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November 29, 2020

Martin Ignasiak
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Our Matter Number: 1167150

Montréal

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Ottawa

Grassy Mountain Coal Project Joint Review Panel
Impact Assessment Agency
160 Elgin Street, 22nd Floor
Place Bell Canada
Ottawa, ON K1A 0H3

Vancouver

New York

Attention: Alex Bolton, Chair, Joint Review Panel

Dear Mr. Bolton:

**Re: Benga Mining Limited (“Benga”)
Grassy Mountain Coal Project (“Project”)
CEAA Reference No. 80101
Response to Undertaking #22**

We write to provide Benga’s response to undertaking #22, given in the public hearing for the above noted Project.

Undertaking #22: Provide calculated flow reductions for all study reaches and Westslope Cutthroat Trout (“WSCT”) life stages on Gold Creek which cause fish habitat (Area Weighted Suitability or “AWS”) to decline by 10% averaged over the pertinent fish bioperiods.

Benga’s Response: Attached at Appendix “A” is a memorandum that sets out the flow reductions for all study reaches and WSCT life stages on Gold Creek which cause AWS to decline by 10% averaged over the pertinent fish bioperiods, and the methodology used to determine the same.

Status: Complete

We assume the above response satisfies the undertaking given.

Yours truly, 
<Original signed by>

Martin Ignasiak

cc. Gary Houston
Mike Bartlett

Appendix “A”



Hatfield Ref #: MEMS9950-NV

November 27, 2020

BENGA MINING LTD.
12331 – 20 AVENUE, PO BOX 660
BLAIRMORE, AB
CANADA T0K 0E0

Attention: Gary Houston, VP of External Affairs

Re: Response to CIAR 881 Undertaking #22 request for information relating to the Grassy Mountain Coal Project (80101)

Dear Mr. Houston:

As per CIAR 881 Undertaking #22 (pdf page 4183, beginning on transcript line 12), Mr. Dean O’Gorman (AER) requested that flow reductions be provided for all study reaches and WSCT lifestages on Gold Creek, which cause fish habitat (Area Weighted Suitability- AWS) to decline by 10% averaged over pertinent fish bioperiods. Details regarding the methodology used were also requested. The following outlines the flow reductions and the methodology used.

We trust these additional data satisfy the request. If more follow up is required, please let me know.

Sincerely,

<Original signed by>

Dan Bewley, PhD
Senior Hydrologist
HATFIELD CONSULTANTS

cc: Cory Bettles, MSc RPBio FP-C, Senior Fisheries Biologist (Hatfield)
Mike Bartlett, Senior Project Manager (MEMS)

METHODS

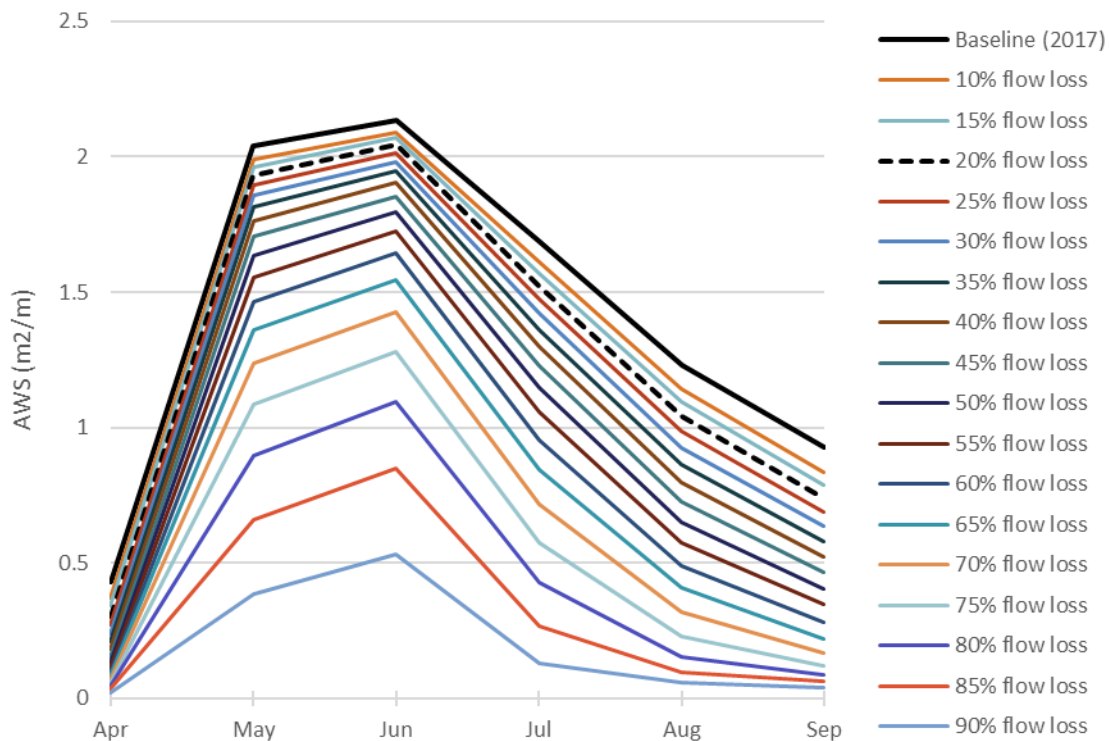
To generate modeled hydrological-habitat relationships and associate changes in flow with a 10% change (decline) in area weighted suitability (AWS) we used the same software (System for Environmental Flow Analysis; SEFA) that was used in the Instream Flow Assessment (IFA, CIAR#44, Appendix A3).

