Fisheries and Oceans Canada | Pêches et Océans Canada

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December 15, 2021

Your file *Votre référence*
Reference No. 80111

Our file *Notre référence*
15-HMAR-00463

Kathryn MacCarthy
Project Manager - Atlantic Regional Office
Impact Assessment Agency of Canada
200-1801 Hollis Street
Halifax, NS B3J 3N4

Subject: Beaver Dam Mine Project – Technical Review Comments on the 2021 Environmental Impact Statement and Round 2 Information Request Responses

Dear Kathryn MacCarthy:

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your request on November 15, 2021 for a technical review of the revised Environmental Impact Statement (EIS) and associated appendices, and the proponent's responses to the Round 2 Information Requests for the Beaver Dam Mine Project. It is important to note that these documents include thousands of pages of technical information, and DFO was not able to conduct a comprehensive review of all of this information within the time provided. DFO's technical review focused on the Department's key concerns related to the project and assessment that have been raised during the environmental assessment process to date. DFO has considered the questions posed by the Impact Assessment Agency (the Agency) in Annexes 1-3, and the Department is pleased to provide the comments and advice in outlined in Attachment 1.

DFO is responsible for the conservation and protection of fish and fish habitat as set out under the *Fisheries Act* which includes implementing Canada's Wild Atlantic Salmon Conservation Policy. In DFO's letter to the Agency on April 23, 2019, the Department raised a number of concerns regarding the proposed project, including the project's potential to result in significant adverse impacts to Southern Upland Atlantic Salmon in the Killag River and the challenges of identifying adequate offsetting measures to counterbalance the large spatial extent of harmful alteration, disruption and destruction of fish habitat from the project. These concerns have not been adequately addressed in the proponent's responses to the Round 2 Information Requests and revised 2021 EIS.

In addition to the proponent's EIS, DFO recommends that the Agency consider additional baseline and scientific information about Atlantic Salmon in the environmental assessment. There are few species of fish in Canada as well studied as Atlantic Salmon,

Canada

and there is an abundance of scientific and technical information about Southern Upland (SU) Atlantic Salmon available (e.g., DFO Science Branch publications, peer-reviewed journals) to support an assessment of the potential effects of the Project on this species and its habitat. Detailed information is available about SU Atlantic Salmon population status and trends; the functions, features, and attributes of freshwater habitat required to support the various life stages of Atlantic Salmon life history processes; and threats to the species' survival and recovery in the SU Region. An important source of information are the scientific reports produced during the COSEWIC assessment and DFO Recovery Potential Assessment processes. DFO has prepared a summary of some of the most relevant scientific advice and recommendations from these information sources, with a focus on the West River, Sheet Harbour Atlantic Salmon population and its habitat that is likely to be impacted by the Project (see Attachment 2). Readers are encouraged to review the studies and reports referenced in this document for additional information.

If you have any questions with the content of this letter, please contact me at our Dartmouth office at 902-233-9731 or by email at christopher.burbidge@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

<Original signed by>

Chris Burbidge
Senior Biologist
Regulatory Reviews-Ecosystems Management
DFO Maritimes

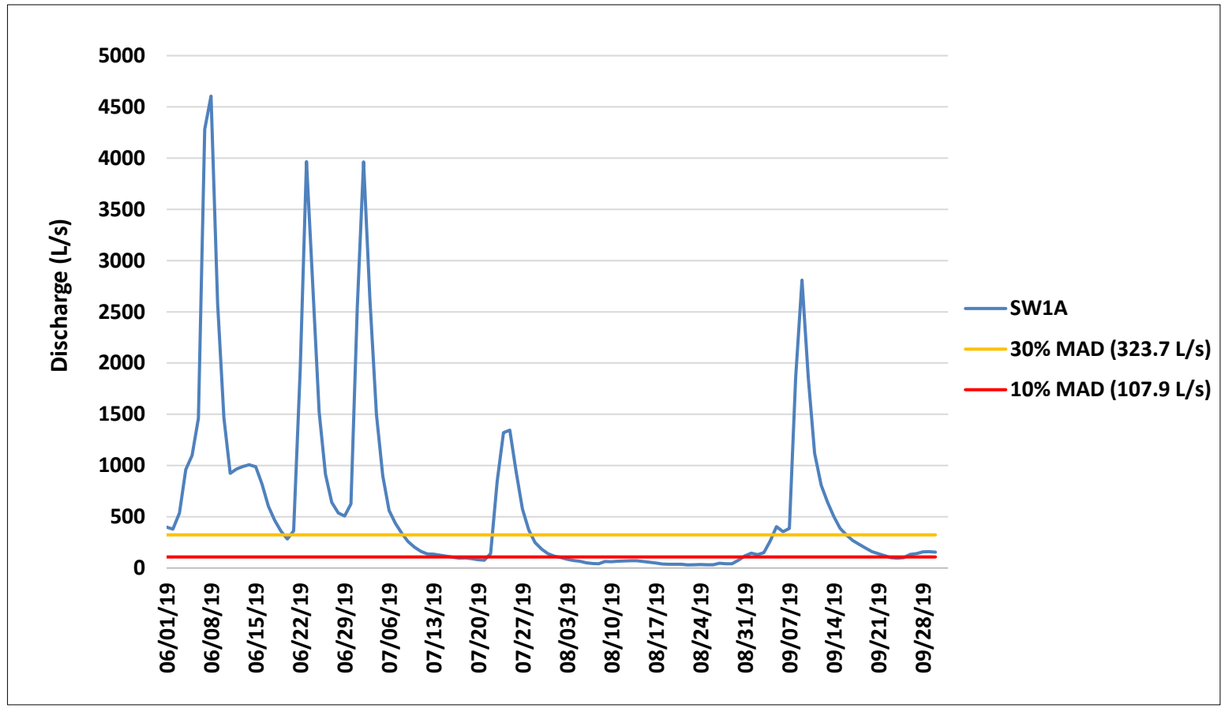
Attachments (2):
1. Annexes 1-3 – DFO Technical Review comments on the revised Round II (Part 1 and Part 2) information requirement (IR) responses and revised Environmental Impact Statement (EIS) for the Beaver Dam Mine Project
2. Additional information related to Atlantic Salmon (Southern Upland population) in support of the CEAA, 2012 Environmental Assessment of the proposed Beaver Dam Mine Project

ANNEX 1: Advice to the Agency

Table 1: Please use the table below to provide advice for the Agency's consideration in its recommendation to the Minister of Environment and Climate Change and preparation of draft conditions

Questions	Responses/Comments
• Has the proponent described all project components and activities in sufficient detail to understand all relevant project-environment interactions? If not, identify what additional information is needed.	• There is sufficient information about the project components and activities for the purposes of the EA to identify the main project's interactions with fish and fish habitat, and to conclude that there will be a number of adverse impacts to fish and fish habitat from the project. Additional detailed information about the project components and activities (e.g., baseline data, detailed design drawings, figures, detailed erosion and sediment control plans, blasting plan, detailed monitoring plans, offsetting plan, etc.) are required to support an application for *Fisheries Act* authorization for the project.
• Were the study areas sufficient to predict potential effects from all relevant project-environment interactions, and to consider the effects within a local and regional context? • Is the baseline information sufficient to characterize the existing environment, predict potential effects and obtain monitoring objectives? If not, identify what additional information is needed.	• For the purposes of an assessment of the potential impacts of the project on Southern Upland (SU) Atlantic Salmon, the SU Region is the most appropriate study area to consider regional context (see Attachment 2). This is particularly important given that in addition to the Project, there is one operating open pit gold mine (Touquoy) and three other proposed open pit gold mines in watersheds within the SU Region (Fifteen Mile Stream, Cochrane Hill, Goldboro). • Additional baseline data will be required to support an application for *Fisheries Act* authorization and associated long-term effects monitoring program. A reliable and accurate baseline dataset on fish and fish habitat prior to the start of project construction is required for a successful and effective long-term monitoring program. DFO recommends that the proponent develop and implement a detailed Before-After-Control-Impact (BACI) study as the basis of monitoring effects to fish and fish habitat from the project. This will involve collecting additional baseline data on fish and fish habitat at strategically selected monitoring sites in Killag River and Cameron Flowage and other locations in the project area prior to the start of construction (see additional comments below related to monitoring).
Alternatives Assessment	
• Has the proponent adequately described the criteria it used to determine the technically and economically feasible alternative means? • Has the proponent listed the potential effects to valued components (VCs) within your mandate that could be affected by the technically and economically feasible alternative means? • Has the proponent adequately described why it chose each preferred alternative means? • Are there other alternative means that could have been presented? If so, please describe.	• Moving the location of the waste rock stockpile may reduce impacts to fish habitat in some watercourses and waterbodies in the project area, but will result in impacts to downstream fish habitat in WC-23 (tributary to Cope Brook). • Any alternatives that would further avoid and mitigate the impacts to important habitat for SU Atlantic Salmon in Killag River from the project, and do not involve the release of mining effluent into the habitat would have been preferable.
Environmental Effects Assessment	
• Has the proponent clearly described all relevant pathways of effects to be taken into account under section 5 of CEAA 2012? • Has the proponent identified all potential effects to VCs, including species at risk, within your mandate? • Were all potential receptors considered?	• The proponent's assessment of effects to fish and fish habitat focuses on describing their predictions about the potential changes to the physical and chemical properties of surface water features. The assessment does not always make clear linkages to fish habitat functions and attributes and how they influence the life processes of fish. As a result, the potential pathways of effects to fish and fish habitat are not always clearly described in the assessment. DFO has provided additional information about SU Atlantic Salmon habitat use in the project area in Attachment 2. Detailed information about Pathways of Effects to fish and fish habitat and SU Atlantic Salmon in particular is available on DFO's Projects Near Water website (https://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html), and in Section 5 of DFO's Recovery Potential Assessment RPA for SU Atlantic Salmon (see Bowlby et al. 2014 https://waves-vagues.dfo-mpo.gc.ca/Library/359664.pdf). • The pathway of effects to fish and fish habitat from hydrological alterations is not clearly described in the assessment, and this is one of DFO's main concerns regarding the project. Atlantic Salmon and Brook Trout are particularly sensitive to hydrological alterations to their habitat, and altered hydrology has been identified in the RPA for SU Atlantic Salmon as threat to their freshwater habitat (Bowlby et al. 2014). The RPA ranks Altered Hydrology as a high level of concern and severity due its potential to lead to substantial impacts to fish habitat and loss of population productivity. Please refer to DFO's Pathways of Effects for "Excavation" and "Change in Timing, Duration, and Frequency of Flow" as well as the reference list below for additional information about how hydrological and temperature variations influence the life processes of Atlantic Salmon and Brook Trout (particularly during summer low flow periods). • The proponent's assessment suggests that juvenile Atlantic Salmon are likely to move from Killag River/Cameron Flowage in the vicinity of the project during the summer months to find thermal refuge habitat due to elevated water temperatures. Available information does not support this conclusion, but instead shows that juvenile Atlantic Salmon are consistently present in the immediate vicinity of the project during the summer period (see Figure 2 in Attachment 2). Juvenile Atlantic Salmon prefer freshwater environments with moderate water temperatures, typically between 15°C and 25°C (Bowlby et al. 2014). This temperature range is consistent with the limited temperature measurements in Cameron Flowage taken during the summer period (19.2 to 24.5°C; see Baseline Fish and Fish Habitat Report and Thermal Imaging Study). • In the study conducted by Wilbur et al. (2020), juvenile salmon were not limited fully to cold-water refugia until ambient river temperature exceeded 27°C and that once this temperature was reached the salmon would aggregate in cold-water plumes from groundwater seeps. While caution should be taken when interpreting data from a single point in time, the proponent's Thermal Imaging study conducted in August 2021 indicates that there are thermal anomalies with water temperatures 1-8°C cooler than the ambient temperature along the banks of Cameron Flowage that could provide thermal refuge for salmonids during high temperature events. Recent habitat suitability curves

