Baffinland Iron Mines Corporation

Appendix I

Summary of Minnow Recommendations and Regulatory Feedback

Summary of Revisions included in AEMP (Rev. 2) and Key Feedback from Regulators and Stakeholders

Proposed Recommendations for AEMP (Minnow, 2016)	Key Feedback from Regulators/Stakeholders	Baffinland Response	Baffinland and Regulators/Stakeholders Correspondence - Document References	Status
1. Discontinue water quality monitoring at Station L1-09 (Camp Lake Tributary 1) Currently, four water quality monitoring stations are located on the main stem of Camp Lake Tributary 1 (CLT1), with Stations L1-09 and L1-05 both located on the portion of the main stem between the confluence with the north branch and the Tote Road water crossing. Monitoring conducted during the 2015 CREMP indicated that water chemistry at these stations was very similar, which can be expected since no sources of dilution occur between these stations. Therefore, the monitoring of two stations within this segment of the CLT1 is redundant.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) rational for removing the station given the original power analysis conducted for CREMP in 2014 for KP. b) removal of L1-09 may limit the CREMP's ability to discern water quality impacts from dustfall. **INAC** c) From a cost/benefit perspective, are there significant savings to warrant the discontinuation of L1-09 given the importance of thsi tributary to Camp Lake and the potential effects of dust deposition?	a) The original baseline water quality power analysis conducted by Knight Piesold (KP) in 2014 identified the number of water chemistry samples required to determine a difference between concentrations during baseline and half the AEMP benchmark ($\alpha = 0.1$, and probability $[1-\beta] = 0.8$) at a given station.Because data are assessed only at the station level, the suggested removal of mine–exposed station L1-09 will not take away from the ability of the program to evaluate effects in the affected tributary given that other existing stations maintained within the tributary provide the same information (i.e., no dilution between stations). b) Stream water qualitiy monitoring stations L1-05 and L1-09 are in the same general area and would experience similar levels of dustfall. In removing L1-09, upstream monitoring stations L1-01 and L1-02 would still be in place to monitor effects on water quality. c) Water chemistry is consistent between L1-09 and L1-05 with no confluences (no dilution) present between stations. Baffinland is of the opinion that htere is limited benefit in continuing L1-09 as L1-05 is expected to receive similar amounts of dustfall and is able to characterize water quality in that region of the tributary.	Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 5 Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 99 - 108)	Given the feedback received by regulators and stakeholders at the 2017 Freshwater Workshop, Baffinland has decided to reject Minnow Recommendation 1 and has maintained monitoring station L1-09 in the AEMP (Rev. 2) document.
2. Add a water quality monitoring station to the lower Tom River. Currently, water quality monitoring stations are located in the tributary exiting Camp Lake (Station J0-01) and on the Tom River upstream of the confluence with this tributary (Station I0-01), but not on the Tom River downstream of this confluence. Therefore, the addition of a water quality monitoring station on the Tom River downstream of the Camp Lake outlet stream confluence would provide information on potential mine-related influence on water quality of the Tom River	No comments following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop.	N/A	Section 4.2.2 of AEMP (Rev. 2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 2 (pg. 20) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 15)	Baffinland has incorporated Minnow Recommendation 2 in the AEMP (Rev. 2) document.
3. Add a water quality monitoring station to each of Sheardown Lake Tributary 12 and Sheardown Lake Tributary 9 Although benthic invertebrate community sampling is conducted at both of these Sheardown Lake tributaries, no water quality monitoring is conducted on either tributary. Therefore, the addition of a water quality monitoring station on the lower segment of each of these tributaries would provide supporting information important to the interpretation of potential mine-related effects to benthic invertebrate communities of these tributaries	No comments following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop.	N/A	Section 4.2.2 of AEMP (Rev. 2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 2 (pg. 20) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 15)	Baffinland has incorporated Minnow Recommendation 3 in the AEMP (Rev. 2) document.
