0000 5497500.0000

A B C D E F G H I J

DUMP

N

0 1000 2000 Meters

LEGEND

- WATER BODY
- WATER COURSE
- PROPOSED POND
- MAJOR CONTOUR 50 m
- MINOR CONTOUR 10 m
- MAJOR TRAIL
- MINOR TRAIL
- REGION PERIMETER
- ULTIMATE PIT
- WASTE ROCK DUMP
- RAIL SPUR

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FIGURE 1-1 GRASSY MOUNTAIN PROJECT
LANDSLIDE SUSCEPTIBILITY REGIONS
WITHIN CONSULTATION ZONE

TERRACON GEOTECHNIQUE

SCALE : REFER TO DRAWING

PROJECT NO. 184140

DRAWING NO.: FIGURE 1-1

SHEET 1 OF 1

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A B C D E F G H I J

1 2 3 4 5 6 7 8 9 10 11

N

0 1000 2000 Meters

LEGEND

- WATER BODY
- WATER COURSE
- PROPOSED POND
- MAJOR CONTOUR 50 m
- MINOR CONTOUR 10 m
- MAJOR TRAIL
- MINOR TRAIL
- REGION PERIMETER
- ULTIMATE PIT
- WASTE ROCK DUMP
- RAIL SPUR
- NEGLIGIBLE LANDSLIDE SUSCEPTIBILITY
- LOW LANDSLIDE SUSCEPTIBILITY
- MODERATE LANDSLIDE SUSCEPTIBILITY
- MOD-HIGH LANDSLIDE SUSCEPTIBILITY
- HIGH LANDSLIDE SUSCEPTIBILITY
- EXTREMELY HIGH LANDSLIDE SUSCEPTIBILITY
- AREAS OF POTENTIAL CONCERN (APC)
- APC IMPACTING INFRASTRUCTURE

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FIGURE 1-2

GRASSY MOUNTAIN PROJECT LANDSLIDE SUSCEPTIBILITY REGIONS WITHIN CONSULTATION ZONE - COLOUR CODED

TERRACON GEOTECHNIQUE

SCALE : REFER TO DRAWING

PROJECT NO. 184140

DRAWING NO.: FIGURE 2-1

SHEET 1 OF 1