Questions	Responses/Comments
	developed for Atlantic Salmon and Brook Trout thermal refuge habitat in Wilbur et al. (2020) suggest that the water temperatures, depths, velocity, and substrate measured by the proponent in Cameron Flowage are within the preferred range for salmon parr and Brook Trout. • The Draft Offset Plan suggests that average water depths of 0.06 m in Cameron Flowage in a post-construction, low flow period would be suitable for juvenile salmon. Water depths below 0.15 m are outside the range of preferred habitat for Atlantic Salmon fry (0.15-0.25 m), salmon parr and small Brook Trout (0.15-1.0 m) (Bowlby et al. 2014). Average water depths of 0.06 m are likely to restrict fish movements and impair the ability of salmonids to carry out life processes. **References** Bowlby, H.D., Horsman, T., Mitchell, S.C., and Gibson, A.J.F. 2014. Recovery Potential Assessment for Southern Upland Atlantic Salmon: Habitat Requirements and Availability, Threats to Populations, and Feasibility of Habitat Restoration. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/006. vi + 155 p. Danielle M. Frechette, Stephen J. Dugdale, Julian J. Dodson, and Normand E. Bergeron. Understanding summertime thermal refuge use by adult Atlantic salmon using remote sensing, river temperature monitoring, and acoustic telemetry. Canadian Journal of Fisheries and Aquatic Sciences. 75(11): 1999-2010. Kurylyk, B.L., MacQuarrie, K.T. B., Linnansaari, T., Cunjak, R.A. and R.A. Curry. 2015. Preserving, augmenting, and creating cold-water thermal refugia in rivers: concepts derived from research on the Miramichi River, New Brunswick (Canada). *Ecohyrology* 8(6): 1095-1108. Wilbur, N.M., O'Sullivan, A.M., MacQuarrie, K.T.B., Linnansaari, T. and R.A.Curry. 2020. Characterizing physical habitat preferences and thermal refuge occupancy of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) at high river temperatures. *River and Research Applications* 36(5): 769-783.
• Were the methodologies used by the proponent appropriate to collect baseline data and predict effects, why or why not? • Has the proponent explicitly addressed the degree of scientific uncertainty related to the data and methods used within the assessment? If there are unaccounted for scientific uncertainties, describe them and indicate the options for increasing certainty in the predictions?	• Baseline information has not been used effectively to characterize the existing fish and fish habitat in the project area and predict effects. There exists additional scientific information about SU Atlantic Salmon and their habitat that can be used to provide a more complete characterization of fish and fish habitat in the project area (see Attachment 2). <u>DFO's Framework for Assessing the Ecological Flow Requirements</u> • The proponent has not interpreted or applied DFO's Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (DFO 2013) as intended in the assessment. The probability of degradation to ecosystems sustaining fish and fish habitat increases with increasing alteration to the natural flow conditions. A "natural flow regime" can be defined as a flow regime that is only affected by the variability in hydrological inputs and outputs (precipitation, evaporation) and natural water storage (such as groundwater) and for which the response in terms of amplitude, timing, duration and frequency of events is unaltered by human impacts. DFO (2013) provides two guidelines for assessing ecological flow requirements: ➢ **Guideline 1** – Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a "natural flow regime" have a low probability of detectable impacts to ecosystems that support commercial, recreational or Aboriginal fisheries. For fisheries in ecosystems subjected to levels of cumulative water extraction or augmentation of greater than 10% of instantaneous flows, a rigorous level of assessment is required to evaluate potential impacts on ecosystem structure and function that support fisheries. This guideline is intended to be used when river discharge is greater than 30%. ➢ **Guideline 2** – Cumulative flow alterations that result in instantaneous flows < 30% of the mean annual discharge (MAD) have a heightened risk of impacts to fisheries. For instances where the cumulative water use reduces the river flow below the level of 30% of the MAD, a rigorous level of assessment should be required to evaluate potential impacts on ecosystem functions that sustain fisheries, including identification of mitigation measures. • Ecological Flow Guidelines 1 and 2 specify potential changes in <u>actual flow</u> (i.e., daily time scale) as the basis for the framework, whereas the proponent mostly uses modelled estimates of mean monthly and mean annual flows. The proponent's approach is not the same and is less conservative than intended by the DFO Framework. As explained further in the comments below related to uncertainty and potential error, the use of modelled mean flow instead of actual daily flow has some important limitations to consider. • Guideline 1 is really intended to be used at times when actual daily river discharge is greater than 30% of MAD. During periods when daily flows are greater than 30% of MAD, flow changes and reductions to fish habitat from the project will comprise a smaller portion of the total flow and are less likely to result in adverse impacts to the habitat. • Guideline 2 is based on the understanding that any flow alteration which results in flows below 30% of the MAD and/or occurs when natural flows are lower than 30% of MAD satisfies the criterion for a more rigorous level of assessment, regardless of the % actual daily flow altered (Guideline 1). In other words, any flow alteration which occurs during a time where flows are naturally below 30% of the MAD would require a more rigorous level of assessment due to the potential adverse impacts to fish and fish habitat. The lower the flows, the higher the risk of adverse effects from flow alterations. It is important to consider that habitat becomes increasingly degraded at daily flows below 30% of the MAD, and flows of ≤10% of the MAD are often considered to be the lowest flow required to sustain short-term survival of aquatic life (Tennant 1976; Caissie et al. 2014).

Questions	Responses/Comments
	• Figures 1 and 2 below show the daily discharge measured at station SW1A in Killag River immediately downstream of Cameron Flowage in summer 2019 and 2020 in relation to 10% and 30% of the MAD at the "Killag River at Pit Assessment Point" used in the proponent's Water Balance Analysis (Appendix P.4 of the EIS). These figures show that there were extended periods in both years when flows in Killag River – and likely most other streams in the project area – were well below 30% of the MAD, even falling below 10% of the MAD for weeks on end in summer 2020. For example, daily flows at SW1A were less than 30% of MAD for the entire month of August 2020, and less than 10% of MAD for 95% of the month. The lowest daily discharge measured at SW1A was approximately 8.8 L/s (equal to 0.8% of MAD) on August 17, 2020. ➢ **Key message:** During these low flow periods fish habitat in Killag River is naturally degraded (e.g., low water levels, fragmented habitat, higher water temperatures, etc.) and any permanent hydrological alterations from the project present a high risk to fish and fish habitat during this sensitive period. As noted above, hydrological alterations have been identified as a threat to SU Atlantic Salmon habitat that can result in substantial habitat impacts and reduce population productivity (Bowlby et al. 2014).  **Figure 1. Daily discharge measured at Killag River hydrometric station SW1A, June 1 to September 30, 2019**

Questions	Responses/Comments

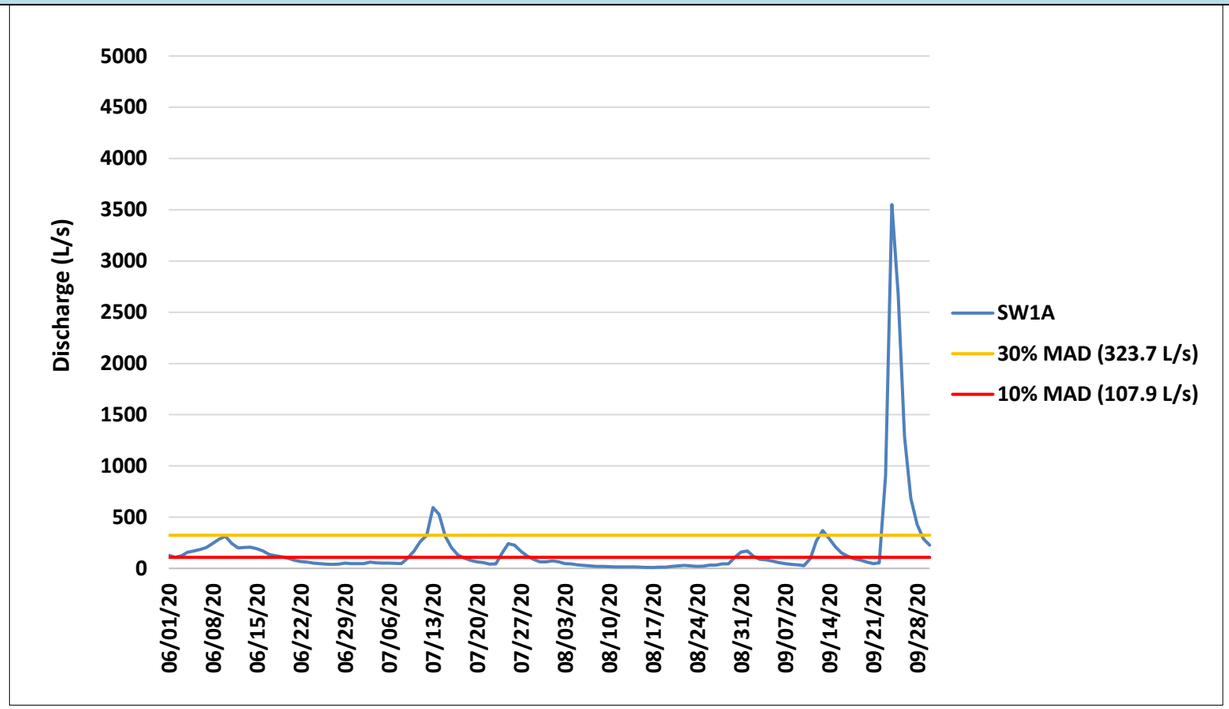


Figure 2. Daily discharge measured at Killag River hydrometric station SW1A, June 1 to September 30, 2020

- Staff gauge readings of less than 0.05 m were taken at SW2A located in Killag River immediately upstream of Cameron Flowage in August 2019 and August 2020. This is concerning because fish movements upstream of Cameron Flowage would already be naturally inhibited at such low water levels, and any further reduction in flow could further inhibit fish movements and restrict access to upstream/downstream habitats. Habitat use by fish upstream of Cameron Flowage has not been characterized, but downstream habitat has been identified as the historically most productive spawning habitat for salmon in the West River, Sheet Harbour watershed (see Attachment 2).
- The DFO Ecological Flow Framework has not been interpreted or applied correctly in Table 6.9-16 of the EIS and Table 10 of the Fish Habitat Offset Plan. These tables and any conclusions drawn from them should be disregarded for the following reasons.

  1. This analysis calculates the 30% of MAD threshold based on the modelled annual discharge in the river for each of what the proponent considered a “dry year” and an “average year”, whereas the DFO Framework specifies that this threshold must be based on the mean annual discharge from a long-term dataset (≥20 years) that characterizes the natural flow regime of the river, and not from an individual year. The approach taken in in Table 6.9-16 and Table 10 implies that fish require less water to support their life processes in dryer years than in wetter years, which not biologically accurate.
  2. “Daily flows” summarized in the tables were synthesized using models and there is a lot of uncertainty regarding the methods. As explained and demonstrated below, monthly flows presented in the WBA for Killag River do not appear to be representative of the natural flow regime of neighboring rivers of similar size. Therefore the WBA and any daily flows synthesized from it may not be entirely representative of natural conditions in the project area. As noted in the DFO Framework, prorating and analyzing long-term datasets from nearby hydrometric stations is an acceptable approach for characterizing the natural flow regime and the determining the MAD of an ungauged river (i.e., Killag), which is the approach that should have been taken in the assessment. DFO’s Framework refers to actual flows which means measured flow in the river at a given time and day, not a single flow value synthesized in a model.
  3. The proponent supposes a different guideline without biological justification, which is that if the increase of days below 30% MAD due to the flow alteration from the project is less than 10%, then it is reasonable. This not consistent with DFO’s Framework and is not protective of fish and fish habitat. The natural flow regime of rivers in Nova Scotia are well understood and other methods of estimating ecological flow have been examined and considered in a regional context (e.g., Caissie and Robichaud

Questions	Responses/Comments

2009; Caissie et al. 2014). The assessment of effects to fish habitat from flow alterations should be based on DFO's Ecological Flow Framework as it was intended without modifications to the approach and thresholds described in the advice.

- Determining the magnitude and temporal patterns of flow changes in Killag River (i.e., Guideline 1) and other watercourses from the project to a high degree of accuracy is difficult because numerous surface water features in the project area will be affected by complex hydrological alterations associated with project components and activities. Any model predictions will be subject to a moderate to high degree of uncertainty and error (see comments below). A comparison of the various estimates of base flow reductions to Cameron Flowage provided in the assessment to the minimum, maximum, and mean <u>total stream flow measured at station SW1A in August 2020</u> (i.e., actual daily flows) indicates that the base flow reductions are likely to adversely impact fish habitat in Killag River during summer periods (Table 1 below). It is important to consider that temporary water withdrawals can be reduced during low flows to maintain ecological flow and protect fish and fish habitat, but permanent hydrological alterations from project activities (e.g., excavation of the open pit) cannot be rapidly adjusted and therefore present a greater risk of impacts to fish habitat.

Table 1. Comparison of estimated base flow reduction scenarios in Cameron Flowage from the EIS and discharge measurements from hydrometric station SW1A in August 2020.

Scenario	Estimated Base Flow Reduction	% of Maximum Instantaneous Discharge Measured at SW1A in August 2020	% of Minimum Instantaneous Discharge Measured at SW1A in August 2020	% of Time during August 2020 that DFO Guideline 1 is not met (≥10% reduction in instantaneous flow)
Base Flow Reduction at Cameron Flowage – Average Conditions (Hydrogeologic Model Report Table 7.4)	304 m^3/d (3.52 L/s)	2	55	71
Base Flow Reduction at Cameron Flowage – Dry Conditions (Hydrogeologic Model Report Table 7.4)	274 m^3/d (3.17 L/s)	2	50	67
Base Flow Reduction – August at Killag River at Pit Assessment Point (Water Balance Analysis Table 5-17)	243 m^3/d (2.81 L/s)	1	44	62

- The proponent will also be constructing spillways and releasing mining effluent into Cameron Flowage which will further alter the natural flow regime of Killag River, but there is uncertainty about how much effluent will be released into Cameron Flowage under various flow conditions and how the habitat will be altered for reasons explained below.