4. Discontinue water quality monitoring at Station D1-05 (Sheardown Lake Tributary 1). Currently, two water quality monitoring stations, upstream Station D1-05 and downstream Station D1-00, are located on Sheardown Lake Tributary 1 (SDLT1). Water quality monitoring data collected at the downstream station is sufficient for evaluating mine related effects to water quality of SDLT1. Therefore, water quality monitoring at upstream station D1-05 does not provide additional information important to valuating effects at SDLT1.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** ECCC requests additional rationale for the removal of sampling stations given that the power analysis completed in 2014 identified the need for additional sampling locations in these areas. ECCC recommends that stream water quality sampling locations be maintained until sufficient data is acquired to determine if there are potential impacts to these waterbodies. In addition, the removal of the upstream reference sampling locations may be inappropriate as an accurate understanding of the reference (upstream) conditions is essential to determine if impacts are occurring in the receiving environment.	N/A	Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 5 Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck	Given the feedback received by regulators and stakeholders at the 2017 Freshwater Workshop, Baffinland has decided to reject Minnow Recommendation 4 and has maintained monitoring station D1-05 in the AEMP (Rev. 2) document.
5. Discontinue water quality monitoring at upstream Mary River Stations GO-09A and GO-09B. The G0-09 series of stations, including G0-09A, G0-09 and G0-09B, are located on Mary River well upstream of the area of mine influence, and thus act as reference stations. Due to the close proximity of all three G0-09 series stations to one another, the water quality data provided from all three stations is redundant. The sampling of a single station at this upstream area is sufficient for interpreting potential effects of the Mary River Project on water quality of Mary River.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) removal of monitoring stations may limit the program's ability to characterize reference conditions along the Mary River, upstream of the Project.	a) Upon further review of the Mary River GO-09 series reference water quality stations, relatively high variability in concentrations of non-conservative parameters (e.g., aluminum, iron) related to natural turbidity differences was shown among the three GO-09 stations. Therefore, the three GO-09 stations will be maintained in the CREMP to better capture the influence of natural turbidity on parameter concentrations in the Mary River system.	Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 5 Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 5 (pgs. 15 - 16) Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 99 - 108)	Based upon a reassessment of the water quality data associated with the GO-09 stations, Baffinland has chosen not to incorporate Minnow Recommendation 5 in the AEMP (Rev. 2) document.
6. Discontinue water quality monitoring at Station CO-01 (Mary River). Because no substantial sources of dilution to Mary River occur between the current C0-05 and C0-01 water quality monitoring stations, Station C0-01 does not provide any additional, useful, information for the evaluation of potential mine influence on Mary River or Mary Lake.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) rational for removing the station given the original power analysis conducted for CREMP in 2014 by KP. b) affect on the program's ability to detect and monitor water quality gradient's along the Mary River, downstream of Project discharge locations	a) Refer to Baffinland's response to ECCC Comment 4 (Minnow Recommendation 7) and ECCC Comment 5 in Appendices I in regard to the interpretation and appropriate application of the power analysis conducted in 2014. b) Because there are no main confluences (sources of dilution) between CO-05 and CO-01, it would be expected that there would be no change in water quality between stations. There are six (6) water quality stations on the Mary River downstream of the MS-08 final discharge point, removing one station shouldn't impede the CREMP's ability to determine any gradients present on the Mary River, downstream of the Project.	Section 4.2.2 of AEMP (Rev. 2) Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 5 Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 5 Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 99 - 108)	Based on discussion with regulators and stakeholders, Baffinland has incorporated Minnow Recommendation 6 in the AEMP (Rev. 2) document.