To recap from the IFA, each input monthly surface flow value translates into a predicted AWS value using the flow-habitat curves modelled for each life stage and reach (themselves determined by a combination of field-calibrated flow-hydraulic relationships and the WSCT life stage-specific Habitat Suitability Criteria). The baseline (2017) mean AWS for adult rearing WSCT, for instance, is calculated as the average of six (6) AWS values specifically from April to September (the annual period in which rearing occurs).

To derive the predicted 10% change in AWS, a sensitivity analysis was conducted that introduces a series of incremental, hypothetical flow alterations to each monthly baseline surface flow value for a given WSCT life stage. These alterations ranged from 10% flow reduction, to 90% flow reduction, in increments of 5% flow reduction. The mean AWS was calculated under each change (flow-loss) scenario and compared to the mean AWS value calculated under baseline (existing) conditions (i.e., no change in surface flow as a result from the Project). The 'flow loss' scenario, which resulted in a mean AWS reduction closest to 10%, was then carried forward into the final results table.

Figure U22.1 provides an illustration to clarify the methods described. Figure U22.1 highlights the monthly predicted change for Reach 8 adult rearing WSCT AWS under average, existing conditions as well as applying incremental flow reduction scenarios. In this particular example, the 20% flow reduction scenario produced a 10.2% decline in adult rearing WSCT AWS averaged over the 6-month (stanza) period; the closest scenario to a 10% reduction. This implies that a 10% mean AWS loss is predicted to occur if April-September monthly total surface flows decline by, on average, 20% during an individual year (or series of consecutive years) during project operations or beyond.

Figure U22.1. Gold Creek Reach 8 Predicted Adult Rearing WSCT AWS under average, baseline conditions, and modelled incremental flow loss scenarios



RESULTS

Table U22.1 provides the following metrics, for each life stage of WSCT and reach on Gold Creek:

1. Average Baseline Flow (m^3/s);
2. Mean Flow required to reduce average AWS by ~10% (m^3/s);
3. Mean Flow reduction (subtraction of 2. from 1.) (m^3/s);
4. Mean Flow reduction (in %);
5. Actual % AWS loss to the nearest %, using the selected flow reduction scenario.

Point 5 has been included since an exact flow loss scenario producing exactly 10% AWS reduction requires a deeper level of analysis beyond the timeline available for this undertaking (for instance, running flow loss scenarios at 1% or even 0.1% increments, compared to the 5% increments used in this analysis). However, the 5% flow incremental reductions were able to simulate AWS reductions of $10\% \pm 1\%$ in the large majority of instances.

A high-level overview of the results indicates the following points:

1. Baseline flows above Caudron Creek (Reaches 9 and 8) are naturally the lowest; here AWS is particularly sensitive to simulated flow losses in these reaches (i.e., 10% AWS reduction is reached with smaller predicted surface flow loss % scenarios); and

2. In the highest flow reaches (Reaches 7 and 5, downstream of Caudron and Morin Creek inflows, respectively), large surface flow losses may be required to reduce AWS by 10% for selected life-stages (most notably spawning and fry). This is because these life-stages, in particular, are more suited to lower flow and corresponding hydraulic (depth, velocity) conditions than those present in these reaches. In effect, an inverse flow-habitat relationship occurs here, until a critical point very close to zero-flow where habitat decreases rapidly. This results in occasionally very high flow reductions (e.g., 70% or above; Table U22.1) needed to reduce mean AWS by 10%. These relationships can be seen as part of the reach and life-stage-specific flow-AWS curves presented in the IFA, which themselves are controlled by the WSCT habitat suitability criteria (HSC) data. This clearly indicates the declining preference of fry and spawning WSCT to progressively higher stream depths and velocities.