<u>Scientific Uncertainty and Limitations</u>

- As explained in DFO's Fish and Fish Habitat Protection Policy Statement, the Department will be informed by the best available science, technical information and Indigenous knowledge when making decisions, and the Department will also be guided by the application of a precautionary approach and a risk-based approach to decision-making. The precautionary approach is about being cautious when scientific information is uncertain, unreliable or inadequate and not using the absence of adequate scientific information as a reason to postpone or fail to take action to avoid serious harm to the resource (DFO 2009).
- There are numerous interconnected lakes, rivers, streams and wetlands within the project area that will be affected by the various project components and activities, and the local and regional dynamics of surface water, groundwater, and their interface is a complex system. The proponent presents their modelling and effect predictions related to these dynamic, complex hydrological alterations as definitive results without adequately acknowledging that they are subject to a moderate to high degree of uncertainty that could have important implications regarding the residual effects to fish habitat.
- The assessment relies on a Hydrogeologic Modelling Report and the WBA to predict groundwater inflows to the open pit, and other complex hydrological alterations to Killag River and other surface water features in the project area. DFO understands that these models may be used to predict potential changes to flow on average, but using these models to assess the impacts on fish habitat in nearby rivers and surface water features is beyond the limit of their capabilities. These constraints and limitations have not been adequately considered in the effects assessment.
- The WBA does not consider the variability of input and estimated parameters and confidence intervals should be reported. For instance, precipitation ranges from X to Y (95% conf. intervals), evaporation is A% to B% of precipitation, etc.
- Stream flow in Nova Scotia rivers is highly variable and using mean discharge estimates for effect predictions does not capture the variability of fish habitat conditions that fish will actually experience over time. As explained above, guideline 1 in DFO's Ecological Flow Framework uses <u>actual flows</u> and not mean flows in the guidelines for assessing potential impacts to habitat from flow alterations. Any model used to inform potential impacts to fish habitat should use a daily time scale and at the very least predict maximum and minimum daily alterations.
  - To illustrate this point, consider Figures 3 and 4 below. Figure 3 shows the daily discharge measured at the station SW1A from May 2019 to November 2020. This shows that there is much variability in the river flow over time which is not reflected in an assessment based on averages. Figure 4 shows the estimated mean discharge in Killag

Questions	Responses/Comments
	River at Pit Assessment Site used in the WBA in comparison to the mean and minimum discharge measured at SW1A from the summer low flow period in 2019 and 2020 (these sites are approximately the same location). These figures show that river will regularly experience much lower flows during summer months than those used in the WBA. The lowest discharge used in the WBA for baseline conditions is 373 L/s for August (equal to 35% of MAD), whereas the lowest daily discharge measured at SW1A was 8.8 L/s (equal to 0.8% of MAD) on August 17, 2020. This highlights how the assessment is not precautionary, and does not represent the plausible worst-case in terms of impacts to fish habitat in Killag River from project hydrological alterations.

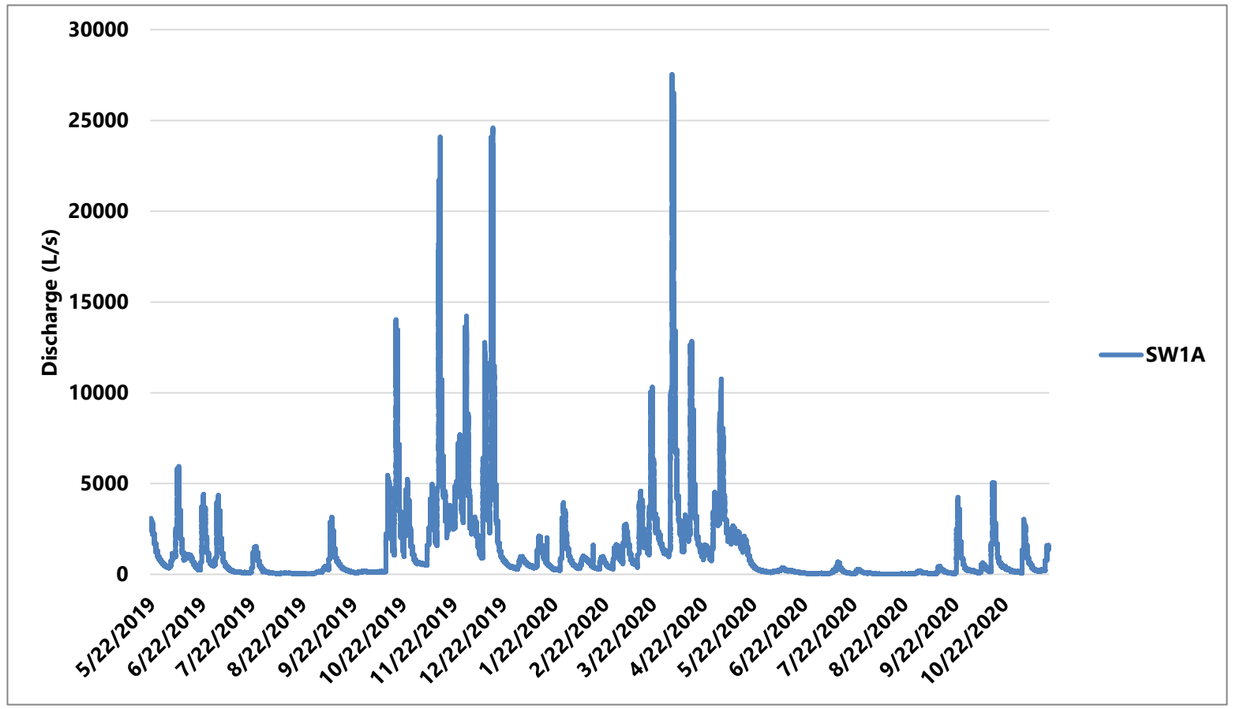


Figure 3. Daily discharge measured at Killag River Hydrometric Station SW1A, May 2019 - November 2020

Questions	Responses/Comments

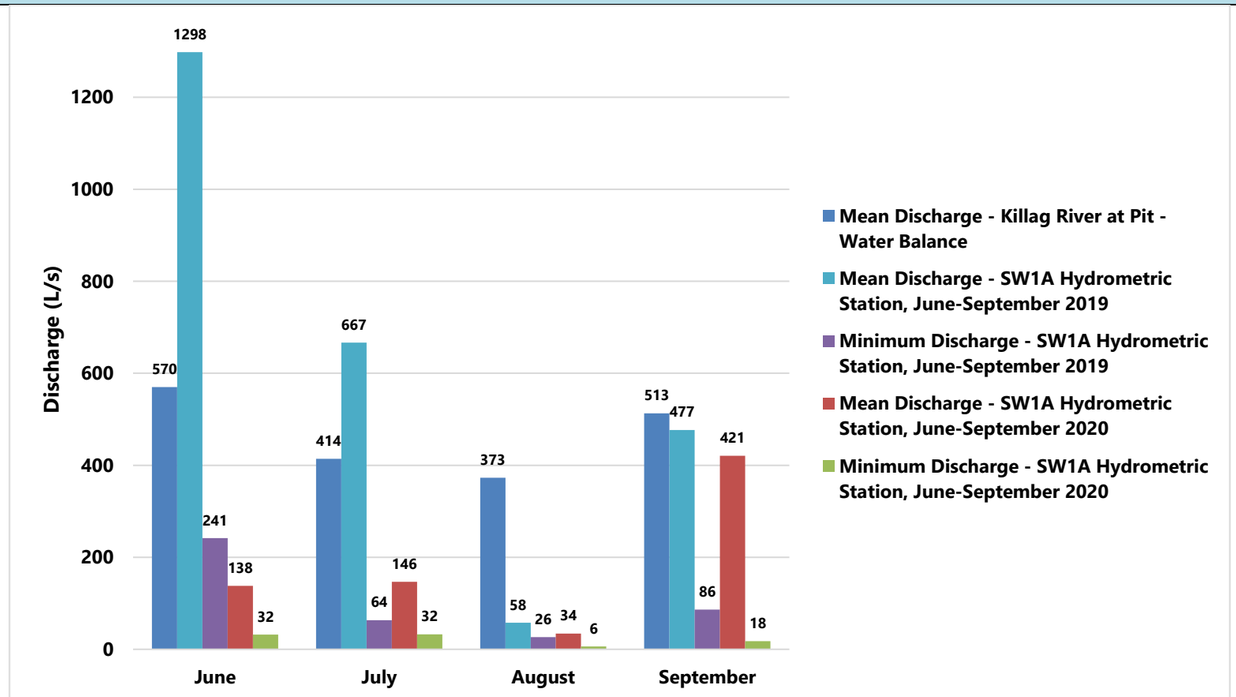


Figure 4. Comparison of mean monthly discharge at Killag River at Pit Assessment Site from the Water Balance Analysis and the mean and minimum discharge measured at station SW1A during the summer low flow period in 2019 and 2020

- Prorating and analyzing long-term datasets from nearby gauged rivers is an established and reliable method for estimating flows in an ungauged river (Caissie and Robichaud 2009; Caissie et al. 2014; DFO 2013) and is likely to yield more reliable results than using a model to synthesize baseline flows from precipitation datasets and other estimated parameters. At the very least, the synthesized flows in the model should be compared to long-term datasets from nearby gauged rivers to verify they reflect the natural flow regime of local rivers. A comparison of the baseline conditions and assumptions for Killag River in the WBA to prorated data from nearby gauged stations suggest that it may not accurately reflect the natural flow regime of Killag River (Table 2 and Figure 5). For instance, the highest flow month in the WBA is March, and this is generally not the case for Nova Scotia rivers. The WBA may also slightly underestimate flows in June and slightly overestimate flows in July, September, and October.

Table 2. Estimated mean annual flow (MAF) of Killag River at Pit Assessment Point using watershed area ratio

Station Name	Station ID	Drainage Area (km^2)	MAF (m^3/s)	MAF ($l/s/km^2$)	MAR (mm)	Prorated* MAF at Killag R. (m^3/s)
Little Sackville River	01EJ004	13.1	0.412	31.4	991	1.18
Moose Pit Brook	01EE005	17.7	0.488	27.6	869	1.04
Musquodoboit River Upper Musquodoboit	01EK004	141	4.462	31.6	998	1.19
Musquodoboit River Near Middle Musquodoboit	01EK003	334	9.942	29.8	939	1.12
Middle River of Pictou	01DP004	92.2	2.668	28.9	912	1.09

Questions	Responses/Comments

Beaverbank River	01DG003	96.9	3.037	31.3	988	1.18

*Killag River DA = 37.6 km²

Average MAF (m^3/s)= 1.13

MAR (mm) = 950

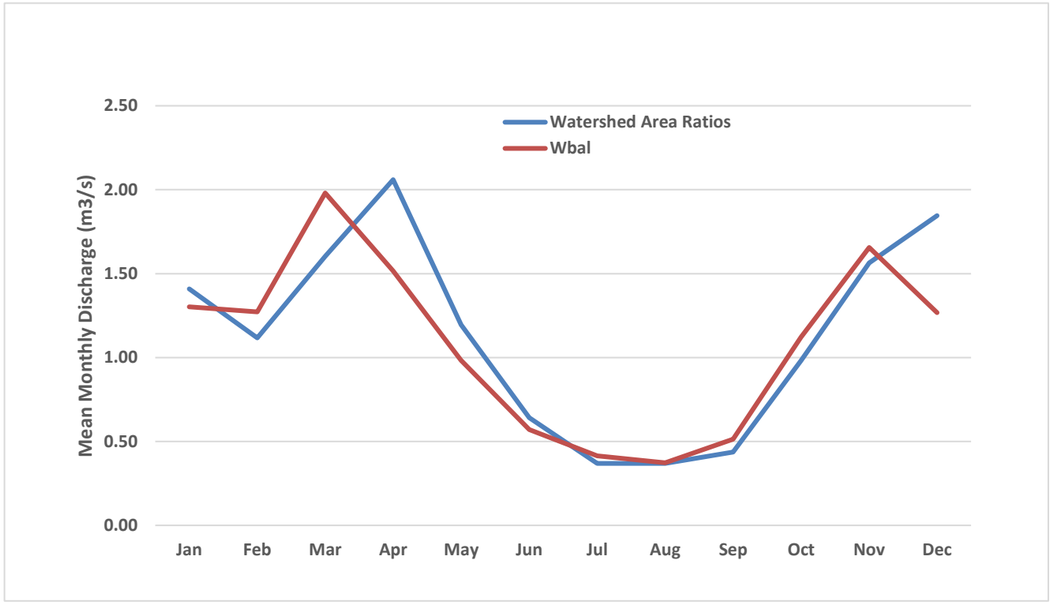


Figure 5. Comparison of mean monthly discharge at Killag River at Pit Assessment Site from the Water Balance Analysis (Wbal) and prorated mean monthly discharge from six nearby reference hydrometric stations.