7. Reduce the number of water quality monitoring stations to three (3) in each of Camp, Sheardown NW and Sheardown SE lakes, and four (4) in Mary Lake. No consistent spatial differences in water chemistry were evident in any of the mine-exposed or reference lakes in 2015, nor during any of the baseline studies. In addition, in-situ water quality profile data collected in 2015 indicates that all lakes are generally well mixed both laterally and vertically, and as a result, water chemistry is likely to be relatively uniform throughout these lakes during most sampling conditions. Therefore, the sampling of several water quality monitoring stations within these lakes is redundant.	Concerns and comments received from regulators and stakeholders are summarized below: **<u>ECCC</u>** a) rational given the original power analysis conducted in 2014 for the CREMP by KP **<u>INAC</u>** b) removal of lake water quality monitoring stations may be premature based on stage of Project's ERP operations c) lack of discussion on lake replenishment rates and the impacts of future point sources are uncertain Refer to the 2017 Freshwater Workshop Meeting Minutes (ECCC Comment 4; INAC Comment 1) for additional details on discussions on the proposed reduction in lake water quality monitoring stations.	a) Refer to the technical memo provided in Appendix H which outlines the statistical approach used to justify the reduction in lake water quality monitoring stations, as presented at the 2017 Freshwater Workshop, and the applicability of the initial power analysis completed by KP in 2014. Additional details on the statistical approach are presented in the 2017 Freshwater Workshop - Day 1 Presentation Slides (Slides 83 - 98). The technical memo provided in Appendix H was requested by both ECCC and INAC during the 2017 Freshwater Workshop to further clarify the statistical approach used to justify Minnow's Recommendation 7. b) & c) The initial submission of AEMP (Rev. 2) occured in April 2016 following the first CREMP field season during commercial mine production (2015). Since then, Baffinland has continued the CREMP and has collected data for three (3) consecutive years of commercial operation of the Project's ERP. Monitoring to date indicates that there are no consistent spatial differences in water chemistry in monitored lakes, with lakes being generally well mixed. As such, the lower number of stations proposed by Minnow (i.e., 3 – 4) would be sufficient to evaluate changes in water quality over time, taking changes in mine operation and lake replenishment rates into account. Replenishment rates for monitored lakes under the CREMP are provided in the 2017 CREMP Monitoring Report. Refer to the 2017 Freshwater Workshop Meeting Minutes (ECCC	Section 4.2.2 of AEMP (Rev.2) Appendix H - CREMP Lake Water Quality Power Analysis Memorandum (Minnow) Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 4 Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 4 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 4 (pgs. 12 - 15) Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 83 - 98)	Baffinland has incorporated Minnow Recommendation 7 in the AEMP (Rev. 2) document.
8. Conduct water quality profiling at only a single station in each of Camp, Sheardown NW and Sheardown SE lakes, and two stations at Mary Lake. No consistent spatial differences in in-situ water quality depth profiles were evident among stations at each mine-exposed and reference lake in 2015, nor would they be expected under typical mixing patterns driven by density gradients (Wetzel 2001). Therefore, it is recommended that water quality profiling be conducted only at the main (i.e., deepest) basin of each study lake, except at Mary Lake where water quality profiling is recommended at the north and south basins, to provide information on lake stratification. Stations recommended for the implementation of water quality profiling include: Camp Lake Station JL0-07; Sheardown Lake NW Station DL0-01-2; Sheardown Lake SE Station DL0-02-3; Mary Lake (north basin) Station BL0-1A; Mary Lake (south basin) Station BL0-9; and, Reference Lake 3 (northwest basin) Station REF03-3.	Concerns and comments received from regulators and stakeholders are summarized below: **<u>ECCC</u>** a) Would a single sample be taken at these lake water quality stations or would water samples be collected at the top and bottom of the water column? **<u>INAC</u>** b) What parameters would be used to determine stratification?	a) If stratification (further discussed below in Minnow Recommendation 9) is observed at these stations, water samples will be collected near the top and bottom. It should be noted that if stratification is observed at these stations, top and bottom water samples would be taken at all of respective lake's monitoring stations with depths below the determined epilimnion (upper ayer of lake stratification). b) Temperature would be the main parameter used to determine the presence of stratification in lakes. However, dissolved oxygen concentrations would also be examined to support the analysis of top and bottom water quality sampling in lakes.	Section 4.2.2 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 8 (pg. 21) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slides 16 - 17)	Baffinland has incorporated Minnow Recommendation 8 in the AEMP (Rev. 2) document.
9. Collect water samples only from mid-water column at each lake water quality monitoring station. Currently, water chemistry and chlorophyll a samples are collected from approximately 1 m below the surface and 1 m above the bottom at each lake monitoring station (i.e., 2 samples per station). Water chemistry data collected during the 2015 CREMP, as well as during baseline studies, has generally shown only minor (i.e., <2-fold higher) differences in water chemistry and chlorophyll a concentrations between the surface and bottom at each station. Therefore, the collection of a single water sample from approximately mid-column will be sufficient for evaluating average water quality conditions at each lake water quality monitoring station unless it is determined that the lake is thermally (or otherwise) stratified, in which case the same sampling convention from previous studies will be applied (i.e., top-bottom). Interpretation of in-situ water quality profile data collected at the main basin of the lake will be used as the basis for determination of whether one or two water samples will be collected from each respective lake station during each winter, summer or fall sampling event.	Concerns and comments received from regulators and stakeholders are summarized below: **<u>INAC</u>** a) Weak stratification has been observed (i.e. summer 2011, as documeted in the FEIS) at monitored lakes under the CREMP. Stratification may result in variation in water quality throughout the lake's water column, making a mid-depth sampling approach inappropriate for stratified conditions.	a) Baffinland has revised the AEMP (Rev. 2) to specify that under stratified conditions, a top and bottom water sampling approach will be taken at lake water quality stations under the CREMP. In the absence of lake stratificaiton, a mid-depth approach will used to collect water samples at lake water quality monitoring stations. To ensure consistency in sampling methodology under the CREMP, a clear decision framework for determining lake stratification in the field, based on temperature and dissolved oxygen (DO), has been included in the AEMP (Rev. 2). In summary, a lake water quality station will be considered stratified in the event that the water column temperature changes by more than 0.8 °C in a metre depth interval . In such event, water samples would be collected at 1 metre below water surface and 1 metre above lake bottom. The use of 0.8 °C per metre interval of water column is more conservative the conventional definition of 1 °C per metre inverval of water column, as defined by Wetzel, 2001, and should ensure that water samples are collected at the top and bottom of the water column in the case of weak lake stratification. The Refer to Appendix XX for additional information on the decision framework used to determinethe presence of stratification and the appropriate lake water sampling methodology.	Section 4.2.2 of AEMP (Rev.2) Appendix I - INAC Review of AEMP - Rev. 2 (May 25, 2016) - INAC Comment 2 (pg. 3) Appendix I - BIMC Response to INAC Review (Nov. 1, 2017) - INAC Comment 2 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - INAC Comment 2 (pgs. 18) Appendix I- 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 124 - 134)	Baffinland has incorporated Minnow Recommendation 9 in the AEMP (Rev. 2) document.