While the outcomes regarding the latter (point 2.) are important, our primary focus of the IFA was to the former (point 1.) and especially low-flow reaches such as 9 and 8, above Caudron Creek, where the increased sensitivities of flow losses were identified and where monitoring efforts were focused (e.g., using 10 microhabitat transects in Reach 8 as opposed to 2 transects in Reach 5).

Table U22.1 Mean Flow Loss and Habitat predictions for all lifestages and reaches on Gold Creek.

Bioperiod	Metric	Unit	GOLD CREEK				
			Reach 9	Reach 8	Reach 7	Reach 6	Reach 5
Juvenile Rearing (Apr-Sept)	Baseline (2017) mean flow	m ³ /s	0.084	0.121	0.525	0.161	0.602
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.067	0.096	0.368	0.089	0.271
	Mean Flow Reduction	m ³ /s	-0.017	-0.024 ¹	-0.158	-0.072	-0.331
		%	-20%	-20%	-30%	-45%	-55%
	Mean AWS Loss (nearest %)	%	-11%	-9%	-9%	-10%	-10%
Benthic Invertebrates (Jun-Sept)	Baseline (2017) mean flow	m ³ /s	0.085	0.122	0.509	0.156	0.583
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.076	0.104	0.407	0.117	0.467
	Mean Flow Reduction	m ³ /s	-0.008 ¹	-0.018	-0.102	-0.039	-0.117
		%	-10%	-15%	-20%	-25%	-20%
	Mean AWS Loss (nearest %)	%	-8%	-11%	-11%	-10%	-9%
Adult Rearing (Apr-Sept)	Baseline (2017) mean flow	m ³ /s	0.084	0.121	0.525	0.161	0.602
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.071	0.096	0.263	0.049	0.181
	Mean Flow Reduction	m ³ /s	-0.013	-0.024	-0.263	-0.113	-0.421
		%	-15%	-20%	-50%	-70%	-70%
	Mean AWS Loss (nearest %)	%	-10%	-10%	-10%	-10%	-11%
Overwintering (October-March)	Baseline (2017) mean flow	m ³ /s	0.011	0.016	0.159	0.049	0.182
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.007	0.010	0.095	0.022	0.018
	Mean Flow Reduction	m ³ /s	-0.004	-0.006	-0.064	-0.027	-0.164
		%	-35%	-35%	-40%	-55%	-90%
	Mean AWS Loss (nearest %)	%	-10%	-10%	-10%	-9%	-3% ³
Fry (July-September)	Baseline (2017) mean flow	m ³ /s	0.051	0.074	0.332	0.102	0.381
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.030	0.033	0.033	0.010	NA ²
	Mean Flow Reduction	m ³ /s	-0.021	-0.041	-0.299	-0.092	NA
		%	-40%	-55%	-90%	-90%	>-90% ²
	Mean AWS Loss (nearest %)	%	-10%	-10%	-9%	-6%	NA
Spawning (May-July)	Baseline (2017) mean flow	m ³ /s	0.137	0.198	0.778	0.239	0.891
	Mean Flow to reduce mean AWS by ~10%	m ³ /s	0.116	0.149	0.195	0.167	0.089
	Mean Flow Reduction	m ³ /s	-0.021	-0.049	-0.583	-0.072	-0.802
		%	-15%	-25%	-75%	-30%	-90%
	Mean AWS Loss (nearest %)	%	-10%	-9%	-5% ³	-10%	-8%

1: instances like this, where calculated mean flow reductions are different by 0.001, are due to rounding.

2: habitat gains are still predicted at modelled 90% flow reduction here given the highest flow regime and preference of fry for very low flow and hydraulic conditions. An estimated 10% AWS change will occur at or above 91% and needs further analysis.

3: instances like this, where AWS loss is not close to -10%, are the closest to 10% using incremental flow reductions of 5%, and would require a finer increment resolution (1% or below) to produce a closer AWS reduction to 10%.