- There are options for addressing the uncertainties and potential sources of error in the WBA:
  - Confidence intervals and the variability of parameters should always be reported with model predictions and estimated values.
  - Additional baseline data from the project area and long-term datasets from nearby gauged rivers could be analyzed, incorporated into the model, and used to validate the baseline condition of WBA.
  - Different scenarios could be modelled to better reflect the range of potential outcomes to address the uncertainties regarding the model inputs, assumptions and predictions. This would help understand the potential worst-case scenario in terms of flow alterations from the project.
- Although these options may help refine the effect predictions, the any attempt to model how the dynamic, complex hydrological system in the project area will respond to complex changes from project components and activities will always be subject to a relatively high degree of uncertainty. As explained above, any permanent hydrological alterations from the project present a heightened risk to fish and fish habitat during summer low flow periods, especially sensitive habitat for SU Atlantic Salmon in Killag River where flows can be below 10% of MAD (i.e., severe habitat degradation) for extended periods during some years.

<u>eDNA Study for Aquatic Habitats within the proposed Waste Rock Stockpile Area (Appendix J.2)</u>

- The assay used in the analysis is designed to be general in seeking fish DNA that is non-species specific and to produce a positive signal when ‘fish’ DNA is present. This suggest the assay is a multiplex of many specific primers that are susceptible to off-target amplification.
- No information was provided as to whether the assay would produce a positive reaction for fish species other than the 19 listed in the Certificate of Analysis and Brook Trout.
- It is not possible, with the information provided, to determine whether the assay used is capable of determining the presence or absence of all fish species that could be present in this type of system in Nova Scotia.
- The laboratory methods are consistent with those that have been previously published in the primary literature.

Questions	Responses/Comments
	• The number of sites sampled and their locations do not appear adequate to ascertain whether fish are present in WC-22 through eDNA analysis. The spatial extent represented by an individual site is anticipated to be small and eDNA is not homogeneously distributed throughout a waterbody. • The Certificate of Analysis does not indicate the assay's sensitivity. • It is not possible to determine how likely a negative eDNA result is to reflect the true absence of fish from the information provided. • Persistence of eDNA can be highly variable and is influenced by a number of physical and environmental factors. These conditions, and the timing are generally site-specific, making it difficult to provide a precise time estimate. • It is likely that during the July eDNA sampling period the results are reflective of fish absence/presence within an estimated 2-week period prior to sample collection. The eDNA sampling provides a snapshot of results for a given time, and these results should not be extrapolated to suggest that fish do not access the sampling sites during other times of year. • The report does not indicate the volume of water collected for each field replicate, which is needed for the interpretation of the results. • The report indicates that a single field negative control (blank) was used. It would have been beneficial for interpretation of results, especially sample sites where ≤2 technical replicates returned positive detections, to have had a negative control per sample site. • The report states, "If at least one replicate yields a positive qPCR result for 2/8 runs and the other replicates yield a score >0 the site is categorized as suspected". Based on this criteria, sites 3 and 4 within Wetland 205 should also be categorized as "suspected", in addition to site 6. The presence of positive detection in 1-2 technical replicates from each field replicate at sites 3 and 4 suggests that fish may have been present at low abundance or that the DNA from fish present prior to sampling had degraded and provided a weak signal, field samples were contaminated, or fish DNA was transported to sample sites by another means (i.e., avian or terrestrial predator). Without negative field controls, it is difficult to determine if contamination contributed to the positive results in technical replicates at sites 3 and 4. <u>Impacts from Haul Road</u> • In Section 6.9.7.3.1, the proponent indicates that the Project is expected to result in direct impacts to fish and fish habitat through construction of the Haul Road and associated watercourse crossings. In the text, the proponent indicates that there are 36 watercourse crossings which may be affected by the Haul Road. Table 6.9-19 indicates that there are 37 watercourse crossings which may be directly impacted by the Haul Road. Table 6.9-25 lists 38 watercourse crossings which have the potential to be impacted by the Haul Road. The proponent's calculations of the number of watercourses which have the potential to be affected by the Haul Road is inconsistent throughout the EIS. These inconsistencies do not lead to confidence in the estimated area (m^2) of fish habitat affected by the Haul Road. • Table 6.9-25 of the EIS describes potential habitat destruction or permanent alteration along the haul road. The proponent offers two different calculations for potential impacts from the Haul Road: Potentially Impacted Area (m2) and Direct Footprint Impact (m2) Considering Site Specific Impact Assessment. All 38 of the Haul Road watercourse crossings listed in the table have a Potentially Impacted Area, however, only 16 watercourses list a Direct Footprint Impact, which are all greatly reduced from the Potentially Impacted Areas. It is not clear how the reduced Direct Footprint Impacts were calculated. • Principle 3 of DFO's Offsetting Policy explains that measures to offset should provide additional benefits to the ecosystem. Measures to offset are additional works, undertakings, or activities that should achieve conservation and protection outcomes greater than the results that would have occurred if the measures to offset had not taken place. In other words, the coincidental positive benefits of the works, undertakings and activities being authorized should not be considered as measures to offset. In plain language, the fact that the proponent is required to upgrade the haul road for the purposes of their Project, and as a result, replace culverts which may improve fish passage, cannot be taken into account when calculating an estimate of the surface area impacted from the Project (i.e., coincidental benefits from the culvert replacements will not count as mitigation or offsetting for the potential HADD caused by the Haul Road). • Table 5 of the Draft Offsetting Plan indicates that many of the watercourse crossings are not expected to result in a HADD, but later indicate that there will be minor impacts. The proponent indicates that perpendicular culvert replacement along a straight section of stream and improvements of fish passage as reasons why no HADD is expected. It is not clear how culverts will be installed perpendicular to the watercourses and also provide fish passage. • There are many wetlands which appear to be impacted by the proposed Haul Road route which are associated with watercourses (WL 94, 110, 142, 143, 144, 156, 159, 160, 161, etc.), but the haul road does not directly impact the watercourses themselves. Wetlands provide indirect benefits to fish and fish habitat through a variety of means (food sources, nutrient sinks, hydrological sources, etc.) and the proponent has not assessed how the reduction of these wetlands may affect these associated watercourses in an indirect manner along the Haul Road. • Additional advice to the proponent on how to calculate the potential surface area affected by each watercourse crossing (HADD) is provided in Annex 3. **References** Bowlby, H.D., Horsman, T., Mitchell, S.C., and Gibson, A.J.F. 2014. Recovery Potential Assessment for Southern Upland Atlantic Salmon: Habitat Requirements and Availability, Threats to Populations, and Feasibility of Habitat Restoration. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/006. vi + 155 p. Caissie, J., Caissie, D. and N. El-Jabi. 2014. Hydrologically Based Environmental Flow Methods Applied to Rivers in the Maritime Provinces (Canada). *River and Research Applications* 31(6):651-662.

Questions	Responses/Comments
	Caissie, D. and S. Robichaud. 2009. Towards a better understanding of the natural flow regimes and streamflow characteristics of rivers of the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2843: viii + 53p. DFO. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/017 DFO. 2009. A fishery decision-making framework incorporating the precautionary approach. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm Tennant, D.L. 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries 1: 6-10. Wilbur, N.M., O'Sullivan, A.M., MacQuarrie, K.T.B., Linnansaari, T. and R.A.Curry. 2020. Characterizing physical habitat preferences and thermal refuge occupancy of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) at high river temperatures. *River and Research Applications* 36(5): 769-783.
• Are the predicted effects described in objective and reasonable terms (e.g. beneficial or adverse, temporary or permanent, reversible or irreversible)?	• Many of the proponent's predicted effects to fish and fish habitat are not consistent with the concept of ecological flows, DFO's pathway of effects, and available scientific information. DFO recommends the Agency review the threats to freshwater habitat identified in the SU Atlantic Salmon Recovery Potential Assessment (see Table 5.3 in Bowlby et al. 2014) and consider updating the ranking criteria as appropriate.
• Has the proponent adequately assessed the potential cumulative environmental effects, including using appropriate temporal and spatial boundaries , examining physical activities that have been and will be carried out, and proposing mitigation and follow-up program requirements? Provide rationale.	• For the purposes of a cumulative effects assessment of the potential impacts of the project on SU Atlantic Salmon, the Southern Upland Region is the most appropriate study area to consider in a regional context. This is particularly important given that in addition to the Project, there is one operating open pit gold mine (Touquoy) and three other proposed open pit gold mines in watersheds within the SU Region (Fifteen Mile Stream, Cochrane Hill, Goldboro). Three of these watersheds contain priority freshwater habitats for the conservation and protection of SU Atlantic Salmon based of advice in the DFO Recovery Potential Assessment for the species (Ship Harbour-Fish Lake, West River-Sheet Harbour, St. Mary's River). • The proponent's assessment and monitoring of cumulative effects to fish and fish habitat is not adequate. Without additional baseline data and clearly defined monitoring plan and objectives, follow up programs related to fish and fish habitat are unlikely to be effective. DFO recommends the proponent develop and implement a BACI study design for monitoring effects to fish and fish habitat (see comments below in Annex 3).
• Has the proponent adequately described the potential for environmental effects caused by accidents and malfunctions, including the types of accidents and malfunctions, their likelihood and severity and the associated potential environmental effects? If not, identify what additional information is needed.	• Attachment 2 provides a summary of population viability modelling that has been done for SU Atlantic Salmon, including the West River, Sheet Harbour population. This modelling shows that any effects that adversely impact the population productivity are likely to increase the extirpation risk. Therefore, any accident or malfunction that adversely impacts fish habitat in the Killag River has potential to be considered a high consequence event.
• Are you satisfied with the proponent's assessment of effects of the environment on the Project? • Has the proponent characterized the likelihood and severity appropriately? Provide rationale.	• DFO was unable to review this section within the timeframe provided, but understanding the potential effects of climate change on fish and fish habitat is important (e.g., extreme precipitation and high flows, extreme drought and low flows, etc.).
• Has the proponent sufficiently described and characterized the project activities and components as they relate to federal decisions within your mandate? If not, identify what additional information is needed. • Are changes to the environment, as they relate to federal decisions within your mandate, sufficiently described? If not, identify what additional information is needed.	• Additional detailed information about the project components and activities (e.g., detailed design drawings, figures, erosion and sediment control plan, monitoring plans, etc.) are required to support an application for *Fisheries Act* authorization for the project. The proposed offsetting plan is not complete or adequate to support an application for *Fisheries Act* authorization for the Project. • Changes to fish and fish habitat from the project have not been sufficiently described to support an application for *Fisheries Act* authorization for the Project. DFO has outstanding concerns regarding aspects of the proponent's characterization of the impacted fish habitat and their assessment of effects to fish and fish habitat. Additional work is needed to demonstrate that residual HADD can be counterbalanced through the implementation of offsetting measures (see comments below).
Mitigation	
• Has the degree of uncertainty regarding the effectiveness of the proposed mitigation measures been described? If not, identify what information is needed. • Is it clear how each proposed mitigation measure links to each potential pathway of effect?	<u>Fish Habitat Offset Plan</u> • The Draft Fish Habitat Offset Plan is not complete or adequate, and does not provide DFO with confidence that the residual impacts to fish and fish habitat from the project will be counterbalanced. As outlined in DFO's Policy for applying measures to offset adverse effects on fish and fish habitat under the *Fisheries Act*, the amount of offsetting required must provide ecological benefits that are proportional to the residual effects resulting from the project, with additional offsetting to account for uncertainty and additional offsetting to account for time lag. • DFO has provided advice and recommendations to the Agency and the proponent regarding offsetting measures on a number of occasions during the EA process. DFO's letters to the Agency dated April 23, 2019 and April 22, 2020 emphasized the challenge associated with identifying measures to offset the large spatial extent of residual impacts to fish and fish habitat from the project, especially important habitat for SU Atlantic Salmon, and the need for the proponent to demonstrate that adequate offsetting measures can be identified. DFO's April 22, 2020 letter to the Agency included detailed comments on the Department's review of an earlier version of the conceptual offsetting plan. DFO has also reviewed draft versions of the Offset Plan on a number of occasions in 2021. The majority of DFO's comments and concerns related to offsetting measures have not been addressed in the October 2021 EIS submission and Draft Fish Habitat Offset Plan.