10. Discontinue stream sediment quality monitoring as part of the CREMP. Stream sediment sampling was included in the Mary River Project CREMP to provide qualitative information to support the lake sediment quality data analysis (KP 2014, 2015). Streams and rivers in the Mary River Project local study area (LSA) contain very limited depositional habitat suitable for the collection of fine sediments. The general absence of any substantial accumulation of fine sediments within these watercourses precluded any meaningful assessment of potential mine-related influences on sediment quality within, along and/or between watercourses during the 2015 CREMP, as well as during baseline studies (KP, 2015). Because the current sediment sampling program provides no ecologically meaningful information considered useful for the evaluation of potential mine-related effects, it is recommended that stream sediment sampling be discontinued.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) requested results for stream sediment quality samples collected in 2017 prior to supporting removal of stream sampling locations during the 2017 Freshwater Workshop **INAC** b) requested further discussion on whether ERP activities could reduce flows in Camp Lake Tributary 2 (CLT-2) and Sheardown Lake Tributary 1 (SDLT-1), as predicted for the full scale Project, to the levels at which the streams could become depositional habitat	a) Results for stream sediment quality samples collected in 2017 under the CREMP are provided in the 2017 CREMP Monitoring Report. As observed in previous years, the vast majority of stream sediment quality samples collected in 2017 consisted of coarse sand. b) Some streams will potentially be subject to flow reductions due to mine operations in the future (e.g., Camp Lake Tributary 2, Sheardown Lake Tributary 1). Currently, no substantial alteration of watershed flow has occurred within any of the Mary River Project mine site watercourses. In the future, should reductive diversion of flow occur in watercourses as a result of Mary River Project mine operations, affected watercourses will routinely be assessed to determine changes in depositional features. Visual surveys, conducted at the time of water sampling and/or during other sampling events (e.g., benthic invertebrate community sampling), will be used to ascertain the occurrence of fine sediment deposits (e.g., silts, clays). In the event that fine sediment deposits are observed at these watercourses, stream sediment sampling for metals analysis will be included as a means to track changes in sediment chemistry over time at the affected watercourse(s). The AEMP (Rev. 2) has incorporated wording to this effect in Section 4.2.3.	Section 4.2.3 of AEMP (Rev.2) Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 6 (pgs. 3) Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 6 (pgs. XX) Appendix I - INAC Review of AEMP - Rev. 2 (May 25, 2016) - INAC Comment 3 (pgs. 4) Appendix I - BIMC Response to INAC Review (Nov. 1, 2017) - INAC Comment 3 (pgs. XX) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 6 (pgs. 16 - 17) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - INAC Comment 3 (pg. 19) Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 109 - 112) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slides 6 - 7)	Based on discussions with regulators and stakeholders, Baffinland has incorporated Minnow Recommendation 13 in the AEMP (Rev. 2) document.
11. Add a benthic invertebrate community study area to the Camp Lake Tributary 1 upper main stem. Elevated concentrations of chloride, iron, nitrate and other parameters were observed at the upper main stem area of CLT1 (Station L2-03) in 2015 compared to reference conditions and the mine baseline period, with iron concentrations above water quality guidelines and AEMP benchmarks at this area. Mine-related influence on water quality of CLT1 was consistent with blasting/quarrying activity at the QRM2 pit. Therefore, the addition of a benthic invertebrate community study area to CLT1 near Station L2-03 is recommended to evaluate potential biological effects associated with mine activity in the upper portion of the CLT1 watershed. The benthic invertebrate community sampling will follow the same approach as that employed elsewhere for the stream program.	No comments following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop.	N/A	Section 4.2.5 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 11 (pg. 21) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 18)	Given the lack feedback received by Baffinland from regulators and stakeholders on the proposed revision, Minnow's proposed revision has been incorporated in the AEMP (Rev. 2) document.
12. Discontinue benthic invertebrate community sampling at the two upper reaches of Sheardown Lake Tirbutary 1. Currently, three benthic invertebrate community study areas are situated on SDLT1. Similar to sampling conducted at Sheardown Lake Tributary 9 and Tributary 12, one study area is sufficient for evaluating mine related effects to the benthic invertebrate community of SDLT1. This study area should be situated at the lower creek reach (Reach 1) to provide temporal continuity with previous studies, and because water chemistry data is also collected at this location (i.e., Station D1-00).	No comments following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop.	N/A	Section 4.2.5 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 12 (pg. 21) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 19)	Based on discussions with regulators and stakeholders, Baffinland has incorporated Minnow Recommendation 13 in the AEMP (Rev. 2) document.
13. Add a stream reference benethic invertebrate community study area. No stream reference study area has been established for the stream benthic invertebrate community component of the CREMP (NSC, 2014). Therefore, in order to provide a stronger basis for evaluating mine-related effects to biota residing in the mine-exposed tributaries of Camp and Sheardown lakes, it is recommended that a reference study area be incorporated into the program. The ideal reference area should share similar habitat features with the mine-exposed tributaries (e.g., similar width, water velocity, substrate size, etc.) and be outside the area of mine influence. It is recommended that one of the watercourses used as a lotic reference for water monitoring (i.e., CLT-REF4, MRY-REF2, MRY-REF3) also serve as a reference area for the stream benthic invertebrate community assessment. The determination of the most suitable reference watercourse, based on similarity in habitat characteristics to the mine-exposed tributaries, can be selected during the next CREMP biological field study (i.e., August 2016).	No comments following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop.	N/A	Section 4.2.5 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 13 (pg. 22) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 20)	Based on discussions with regulators and stakeholders, Baffinland has incorporated Minnow Recommendation 13 in the AEMP (Rev. 2) document.
14. Consider updating the AEMP sediment quality benchmarks. On average, arsenic, copper and iron concentrations were elevated above respective AEMP sediment quality benchmarks within Reference Lake 3 littoral and/or profundal station sediment during the 2015 CREMP. In turn, this suggested that the AEMP benchmarks for these metals may be overly conservative. Because reference lake information had not been available at the time of AEMP benchmark development, it is recommended that reference sediment quality data be factored into the derivation of AEMP benchmarks for arsenic, copper and iron to improve the applicability of these benchmarks as a tool for evaluating potential mine effects for the Mary River Project CREMP.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) Clarification required on the status of benchmarks for Sheardown Lake NW. **INAC** b) Modifying AEMP sediment quality benchmarks as result of elevated sediment parameter concentrations in Reference Lake 3 may not be appropriate given the biological differences (lake productivity) between Reference Lake 3 and mine-exposed lakes monitored under the CREMP. INAC would need to conduct further research into the inclusion of reference area data into monitoring program benchmarks at other project sites prior to supporting Minnow's Recommendation 14 c) Clarify how the AEMP sediment quality benchmarks would be modified.	a) Refer to Appendix I and slides 2017 Freshwater Workshop - Day 2 Pres. Slides (Slides XX to XX) for Baffinland's response on the current status of sediment quality benchmarks for Sheardown Lake NW. In summary, confounding factors in the sediment quality data collected during baseline and construction periods prevented the finalization of sediment quality benchmarks for Sheardown Lake NW. Due to start of commercial operation of the Project in 2015, baseline data can no longer be collected for Sheardown Lake NW. Baffinland continue to assess AEMP sediment quality benchmarks and will provide a proposed path forward to the NWB and other relevant parties at later date. b) Baffinland believes that Reference Lake 3 sediment and water quality data are relevant for comparisons with monitored mine-exposed lakes under the CREMP. Baffinland conducted a number of reconnaissance surveys during the baseline period to identify a suitable reference lake and of these, due to a number of variables that included abiotic (physical), chemical and biological features, determined that Reference Lake 3 was the best reference area available from the suite of surveyed waterbodies. c) At the 2017 Freshwater Workshop, Baffinland agreed that more discussions would be required with regulators and stakeholders prior to modifying the existing AEMP sediment quality benchmarks. Baffinland will propose a path foward at a later date.	Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 8 (pgs. 3) Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 8 Appendix I - INAC Review of AEMP - Rev. 2 (May 25, 2016) - INAC Comment 4 (pgs. 4 - 5) Appendix I - BIMC Response to INAC Review (Nov. 1, 2017) - INAC Comment 4 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 8 (pg. 17) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - INAC Comment 4 (pgs. 19 - 20) Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 116 - 118) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slides 8 - 11)	Minnow Recommendation 14 has not been included in AEMP (Rev. 2) document. During 2018, Baffinland will continue to assess potential revisions to the AEMP's sediment quality benchmarks and propose a path forward to relevant parties at a later date.