Questions	Responses/Comments
	• DFO has identified additional HADD of fish habitat from project components and activities that has not been identified by the proponent in the assessment, and the area of residual HADD has been underestimated. Based on the information provided, permanent hydrological alterations are likely to result in additional areas of HADD to Killag River/Cameron Flowage and Mud Lake. Residual HADD from the haul road may also have been underestimated. These impacts need to be counterbalanced by the implementation of offsetting measures. • DFO's offsetting policy identifies habitat restoration of degraded habitats as the Department's highest priority. Habitat enhancement and creation measures should only be considered only after options for Atlantic Salmon and Brook Trout habitat restoration options have been carefully considered. There are 22 watersheds within the Southern Upland region have been identified as having an existing population of SU Atlantic Salmon. A more effective and acceptable approach than the options proposed would be to identify degraded salmonid habitat in these SU watersheds that could benefit from targeted restoration and enhancement measures that address the causes of degradation. Since the project will adversely impact habitat for SU Atlantic Salmon in the West River, Sheet Harbour watershed, additional effort should be made to identify potential habitat restoration and enhancement measures in this watershed as a component of the offsetting plan to counterbalance the project impacts. • Alternative 1 – Groundwater Upwelling Stations (Mitigation) o Available information indicates Cameron Flowage is a groundwater discharge area, and this is likely an important feature of the Atlantic Salmon and Brook Trout habitat in the river because it provides a source of cool water and base flow during summer low flow periods. DFO does not consider the pumping of mining effluent from the north settling pond into the streambed of Cameron Flowage to be a mitigation or offsetting measure. This measure should be removed from the plan and not considered further. • Alternative 2A – Off-Channel Habitat Construction o The Musquodoboit River contains important habitat for SU Atlantic Salmon and Brook Trout, and DFO could support habitat restoration and/or enhancement measures that are likely to provide self-sustaining benefits to these species over the long-term in this watershed. However, DFO has a number of concerns about the proposed pond as an offsetting measure: ▪ DFO is not aware of any successful off-channel pond offsetting projects in the Maritime Provinces and therefore there is high degree of uncertainty associated with the effectiveness of this proposed measure. ▪ The Offset Plan does not describe the features and attributes of "high quality pond habitat"; however, it is unlikely that the ponds will provide good quality habitat for salmonids based on the information provided. It is not clear what species or life processes the pond will support or how it will be beneficial to salmonids or other species. ▪ Offsetting measures should provide benefits to fish and not present additional risks. ▪ Excavation of pit to create the pond in close proximity to streams and rivers has a high potential of resulting in the sedimentation of fish habitat. For example, there appears to be a large area of exposed soil and a large sediment plume in the example photo provided in the Offset Plan, with insufficient erosion and sediment control measures in place. DFO does not support any offsetting measures that are likely to result in sedimentation of fish habitat in Musquodoboit River. ▪ If the pond is not groundwater-fed and/or regularly flushed, water quality may be insufficient to support salmonids (e.g., warm water, low dissolved oxygen) and fish may become stranded in the pond during summer low flow periods. The combined average discharge estimates provided for WC1 and WC2 during average summer conditions are very low (~0.0025 m^3/s). Considering the approximate size of the proposed pond (41,000 m^2 x 1 m average depth) and these discharge estimates, the retention time for the pond would be approximately 190 days which is greater than the entire summer period. This suggests poor water quality may be an issue. ▪ Such ponds can be associated with invasive fish species, such as Smallmouth Bass and Chain Pickerel, and when directly connected to and/or within the floodplain of the river they can present a risk of these invasive species being introduced into the river. Introduction of these invasive fish species into the Musquodoboit River would represent a serious threat to native fish species, including salmon and trout. ▪ Information in the Draft Offset Plan does not support the conclusion that WC3 is currently or could be enhanced to provide high quality stream habitat for salmonids. ▪ It is not clear whether any of the existing watercourses are existing fish habitat. If these watercourses are fish habitat, then realignment – even as a component of a proposed offsetting measure – may be considered a HADD. ▪ The Draft Offset Plan does not contain sufficient information to give DFO confidence that the pond will provide 41,000 m^2 of habitat offsets. ▪ Information has only been provided about one of the 160,000 m^2 of proposed pond locations, and DFO cannot consider or support offsetting measures for which only a waypoint on a map is the only detail provided. ▪ Based on the information provided, DFO is unlikely to support the proposed offsetting measures involving the creation of off-channel ponds. • Alternative 2B - Main Stem Musquodoboit River o DFO supports the concept of spawning habitat enhancement for Atlantic Salmon and Brook Trout as a potential offsetting measure for the project. The proponent has not identified any specific locations with the Musquodoboit River where existing habitat could benefit from the enhancement described. Any site selected for substrate enhancement would need to have other features and attributes of spawning habitat to be effective, and studies would need to be done to understand

Questions	Responses/Comments
	existing habitat use and whether these areas may already provide salmonid spawning habitat. It is not possible for DFO to determine the feasibility or effectiveness of this proposal based on the information provided. • Most of the remaining alternatives are general descriptions of different types of offsetting measures with no actual proposals. • The fact that culvert installations or replacements along the haul road will provide or improve fish passage is not a mitigation or offsetting measure for any HADD associated with their installation. <u>Erosion and Sediment Control (ESC) measures</u> • Sedimentation of fish habitat from project activities can be mitigated to a degree through the application of industry standard ESC measures, but such measures are less effective at preventing fine sediments from being mobilized in surface water runoff and entering watercourses. The proponent has proposed designing their sediment collection ponds to have a 24-hour residence time for sediment-laden water, which is unlikely to be effective at removing fine sediment particles from surface water before being released into Killag River. Since the proponent has selected Killag River as the final discharge location for all surface water from the mine site, some degree of sedimentation of Atlantic Salmon spawning and rearing habitat downstream of Cameron Flowage from project activities is likely to occur over the long-term (i.e., greater than 10 years). The potential impacts to the Atlantic Salmon population from sedimentation of important spawning and rearing habitat in Killag River will ultimately depend on the quantity, duration, and frequency of sediment deposition, but there is potential for sedimentation to result in a substantial loss of population productivity (see Table 5.3 in Bowlby et al. 2014). • The ESC measures shown in the example photo provided in the Draft Offset Plan do not appear to be effective at preventing sedimentation impacts to fish and fish habitat and do not appear to be consistent with best management practices for ESC. • Based on recent experience, it is possible that ESC measures may not be completely effective at preventing sedimentation of fish habitat on a mine site. A detailed ESC Plan for the project is required to support an application for *Fisheries Act* authorization.

• Would you propose different or additional mitigation measures? If so, provide a description of the mitigation measure(s), with rationale.	<u>Release of mining effluent is not a mitigation measure</u> • Over the 5-year operational phase and the 14-year EOM phase, the proponent plans to release mining effluent containing deleterious substances into Cameron Flowage. The proponent has suggested that the release of mining effluent into Killag River is a mitigation measure and potential offsetting measure for flow reductions due to project components and activities. The release of mining effluent containing deleterious substances into water frequented by fish is prohibited under section 36 of the *Fisheries Act* due to potential adverse effects to fish and fish habitat, and therefore requires authorization under the *Metal and Diamond Mining Effluent Regulations* (MDMER). Any work, undertaking, or activity that requires authorization under the Act due to adverse effects to fish and fish habitat should not be considered a mitigation measure. • The MDMER allow for the release of certain deleterious substances, and establishes maximum concentration limits to provide some level of protection to fish and fish habitat from mining activities. An important point to consider in the context of the assessment is that the maximum authorized monthly mean concentration of many deleterious substances under the MDMER are greater than the CCME water quality guidelines for the protection of aquatic life. While the EIS predicts that effluent will meet the concentration limits set out under the MDMER, monitoring data from ECCC's effects monitoring program shows that effluent from mines meeting the MDMER concentration limits has potential to result in a variety of adverse effects to fish and fish habitat downstream (https://www.canada.ca/en/environment-climate-change/services/managing-pollution/publications/third-national-assessment-monitoring-data.html). Any adverse impacts to fish and fish habitat that result from the deposit of deleterious substances carried out in accordance with the MDMER are exempt from the Fish and Fish Habitat Protection Provisions of the *Fisheries Act* and therefore do not require authorization under s. 34.4 or s. 35 of the Act. The Pollution Prevention Provisions under section 36 of the Act and the MDMER are administered by ECCC. <u>Ecological flows</u> • DFO (2013) recommends that during low flow events a "cut-off limit" for water alterations should be established to conserve and protect fish and fish habitat, and that having such a limit can preserve ecosystem structure and function in riverine ecosystems that support fisheries. Implementing such a limit during low flow events does not appear to be possible as a mitigation measure since the project components and activities represent permanent hydrological alterations to fish habitat that cannot be readily stopped or reversed. DFO recommends that the proponent examine whether contingency measures could be implemented in a timely manner to maintain ecological flows during low flow periods. Contingency measures should not involve the release of more mining effluent. Low flows have a limited capacity to disperse contaminants compared to high flows. <u>Haul Road</u> • To avoid sedimentation of fish habitat at watercourse crossings along the haul road, DFO recommends that any rock used in construction of the haul road be washed and free of fines prior to placement, that runoff from the haul road be directed away from watercourses, and that the proponent consider paving the road at watercourse crossings. • Bridges that are preferred over culverts for crossings over larger streams and rivers.
• Which of the proposed mitigation measures and/or project design elements do you consider to be necessary to reduce the likelihood of significant adverse environmental effects? Provide rationale.	• The project area encompasses important habitat for SU Atlantic Salmon, and there is potential for the project to cause a variety of adverse impacts to this species and their habitat that have been identified as threats to the survival and recovery of the species (e.g., acid rock drainage, deleterious substances, sedimentation, altered hydrology, habitat fragmentation). A substantial amount of effort and resources have been put into the West River, Sheet Harbour Acid Mitigation Project by governments, non-governmental organizations, and stakeholders for nearly two decades. All efforts should be made to avoid and mitigate impacts to salmon habitat and the ongoing restoration project in West River, Sheet Harbour through the implementation of national and international best management practices and guidelines, and to ensure these measures are effective through the implementation of a detailed environmental effects monitoring programs. • Residual HADD to fish and fish habitat from the project must be counterbalanced through the implementation of offsetting measures in accordance with DFO's current offsetting policy.
Residual Adverse Environmental Effects	
• Are the identification and documentation of residual environmental effects described by the proponent adequate? If not, what are the aspects for which there is uncertainty and, where possible, indicate how these residual effects can be best described. If there is uncertainty, what are the options for increasing certainty?	• **Key messages:** ➢ Killag River in the project area is considered important habitat for SU Atlantic Salmon (COSEWIC endangered). ➢ There are 72 watersheds in the SU Region that historically supported Atlantic Salmon populations. West River, Sheet Harbour is one of 22 watersheds in the SU Region where salmon are known to persist at present. ➢ The West River, Sheet Harbour Acid Mitigation Project is one of the largest and longest running Atlantic Salmon habitat restoration and enhancement projects in eastern Canada. ➢ Fish habitat in Killag River is naturally degraded during summer low flow periods and Atlantic Salmon are sensitive to hydrological habitat alterations. Project components and activities will result in hydrological alterations to Killag River that are likely adversely impact fish habitat and exacerbate habitat degradation during summer low flow periods. These alterations are irreversible. ➢ Altered hydrology, sedimentation, deleterious substances, acid rock drainage, and habitat fragmentation from road crossings have been identified as threats to SU Atlantic Salmon habitat, and have potential to result in substantial impacts to their habitat and reduce population productivity (see Table 5.3 in Bowlby et al. 2014). ➢ Population modelling conducted by DFO Science indicates that any reduction in population productivity from impacts to freshwater habitat is likely to increase the extirpation risk of SU Atlantic Salmon.