15. Focus the lake benthic invertebrate community (benthic) survey only on the littoral zone. Benthic invertebrate density, richness and relative abundance of dominant groups, including metal-sensitive taxa, differed significantly between littoral (shallow) and profundal (deep) stations of the reference lake during the 2015 CREMP, which is consistent with general distribution patterns of benthic invertebrates with depth in lakes (Ward 1992). Thus, the sampling of benthic invertebrates at profundal depths limits the ability to evaluate the occurrence and/or magnitude, of mine-related effects on biota due to natural factors being more important drivers of community structure than mine-related contaminants of concern at these depths (e.g., naturally lower oxygen and food resources with depth). Therefore, it is recommended that benthic sampling at mine-exposed lakes focus solely on littoral sampling depth (i.e., approximately 8 – 10 m depth). Consistent with Environmental Effects Monitoring (EEM) guidance under the Metal Mining Effluent Regulations (MMER), it is recommended that five stations be sampled at each mine exposed lake (Environment Canada 2012) at littoral sampling depths. To the extent possible, the littoral sampling stations will be established at existing benthic stations at Camp, Sheardown NW, Sheardown SE and Mary mine-exposed lakes, as well as at Reference Lake 3. However, in some cases, new stations will be need to be established to ensure sufficient coverage of the lake, and to ensure that substrate properties are comparable among and within lakes. Under this recommendation, benthic sampling would be discontinued at all profundal stations, resulting in a total of 25 lake benthic stations in the CREMP rather than 50 currently.	Concerns and comments received from regulators and stakeholders are summarized below: **INAC** a) INAC agrees with the presented rationale, however because there are differences in benthic communities between profundal (deep) and littoral (shallow) areas in lakes, shouldn't atleast one profundal monitoring station be maintained to monitor long term trends and current differences in benthic communities ? b) Would the removal of the profundal benthic community monitoring stations reduce the overall number of benthic samples per lake? Would the profundal stations removed be replaced by new littoral stations ?	a) Maintaining one station in the profundal area of lakes would not be sufficient to determine statistical differences between profundal and littoral benthic communities in lakes. Due to increased density and richness of benthic communities in littoral areas, as well as the presence of more sensitive taxa, it is expected that mine related effects would be observed in the benthic communities of littoral areas before effects wouldbe observed in profundal benthic communities. b) Yes, the total number of lake stations would be reduced by removal of the profundal stations (from 50 to 26 in total). However, due to natural influences of depth on benthic invertebrate communities, samples collected from the profundal area are not useful for evaluating mine-related influences and thus do not add information. Therefore the removal of profundal stations does not limit the interpretation of mine-related influences nor the objectives of the AEMP. The proposed littoral sampling design (five stations per lake) is based on the approach used for EEM studies under the MMER, and thus has a solid scientific backing.	Section 4.2.5 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 15 (pg. 22) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slides 21 - 22)	Baffinland has incorporated Minnow Recommendation 15 in the AEMP (Rev. 2) document.
16. Harmonize the lake sediment quality and benthic invertebrate community monitoring stations Currently, sediment chemistry data is not collected at all benthic invertebrate community sampling stations, limiting the ability to establish linkages between sediment metal concentrations and potential effects on benthic invertebrates. Therefore, it is recommended that sediment samples be collected at all benthic invertebrate community stations and analyzed for particle size, total organic carbon (TOC), and total metals concentrations as part of the CREMP.	No significant concerns and/or comments regarding the harmonization of sediment quality and benthic community monitoring stations in lakes under the CREMP were provided by regulators or stakeholders. Refer to the 2017 Freshwater Workshop Meeting Minutes (Minnow Recommendation 16; provided as Appendix I, for additional details on workshop discussions regarding the proposed revision).	N/A	Section 4.2.5 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 16 (pgs. 22 - 23) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 23)	Baffinland has incorporated Minnow Recommendation 16 in the AEMP (Rev. 2) document.