	• DFO's assessment of the residual adverse environmental effects of the project on fish and fish habitat differs from the proponent's assessment in key areas, including the likelihood and magnitude of residual adverse impacts to fish and fish habitat from project components and activities, and the demonstrated feasibility of counterbalancing these impacts through the implementation of offsetting measures. • DFO has raised concerns regarding potential impacts to important habitat for SU Atlantic Salmon in Killag River on a number of occasions during the EA process, and explained how these impacts are likely to result in a HADD requiring authorization and the implementation of offsetting measures. DFO has considered the proponent's hydrological models and the characterization of the planned discharge of mining effluent into Cameron Flowage as a mitigation measure. The modelling undertaken by the proponent is not adequate to identify and characterize residual adverse effects to fish and fish habitat from the complex, permanent hydrological alterations that will result from the project. As outlined above, project hydrological alterations will impact ecological flow in Killag River and other habitats in the project area, and will impair the habitat's capacity to support one or more life processes of fish during the summer period. Based on available information, the area of residual HADD in Killag River from the project that was not identified in the assessment is approximately 100,000 m^2 (equivalent to the area of Cameron Flowage downstream to the Killag River bridge). • Furthermore, permanent hydrological alterations to Mud Lake from the project are likely to impair the habitat's capacity to support one or more life processes of fish during the summer period. Based on available information, the area of HADD in Mud Lake from the project that was not identified by the proponent is approximately 32,500 m^2 (equivalent to the approximate area of Mud Lake). • Based on the information provided, the proponent may not have accurately quantified impacts to fish habitat from the watercourse crossings along the haul road and the residual HADD may be an underestimate. The information provided is not sufficient for DFO to be able to quantify the likely area of HADD. • Project components and activities such as site preparation, excavation and blasting, material stockpiling, and haul road construction and use are likely to increase the supply of fine sediment in the project area, and some of this sediment is likely to enter Killag River from overland flows and controlled release from final discharge points. The introduction of excess fine sediments to a watercourse can adversely impact fish habitat. Salmonids are among the most sensitive species to deposited sediments in freshwater ecosystems, and studies demonstrate that elevated levels of fine sediment in streambed substrates have the potential to compromise the survival of salmonid eggs and alevins and affect stream and benthic invertebrate production (food supply). Even small amounts of excess suspended sediment (~7 mg/L) have been shown to increase mortality of salmonid eggs at exposure durations of greater than 30 days (CCME 2002). Silt and sediment can infill spaces in gravel and cobble substrate, smothering salmon eggs and alevins, and obstructing access to overwintering habitat under large cobble and boulders (Bowlby et al. 2014; CCME 2002). In recognition of the potential impacts to salmonid habitat from sedimentation, CCME (2002) provides specific guidelines for quantity of fine sediment in streambed substrates. The potential impacts to Atlantic Salmon population from sedimentation of important spawning and rearing habitat in Killag River will ultimately depend on the quantity, duration, and frequency of sediment deposition and the effectiveness of ESC measures, but it is likely that sedimentation from the project will impact the productivity of freshwater habitat for Atlantic Salmon and Brook Trout. **References** Bowlby, H.D., Horsman, T., Mitchell, S.C., and Gibson, A.J.F. 2014. Recovery Potential Assessment for Southern Upland Atlantic Salmon: Habitat Requirements and Availability, Threats to Populations, and Feasibility of Habitat Restoration. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/006. vi + 155 p. Canadian Council of Ministers of the Environment. 2002. Canadian water quality guidelines for the protection of aquatic life: Total particulate matter. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.
• Did the proponent provide a sufficiently precise, ideally quantitative, description of the residual environmental effects related to your mandate? Identify any areas that are insufficient.	• As noted above, DFO has identified additional large areas of HADD of fish habitat from the project that has not been identified in the assessment, and the area of HADD has been underestimated in the EIS.
Determination of Significance	
• Are the conclusions on significance in the EIS supported by the analysis that is provided? • Are the proponent's proposed criteria for assessing significance appropriate? This includes how the criteria were characterized, ranked, and weighted. Provide rationale. Where the proponent has **not** used one of the Agency's recommended key criteria (magnitude, geographic extent, duration, frequency, reversibility, and social/ecological context), has a rationale been provided?	• The definition refers to DFO's pre-2012 No Net Loss Policy. This policy is obsolete and the proponent's application for *Fisheries Act* authorization must be prepared in accordance with the current Act, regulations and associated policies. DFO's current offsetting policy is available on DFO's Project's Near Water website. This comment has been provided to the proponent a number of times during the EA process and has not been addressed. • The criteria do not accurately reflect DFO's Ecological Flow Framework or risks to fish and fish habitat from the project. Refer to DFO's comments above regarding the DFO Ecological Flow Framework. Altered hydrology, sedimentation, deleterious substances, acid rock drainage, and habitat fragmentation from road crossings have been identified as threats to SU Atlantic Salmon habitat and have potential to result in substantial impacts to their habitat and reduce population productivity. Population modelling conducted by DFO Science indicates that any reduction in freshwater productivity of SU Atlantic Salmon habitat is likely to increase the probability of extirpation. See Attachment 2 and the SU Atlantic Salmon RPA documents for additional information.
• Were appropriate methodologies used in developing the conclusions on significance?	• No, see comments above.

• Do you agree with the proponent's analysis and conclusions on significance? Provide rationale.	• As explained above, DFO's assessment of the potential residual adverse environmental effects of the project on fish and fish habitat differs from the proponent's assessment in key areas. There are large areas of residual HADD (including to important habitat for SU Atlantic Salmon) that have not been identified by the proponent. • Section 6.9.6.2 of the EIS defines the significance threshold for fish and fish habitat: "*Overall, a significant adverse effect from the Project on fish and fish habitat is defined as an effect that results in an unmitigated or uncompensated net loss of fish habitat as defined under the Fisheries Act, and its associated no-net loss policy.*" • As explained above, the Draft Fish Habitat Offset Plan is not complete or adequate, and does not provide DFO with confidence that the residual impacts to fish and fish habitat from the project will be counterbalanced.
Monitoring and Follow-up	
• Does the proposed monitoring and follow-up program verify the predictions of the environmental assessment as they relate to section 5? Please explain additional monitoring or follow-up needed to address uncertainty in the effects assessment.	• The proposed monitoring and follow-up program is not adequate to verify predictions and the effectiveness of mitigation measures. • The proponent identified juvenile Atlantic Salmon and Brook Trout in Moose River adjacent to the Touquoy mine prior to the start of the project. DFO's efforts to verify the predicted effects to Moose River from the Touquoy project are ongoing and the proponent has indicated a high degree of uncertainty in the monitoring results. Based on this experience, DFO recommends the following information and approach to address uncertainties and implement an effective monitoring program. This information and approach will be required to support an application for *Fisheries Act* authorization for the project. <u>Fish and Fish Habitat Effects Monitoring Program</u> • DFO recommends the proponent develop a detailed BACI study design as the basis for the fish and fish habitat effects monitoring program (DFO 2013, DFO 2019, Braun et al. 2019). • The monitoring plan should include standardized fish and fish habitat sampling protocols at fixed control and impact monitoring locations in the project area, including Killag River. Monitoring using these protocols should be conducted before the project commences, and continued through all project phases. • The monitoring plan should include: ➢ a detailed description of the study design and methods, indicators/metrics to be measured, and performance objectives; ➢ a detailed description of all potential sources of error and uncertainty and how they will be addressed; ➢ the contingency measures that will be implemented should the measures to avoid and mitigate not function as described or intended, and/or not meet the specified performance objectives; and ➢ a description of how monitoring results will be reported to DFO in a timely manner. • Indicators/metrics should include, but not limited to: relative abundance and density of fish, the composition and diversity of fish communities, water temperature, water depth, TSS, substrate composition and embeddedness; and daily discharge and water levels. • DFO recommends the proponent provide a draft monitoring plan to the Department prior to initiating the collection of baseline data to verify the approach is acceptable. **References** Braun, D.C., Smokorowski, K.E., Bradford, M.J., and Glover, L. 2019. A review of functional monitoring methods to assess mitigation, restoration, and offsetting activities in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/057. vii + 75 p. DFO. 2019. Science advice on operational guidance on functional monitoring: Surrogate metrics of fish productivity to assess the effectiveness of mitigation and offsetting measures. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/042. DFO. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/017.
• Does the proposed monitoring and follow-up program verify the effectiveness of proposed mitigations as they relate to section 5? Please explain additional monitoring or follow-up needed to address uncertainty in the proposed mitigation.	No, see comments above.
• Is the objective of the follow-up program clear and measurable? • Does the follow-up program include sufficient detail, and technical merit, for the Agency to achieve the stated objective through a condition (e.g. sufficient baseline dataset, monitoring plans, acceptable thresholds of change, contingency procedures)?	No, see comments above.
• Are you aware of any federal or provincial authorizations or regulations that will achieve the same follow-up program objective(s)? If so, how do these achieve the objective(s)?	No.
Additional comments, views, advice	

• Provide any other comments.	DFO has provided detailed advice to the Agency and proponent throughout the project EA process. DFO's main concerns and advice have not been addressed by the proponent in the 2021 EIS and Round 2 IR responses. DFO recommends the Agency review and consider the Department's advice and comments provided to date because many of these comments are still relevant. Some of the letters DFO has sent to the Agency include: • April 7, 2016 notification letter pursuant to Subsection 79(1) of the *Species at Risk Act* for the Proposed Beaver Dam Mine Project • April 23, 2019 regarding Technical Review of the February 2019 Revised Environmental Impact Statement • April 22, 2020 regarding DFO's review of the conceptual offsetting plan • June 9, 2020 DFO follow-up response to notification letter pursuant to Subsection 79(1) of the *Species at Risk Act* for the Proposed Beaver Dam Mine Project

ANNEX 2: ***Information requirements directed to the proponent***

Table 2: Please use the table below to provide your department's comments and suggestions for information that should be required from the proponent to ensure the information in the EIS is scientifically and technically accurate and is sufficient to make a determination of significance on environmental effects.

ID	Project Effects Link to CEAA 2012	Reference to EIS guidelines	Reference to EIS	Context and Rationale	Specific Question/ Request for Information

ANNEX 3: ***Advice to the proponent***

Table 3: Additional advice to the proponent, such as guidance or standard advice related to your departmental mandate

ID	Reference to EIS	Context and Rationale	Advice to the Proponent
DFO-1	All components of the EIS related to fish and fish habitat.	DFO has identified a number of concerns about the project and assessment, and provided detailed advice and guidance throughout the EA process for the project.	• Many of DFO's concerns and comments have not been addressed. DFO recommends that AMNS carefully review the advice and comments provided by the Department to AMNS and the Agency throughout the assessment, including but not limited to, these technical review comments. Should the project receive EA approval, ensure DFO's comments and concerns are addressed prior to submission of an application for *Fisheries Act* authorization.
DFO-2	Fish and Fish Habitat assessment	As outlined in DFO's Fish and Fish Habitat Protection Policy, proponents are required to demonstrate that measures and standards have been fully applied to first avoid, then mitigate, residual impacts to fish and fish habitat before DFO will consider offsetting measures.	• DFO recommends AMNS identify and implement opportunities to further avoid and mitigate impacts to SU Atlantic Salmon and their habitat from the project.
DFO-3	Fish and Fish Habitat assessment, Offset Plan	The Draft Fish Habitat Offset Plan is not complete or adequate, and does not provide DFO with confidence that the residual impacts to fish and fish habitat from the project will be counterbalanced.	• Prepare an offsetting plan in accordance with DFO's offsetting policy. The plan must include detailed information for each of the proposed offsetting measures, including all information set out in Part 3 of the Policy. • Review the documents prepared for the SU Atlantic Salmon Recovery Potential Assessment as well as other available scientific information to understand the functions, features, and attributes of freshwater habitat for Atlantic Salmon throughout their life cycle, and to understand the various threats related to freshwater habitat for the species.

			• DFO's highest priority for offsetting measures are the restoration and enhancement of degraded Atlantic Salmon habitat in the West River, Sheet Harbour watershed that will counterbalance impacts to this population from the project. The second highest priority is the restoration and enhancement of degraded Atlantic Salmon habitat in one or more of the other 21 watersheds within the SU Region where salmon still persist. • Engage with the Mi'kmaq of Nova Scotia, local stakeholders and watershed groups to identify potential Atlantic Salmon habitat restoration and enhancement opportunities. • Seek advice from qualified environmental professionals that have demonstrated experience in Atlantic Salmon habitat restoration and enhancement. • Ensure that the offsetting measures will not result in additional HADD to fish habitat. • Remove all references to mining effluent as a potential offsetting measure and do not consider further.
DFO-4	HADD from Haul Road Crossings	Based on the information provided, it does not appear the potential area of HADD from watercourse crossings correctly has been estimated correctly.	• To calculate the potential surface area of fish habitat (i.e., waterbody, watercourse, and wetland) affected by each watercourse crossing (HADD), AMNS should calculate the footprint of the watercourse that will be abandoned (lost) due to the installation of the new culvert, including the surface area taken up by the energy dissipation pool on the downstream side of the culvert. For crossing sites in which the watercourse is not straight, the footprint of the watercourse lost due to straightening should be calculated. In the event that a culvert is to be replaced and that culvert already has an energy dissipation pool associated with it, AMNS does not need to include the area of the new energy dissipation pool in the calculations. Do not reduce the

			estimated area of impact because the culvert will provide fish passage. • DFO reviews multiple watercourse crossings cumulatively on a watershed basis, so crossings and associated HADD should be grouped by secondary watershed.
DFO-5	Monitoring and Follow up	The proponent's proposed monitoring plan is not adequate to verify effects to fish and fish habitat and the effectiveness of avoidance and mitigation measures.	• Review DFO's comments above in Annex 1 regarding monitoring and follow-up and develop a detailed draft monitoring plan for DFO review and feedback.
DFO-6	Fish and Fish Habitat assessment	DFO's Ecological Flow Framework has not be correctly interpreted or applied in the assessment.	• Seek advice from qualified environmental professionals that understand the concept of ecological flows and can correctly interpret and apply DFO's Ecological Flow Framework.

Attachment 2 – Additional information related to Atlantic Salmon (Southern Upland population) in support of the CEAA 2012 Environmental Assessment of the proposed Beaver Dam Mine Project

Introduction

The purpose of this letter is to provide additional information to the Impact Assessment Agency of Canada (the Agency) in support of the environmental assessment (EA) of the proposed Beaver Dam Mine Project (the Project) under the Canadian Environmental Assessment Act, 2012 (CEAA 2012). DFO recommends that additional baseline and scientific information should be considered by the Agency in the EA process that has not been adequately considered in the proponent's Environmental Impact Statement (EIS) and subsequent responses to information requests. This additional information includes baseline and scientific information regarding the Southern Upland Designatable Unit (DU) of Atlantic Salmon, including the West River, Sheet Harbour population.

Fisheries and Oceans Canada (DFO) is responsible for the conservation and protection of fish and fish habitat as set out under the *Fisheries Act*. DFO is also responsible for implementing Canada's Wild Atlantic Salmon Conservation Policy (DFO 2019). The goal of the policy is "to restore and maintain healthy wild Atlantic salmon populations by rebuilding and protecting the biological foundations of wild Atlantic salmon while taking into consideration the social, cultural, ecological and economic benefits of wild salmon for now and for the future generations of Canadians".

There are few species of fish in Canada as well studied as Atlantic Salmon, and there is an abundance of scientific and technical information about SU Atlantic Salmon that is available (e.g., DFO Science Branch publications, peer-reviewed journals) to support an assessment of the potential effects of the Project on this species and its habitat. Detailed information is available about SU Atlantic Salmon population status and trends; the functions, features, and attributes of freshwater habitat required to support the various life stages of Atlantic Salmon life history processes; and threats to the species' survival and recovery in the SU Region. An important source of information are the scientific reports produced during the COSEWIC assessment and DFO recovery potential assessment processes. This letter presents a summary of relevant scientific advice and recommendations from these information sources, with a focus on the West River, Sheet Harbour Atlantic Salmon population and its habitat that may be adversely impacted by the Project. Readers are encouraged to review the studies and reports referenced in this document for additional information.

SU Atlantic Salmon Population Status and Trends

SU Atlantic Salmon occupy rivers in a region of Nova Scotia extending from the northeastern mainland into the Bay of Fundy at Cape Split comprised of 72 major watersheds thought to contain or to historically have contained Atlantic Salmon (Bowlby et al. 2014, DFO 2013; Figure 1).

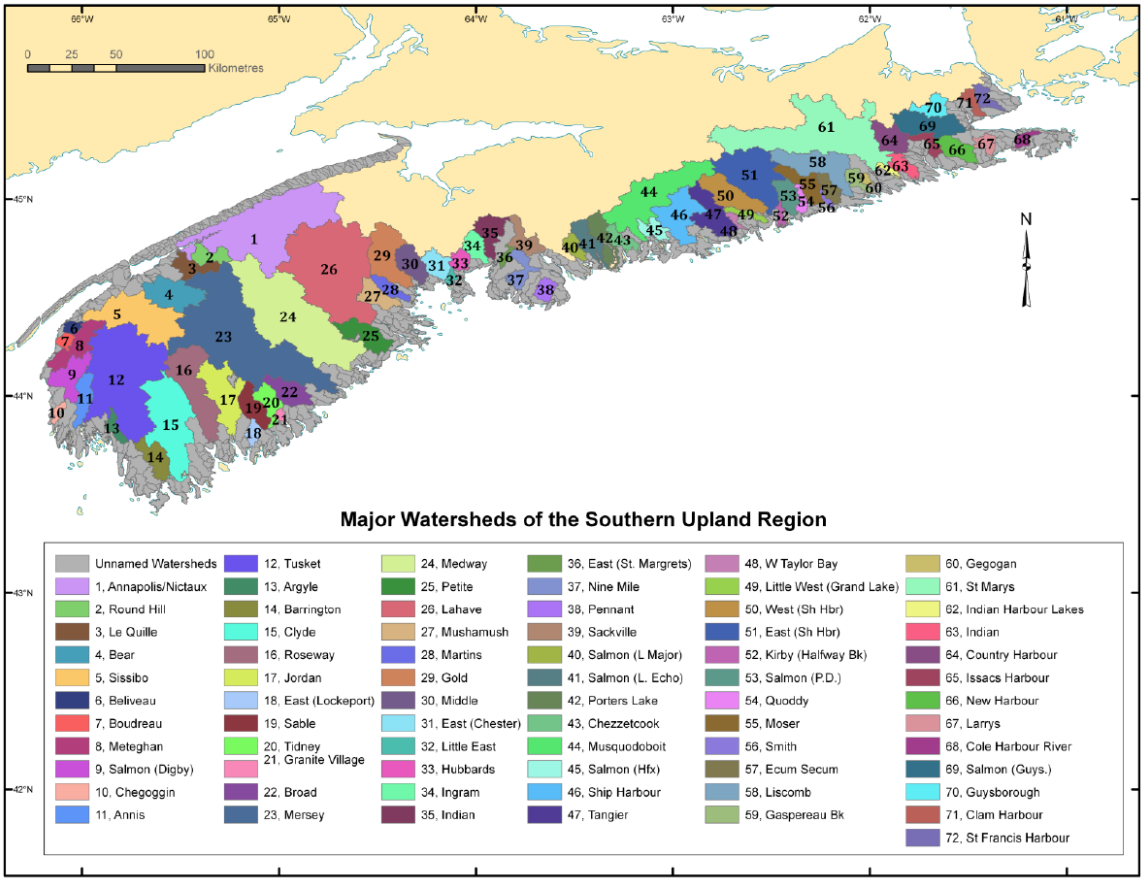


Figure 1. Map of the 72 watersheds known to be used by Southern Upland Atlantic salmon either at present or in the past. West River-Sheet Harbour is identified as watershed #50. Watersheds contained within the Southern Upland that are not known to have been used by Atlantic salmon are not labelled by number and are shown in grey. Source: Bowlby et al. (2014).

Atlantic Salmon populations across the Southern Upland DU, including the West River, Sheet Harbour population in the project area, remain at critically low levels of abundance and are at high risk of extirpation. Southern Upland (SU) Atlantic Salmon were assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) over a decade ago. “Endangered species” are defined by COSEWIC as “a wildlife species facing imminent extirpation or extinction”. There is no evidence that populations in the DU are recovering and declines are occurring in the two most studied populations.

COSEWIC assessed SU Atlantic Salmon as Endangered in November 2010 due to a net decline of 61% for mature individuals over the previous 3 generations (1993 to 2007) and to apparent declines in the area of occupancy across its range (COSEWIC 2010). SU Atlantic Salmon are currently under consideration by the Government of Canada for listing under Schedule 1 of the *Species at Risk Act* (SARA). SU Atlantic Salmon are

biologically unique and that their extinction would constitute an irreplaceable loss of Atlantic Salmon biodiversity (Gibson et al. 2011).

In 2013, DFO Science undertook a Recovery Potential Assessment (RPA) process to provide the information and scientific advice required to meet the various requirements of SARA and provide advice to the Minister regarding the listing of the species under SARA (O'Reilly et al. 2012, Bowlby et al. 2013, Gibson and Bowlby 2013, Bowlby et al. 2014, DFO 2013). Some of the main findings of the RPA process include:

- Available indices show that abundance of SU Atlantic salmon is very low and has declined from levels observed in the 1980s and 1990s.
- Annual adult abundance in four Southern Upland rivers declined 88% to 99% from observed abundance in the 1980s.
- Region-wide comparisons of juvenile density data from 54 Southern Upland rivers indicate significant ongoing declines between 2000 and 2008/2009 and provide evidence for river-specific extirpations.
- Juvenile Atlantic salmon were found in only 22 of 54 river systems in the SU Region surveyed in 2008/2009.

For assessment purposes, two rivers in the SU Region are used as index rivers for long-term monitoring: the St. Mary's River and the LaHave River (above Morgan Falls). The most recent assessment was published in 2020 (DFO 2020). Some of the main findings of the assessment include:

- SU Atlantic Salmon remain at critically low abundance and adult returns to the Lahave index river remain among the lowest returns on record.
- Juvenile salmon densities for six of seven Lahave River electrofishing sites in 2018 were the lowest on record since 1999.
- Recent smolt-to-adult return rates on the Lahave index river indicate that marine survival for SU Atlantic Salmon is the lowest on record with values less than 1% from 2013-2016.
- The Conservation Egg Requirement (CER) for Atlantic Salmon is 2.4 eggs/m^2 of fluvial rearing habitat (Gibson and Claytor 2012). Based on assessments in the Lahave index river, it is estimated that egg deposition was only 4% of the CER in 2018 (DFO 2020).

Population viability modeling was conducted for two of the larger populations remaining in the SU Region including the LaHave and St. Mary's rivers (Gibson and Bowlby 2013, DFO 2013). The modeling indicates:

- a high probability of extirpation (87% and 73% within 50 years for these two populations respectively) in the absence of human intervention or a change in survival rates for some other reason;
- a the loss of past resiliency to environmental variability and extreme environmental events (e.g., extreme high or low water levels) is contributing to the high risk of extinction; and

- relatively small increases in freshwater productivity are expected to decrease extinction probabilities (and vice versa).

Due to the present population status of SU Atlantic Salmon and need to prioritize stock conservation measures, commercial and recreational fisheries for Atlantic Salmon are closed in the SU Region (Salmon Fishing Areas 20 and 21) and there are currently no Indigenous food, social, and ceremonial allocations for the species in these watersheds (DFO 2020).

West River, Sheet Harbour Atlantic Salmon Population

West River, Sheet Harbour, where the Beaver Dam Mine Project is proposed is known to still contain Atlantic Salmon. It is located approximately 60 km northeast of Halifax, NS. It is a relatively large watershed on the eastern shore of Nova Scotia with a drainage area of approximately 289 km^2. The West River main branch is approximately 30 km long and flows into Sheet Harbour. West River has two main tributaries including Killag River to the north and Little River to south. Killag River has a drainage area of approximately 69 km^2 and 27 km long channel, while Little River has a drainage area of approximately 49 km^2 and a 16.5 km long channel (Figure 2).

The West River, Sheet Harbour system is not used by DFO Science as an index river for SU Atlantic Salmon; however, DFO and other organizations have conducted surveys in the system since the 1960s that provide an indication of population status and trends. In the late 1960s and early 1970s, the Atlantic Salmon population in the West River watershed was relatively healthy compared to the neighboring East River, Sheet Harbour population which had experienced a decline of over 95% due primarily to hydroelectric dams throughout the system (Ducharme 1972, Gray et al. 1978). By the mid-1990s, the West River population was identified by DFO as being at risk of extirpation due to the low pH and the low number of juveniles detected there (O'Neil et al. 1995).

DFO and other organizations have conducted periodic electrofishing surveys in the West River, Sheet Harbour watershed (Ducharme 1972, Gray et al. 1978, Halfyard 2008, Bowlby et al. 2014). Based on juvenile salmon density data collected during range-wide electrofishing surveys, the density of juvenile salmon in the West River watershed likely decreased between 2000 and 2009 (Bowlby et al. 2014, Gibson et al. 2011). There are a number of factors that can influence electrofishing capture probabilities and these surveys are typically not used explicitly to determine population trends or abundance of Atlantic Salmon; however, survey data can be a useful indicator of the status of salmon populations (Bowlby and Gibson 2012).