17. Restructure the lake sediment quality monitoring program to reflect changes in the benthic invertebrate community survey sampling station locations. To accommodate the recommended changes to the lake benthic invertebrate community survey, it is recommended that sediment quality monitoring station locations be re-located to the same five littoral benthic sampling depths/stations per lake discussed above (Minnow Recommendation 15). In addition, to maintain proper coverage of each study lake and ensure temporal continuity, it is recommended that three profundal sediment sampling stations be maintained in the program for each mine-exposed lake, resulting in a total of eight sediment quality monitoring stations at all mine-exposed lakes except Sheardown Lake SE, where the majority of the lake is less than 12 m deep (i.e., representative of littoral habitat). Under this approach, the total number of sediment quality monitoring stations sampled would be reduced from 33 currently to 29.	Concerns and comments received from regulators and stakeholders are summarized below: **ECCC** a) Will the current approach of selecting the Mary Lake profundal sediment quality stations closest to the mouth of the Mary River reduce some of the variability between profundal sediment quality stations? b) By restructuring and reducing the number of profundal sediment quality monitoring stations, will the revised CREMP lose the ability to determine and characterize potential effects?	a) In general, there is naturally high variability in lake sediment quality and therefore the presented approach would not be expected to reduce the observed variability in profundal sediment quality. b) No. Baffinland believes the proposed restructured sediment quality monitoring program will be able to effectively assess potential effects from mine operations.	Section 4.2.3 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 17 (pg. 23) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slides 24 - 25)	Baffinland has incorporated Minnow Recommendation 17 in the AEMP (Rev. 2) document.
18. Reduce the non-lethal adult Arctic charr sample size to 50 fish per lake. The adult Arctic charr fish population survey currently targets 100 fish from each study lake using a 'non-lethal' sampling approach (KP 2014, 2015). Based on data acquired during the 2015 CREMP, power analysis indicated that total sample sizes can be reduced by half (i.e., 50 fish) while still maintaining the ability to detect changes between lakes and/or between study periods with sufficient power. Therefore, it is recommended that sample sizes for adult Arctic charr be reduced from 100 to 50 in future CREMP studies. By doing so, the number of incidental mortalities would be reduced substantially. A total of 57 adult Arctic charr incidental mortalities were encountered during the 2015 CREMP under normal sampling conditions, and therefore, by reducing the amount of effort applied, the number of incidental mortalities may be reduced to less than 25 without affecting the ability of the program to meet study objectives.	All concerns and comments received from regulators and stakeholders on the proposed reduction in sample size for adult Arctic charr were addressed during the 2017 Freshwater Workshop. Refer to the 2017 Freshwater Workshop Meeting Minutes (Minnow Recommendation 18), provided as Appendix I, and Baffinland's response to ECCC's initial comments (Appendix I) for additional details on discussions regarding the proposed sample size reduction for adult Arctic charr in monitored lakes under the CREMP.	N/A	Section 4.2.6 of AEMP (Rev.2) Appendix I - ECCC Review of AEMP - Rev. 2 (May 25, 2016) - ECCC Comment 7 (pgs. 3) Appendix I - BIMC Response to ECCC Review (Nov. 1, 2017) - ECCC Comment 7 Appendix I - 2017 Freshwater Workshop - Meeting Minutes - ECCC Comment 7 (pg. 17) Appendix I - 2017 Freshwater Workshop - Day 1 Presentation Slide Deck (slides 113 - 115)	Baffinland has incorporated Minnow Recommendation 18 in the AEMP (Rev. 2) document.
19. Focus the current collection gear for optimal capture rates for adult Arctic charr. Currently, gang index gill nets with net mesh sizes ranging from 25 – 127 mm are prescribed to capture adult Arctic charr at all study lakes under the CREMP (NSC 2014, 2015). During the 2015 CREMP, the majority of Arctic charr were captured in net mesh sizes ranging from 38 – 64 mm, which was also similar to the most efficient mesh size used to capture adult Arctic charr during the previous baseline studies. Therefore, it is recommended that the 38 – 64 mm mesh size be adopted as the 'standard' size used to collect fish samples for the CREMP. In doing so, it is anticipated that fewer incidental mortalities will be encountered (e.g., reduced handling time) and additional sampling efficiencies will be gained.	No comments and concerns following initial submission of the AEMP (Rev. 2) and at the 2017 Freshwater Workshop were received by Baffinland from regulators and stakeholders.	N/A	Section 4.2.6 of AEMP (Rev.2) Appendix I - 2017 Freshwater Workshop - Meeting Minutes - Minnow Recommendation 19 (pg. 23) Appendix I - 2017 Freshwater Workshop - Day 2 Presentation Slide Deck (slide 26)	Baffinland has incorporated Minnow Recommendation 19 in the AEMP (Rev. 2) document.