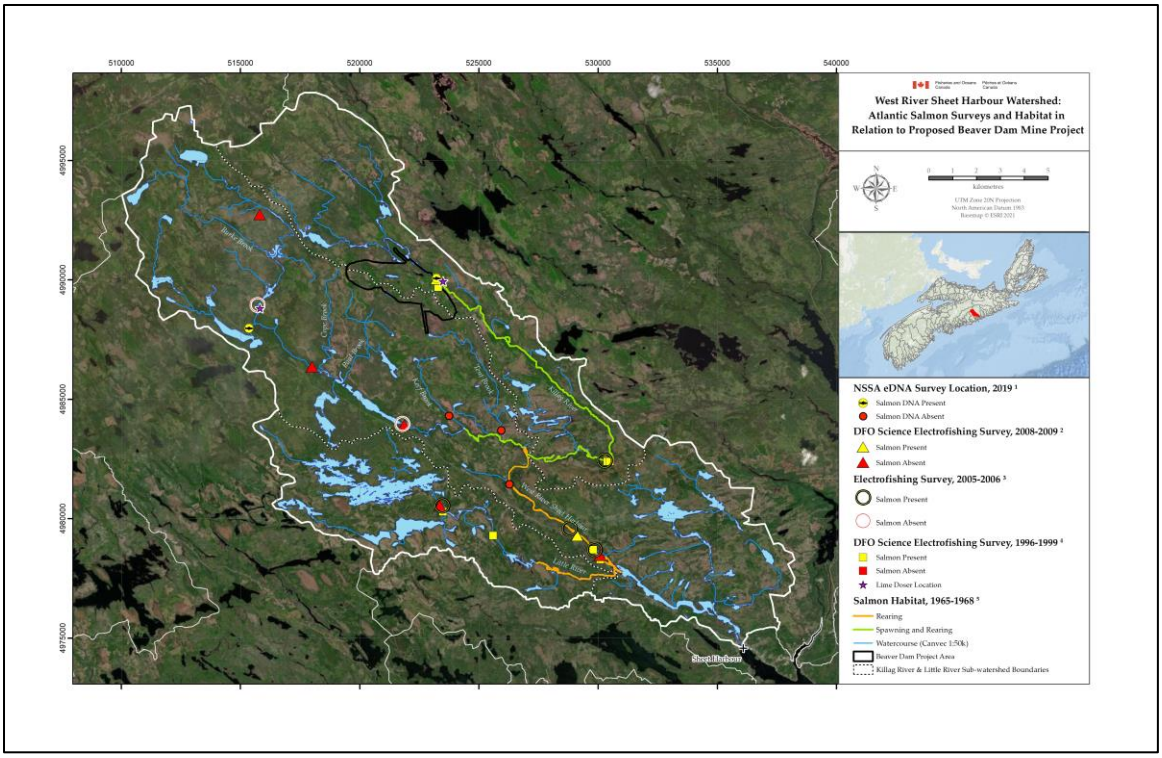


Figure 2. Map of the West River-Sheet Harbour watershed showing the location of Atlantic Salmon surveys and habitat in relation to the proposed Beaver Dam Mine Project. Sources: 1 - Montgomery et al. (2020), 2 - Bowlby et al. (2014), 3 - Halfyard (2008), 4 - Bowlby and Gibson (2019), 5 - Ducharme (1972).

Research undertaken by the Nova Scotia Salmon Association (NSSA) as part of the West River, Sheet Harbour Acid Mitigation Project (discussed below) has demonstrated both the continued presence of juvenile Atlantic Salmon in the West River watershed, and that salmon smolt are migrating to the sea. During the ten year time period from 2010 to 2019, smolt abundance estimates have ranged from 1,012 to 10,950 fish (Halfyard 2021). As a consequence of reduced at-sea survival, the number of adult Atlantic Salmon returning to a counting fence on the West River main branch remains low, ranging from 17 to 62 adult salmon between 2015 and 2019, inclusively (NSSA 2021, unpublished data).

Population modeling conducted on the West River, Sheet Harbour population in 2009 indicated that a small Atlantic Salmon population may be viable if acidity was mitigated throughout the system, but the population is at risk of extirpation from random variability in either environmental or demographic processes, or from genetic effects at small population sizes (Gibson et al. 2009). As was assumed in this model, acidity is now being mitigated throughout the system through the ongoing efforts of the Acid Mitigation Project (discussed below).

SU Atlantic Salmon Habitat

The physical features and attributes of freshwater habitat required for Atlantic Salmon to successfully carry out their life processes are well documented (e.g., Gibson 1993, DFO and MNRF 2008, Bowlby et al. 2014). This section provides a summary of the current condition and availability of Atlantic Salmon habitat in the SU Region and the West River, Sheet Harbour watershed, and of the function and importance of habitat in the watershed.

Habitat Condition and Availability

Two of the main factors limiting freshwater productivity are physical barriers and acidification, and together these factors are thought to have reduced the amount of freshwater habitat in the SU Region by approximately 40%, an estimate that may be conservative (Bowlby et al. 2014, DFO 2013).

At present, over 92% of rearing habitat for juvenile Atlantic Salmon in the West River, Sheet Harbour watershed is accessible (Bowlby et al. 2014), and physical barriers are not considered an important limiting factor in the system. It is estimated that 16,672 units (100 m^2 per unit) of rearing habitat are available in the watershed (Gibson and Claytor 2009; Bowlby et al. 2014).

Acidification of rivers in the SU Region of Nova Scotia, resulting from the emission of pollutants from industrial areas of North America, is a major threat to Atlantic Salmon and is associated with the premature mortality of juvenile salmon and the partial or complete elimination of suitable habitat within a watershed (Bowlby et al. 2014, DFO 2004). The SU Region is believed to be among the most severely affected regions in Eastern Canada because the geology of the region provides very little buffering capacity against the acid rain (DFO and MNRF 2008). Atlantic Salmon are believed to be extirpated from river systems with pH Category 1 (<4.7), severely acid-stressed in rivers with a pH Category 2 (4.8-5.0), and relatively unaffected or unaffected by acidification in pH Category 3 (5.1-5.4), and pH Category 4 (>5.4) rivers (Bowlby et al. 2014).

In the early 2000s, West River, Sheet Harbour was selected by the NS Salmon Association as a demonstration site for an acid mitigation program to investigate and potentially demonstrate the feasibility of liming as a measure to restore freshwater salmon production potential in the Southern Upland salmon rivers (DFO 2004, Halfyard 2008). A lime doser was chosen as the mitigation tool for the Acid Mitigation Project and the first doser was installed in the upper reach of the West River main branch in September 2005 (Figure 2). This lime doser treats approximately 30 km of river (Halfyard 2008). The NS Salmon Association undertakes ongoing annual monitoring and research activities to evaluate the success of the project. Treated sections of river have increased pH to at least 5.5-6.0 and an increase in the abundance of benthic invertebrates and annual smolt production have been observed (Halfyard 2008). Physical habitat restoration efforts were undertaken in the main branch from 2016 to 2019, a second lime

doser was installed on the Killag River in 2017 within the proposed Beaver Dam Mine project area which treats an additional 30 km of the system (Figure 2). Catchment liming using helicopter has been ongoing within the watershed since 2018. The Acid Mitigation Project is one of the largest and longest running Atlantic Salmon habitat restoration and enhancement projects in Eastern Canada, and there are ongoing research and habitat restoration activities in the West River, Sheet Harbour watershed intended to inform about potential recovery activities in other watersheds.

West River, Sheet Harbour has been classified as a pH Category 2 system which means that pH is limiting Atlantic Salmon survival and production (Bowlby et al. 2014). Prior to the installation of the Killag River lime doser in 2017, the proponent measured a mean pH of 5.39 in Killag River just upstream of the lime doser (Intrinsik 2019). More recent measurements of pH in Cameron Flowage (upstream of the lime doser) taken by the proponent in 2020 ranged between 5.54 and 6.62 (McCallum Environmental Ltd. 2021). Liming efforts associated with the Acid Mitigation Project have raised the pH of other sections of the watershed considerably to pH Category 3-4 as well (Halfyard 2008). These measurements indicate that both treated and untreated sections of Killag River have pH levels conducive to Atlantic Salmon survival and production.

Habitat Functions and Importance

Fish and habitat surveys of the West River, Sheet Harbour watershed were conducted from 1965-1968 and documented in Ducharme (1972). These surveys were conducted prior to the most severe impacts of acidification in rivers in the SU Region. The majority of salmon spawning habitat in the system was identified in Killag River from the outflow of Cameron Flowage (adjacent to the Beaver Dam Mine project area) downstream to the river's confluence with the West River main branch (Figure 2). High-quality rearing habitat for juvenile salmon was identified in Killag River, the lower reaches of Little River, and West River main branch between the community of Beaver Dam and the lower Sheet Harbour Lakes (Figure 2). Recent habitat surveys identified Killag River as having the best physical habitat for Atlantic Salmon in the West River watershed (Halfyard 2008). Water temperature in Killag River is typically colder than in Little River or the West River main branch during summer, and thus is likely to provide thermal refugia for Atlantic Salmon during summer when high water temperatures can limit productivity and lower survival rates (Halfyard 2008).

Electrofishing surveys as well as novel techniques such as environmental DNA (eDNA) sampling are useful for monitoring distribution of juvenile salmon and habitat use in a river system. Current and historic information about the distribution of juvenile Atlantic Salmon in the West River-Sheet Harbour watershed is summarized in Figure 2. Juvenile salmon have consistently been detected in Killag River from the 1960s to present day, including the portion of the river within the Beaver Dam Mine Project area (Ducharme 1972, Gray et al. 1978, Gibson et al. 2011, Bowlby et al. 2014, Bowlby and Gibson 2019). eDNA sampling conducted by the NS Salmon Association in summer 2019 detected Atlantic Salmon in Killag River within the project area (Montgomery et al.

2020). Four juvenile Atlantic Salmon were also captured in summer 2020 in Killag River within the project area during electrofishing surveys conducted by the proponent (McCallum Environmental Ltd. 2021).

Juvenile Atlantic Salmon were found in only 22 of 54 river systems in the SU Region surveyed in 2008/2009, including West River, Sheet Harbour. The Recovery Potential Assessment recommends that all of these 22 rivers can be considered the highest priority for habitat allocation and protection given they contain wild populations of Atlantic Salmon and their presence demonstrates that the freshwater habitat is of sufficient quality to support spawning and potentially the establishment of a wild self-sustaining population (Bowlby et al. 2014, DFO 2013). In terms of watersheds that still contain Atlantic Salmon on the eastern shore of Nova Scotia (Salmon Fishing Area 20), West River, Sheet Harbour is the second largest watershed in terms of available rearing habitat.

Potential Impacts to Atlantic Salmon from the Project

A number of the works, undertakings, and activities associated with the Project are likely to result in adverse effects that been identified by DFO Science in the Recovery Potential Assessment as threats to SU Atlantic Salmon in freshwater (Table 2). Furthermore, the Project will impact habitat that has been identified as the most important spawning and rearing habitat for SU Atlantic Salmon in the West River, Sheet Harbour watershed. Each of these threats are detailed in the RPA documents (Bowlby et al. 2014, DFO 2013).

Scientific information and advice from the RPA process indicates that the West River, Sheet Harbour watershed is among the highest priority systems in terms of habitat allocation and protection for SU Atlantic Salmon due to:

- the absence of physical barriers throughout most of the watershed;
- pH levels conducive to survival and production of Atlantic Salmon;
- the continued presence of wild Atlantic Salmon in the system; and
- the ongoing West River, Sheet Harbour Acid Mitigation Project.

An important point to consider in the project EA is the that population viability modeling indicates that relatively small decreases in freshwater productivity within a watershed can increase the risk of extirpation of the Atlantic Salmon population. The overlap between the potential effects of various project components and the identified threats to freshwater habitat of SU Atlantic Salmon further illustrates the potential risk to the West River Atlantic Salmon population from the Project, and the need for a careful and thorough assessment of the potential environmental effects.

Table 2. Comparison of threats to freshwater habitat of Southern Upland Atlantic Salmon identified in the Recovery Potential Assessment and works, undertakings, and activities associated with the proposed Beaver Dam Mine Project. Source: Bowlby et al. (2014).

Project works, undertakings, and activities	Recovery Potential Assessment – Threat to Freshwater Habitat							
	Altered hydrology	Extreme temperature events	Silt and sediment	Acidification	Chemical contaminants	Habitat fragmentation	Infrastructure (roads)	Mining
Site preparation			x					x
Open pit excavation	x	x	x		x	x		x
Material stockpiles (e.g., waste rock, organic materials, till, etc.)	x		x	x	x	x		x
Surface water management	x	x	x	x	x			x
Haul roads	x		x			x	x	x

Based on available information, DFO is particularly concerned about the potential impacts on SU Atlantic Salmon and their habitat from:

- hydrological alterations in Killag River spawning and rearing habitat from excavation of the open pit in close proximity to the river and from other project infrastructure and surface water management within the river's catchment area;
- sedimentation of Killag River spawning and rearing habitat from various project activities; and
- decreased water quality in Killag River spawning and rearing habitat from the discharge of surface water from the mine site containing deleterious substances.

DFO also notes that additional fish species and their habitat may be adversely affected by the Project, including: American Eel (which have been assessed as Threatened by COSEWIC) Brook Trout, and many other species. This letter focuses on SU Atlantic Salmon because populations in the Southern Upland DU remain critically low and they are highly vulnerable to adverse impacts from human activities relative to other fish species.

Closing

DFO recommends that this additional information be considered in the EA process and in the Agency's determination of whether the Project is likely to result in significant adverse environmental effects. The additional baseline and scientific information summarized in this report highlights the high risk of extirpation facing many Atlantic Salmon populations in the SU Region, including the West River, Sheet Harbour population, and the population's vulnerability to adverse impacts from the Project.

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