Baffinland Iron Mines Corporation

Mary River Project, NU

2017 Freshwater Workshop Information Circular

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1 Introduction

1.1 Purpose

The purpose of this information circular is to provide documentation and presentation slides for the 2017 Freshwater Workshop that focus on the proposed revisions to the Project's Aquatic Effects Monitoring Plan (AEMP) and Environmental Effects Monitoring (EEM) Phase 1 Study Design. Due to the amount of content to be discussed during the AEMP and EEM workshop sessions, Baffinland is providing this information circular in advance of the workshop to ensure all participants are adequately briefed on the content to be presented and discussed at the 2017 Freshwater Workshop.

1.2 Background

1.2.1 2017 Freshwater Workshop

Baffinland Iron Mines Corporation (Baffinland) has organized a freshwater workshop in Iqaluit, Nunavut on November 8 & 9, 2017 with relevant regulators and stakeholders. A complete agenda, outlining the topics to be discussed at the workshop, is provided in Table 1 in Section 1.3 of this document.

The main objectives for the workshop include:

- Providing an update on freshwater monitoring programs occurring at the Project, including select results to date and preliminary results from 2017,
- Reviewing and gaining consensus on the proposed rationalizations for Revision 2 of the Aquatic Effects Monitoring Plan (AEMP),
- Providing an update on the Environmental Effects Monitoring (EEM) conducted downstream of the Waste Rock Sedimentation Pond discharges in 2017, as required by MMER, and review the EEM study design, and
- Providing an update on the 2017 Waste Rock Sedimentation Pond and corrective actions taken and planned to date.

Confirmed agencies attending the workshop, to date, include the following:

- Environment and Climate Change Canada (ECCC) – participating by teleconference
- Indigenous and Northern Affairs Canada (INAC)
- Qikiqtani Inuit Association (QIA)
- Nunavut Water Board (NWB)
- Government of Nunavut (GN)

1.2.2 Aquatic Effects Monitoring Plan

The Aquatic Effects Monitoring Plan (AEMP) describes how monitoring of the aquatic environment will be undertaken at the Mary River Project. The AEMP was identified as a follow-up monitoring program in Baffinland`s Final Environmental Impact Statement (FEIS; Baffinland, 2012) and is prescribed by the Type A Water Licence. The AEMP, specifically, is a monitoring program designed to:

- Detect short-term and long-term effects of the Project's activities on the aquatic environment resulting from the Project;
- Evaluate the accuracy of impact predictions;
- Assess the effectiveness of planned mitigation measures; and
- Identify additional mitigation measures to avert or reduce unforeseen environmental effects.

The AEMP focuses on the key potential impacts to freshwater environment valued ecosystems components (VECs), as identified in the Final Environmental Impact Statement and Addendum for the Early Revenue Phase (ERP). The freshwater VECs include water quantity, water and sediment quality, and freshwater biota and fish habitat. The AEMP has been structured to serve as an overarching 'umbrella' that conceptually provides an opportunity to integrate results of individual but related aquatic monitoring programs.

The following are the component studies that comprise the Mary River Project's AEMP.

- Core Receiving Environment Monitoring Program (CREMP), provides a basis for the evaluation of any mine-related influences on water quality, sediment quality and/or biota (including phytoplankton, benthic invertebrates and/or fish) within aquatic environments located near the mine.
- Lake Sedimentation Monitoring Program, evaluates baseline and project-influenced lake sedimentation rates.
- Hydrometric Monitoring Program, assesses flow in several streams and rivers near Project sites and supports the AEMP.
- Dustfall Monitoring Program, evaluates dustfall rates in proximity to the Tote Road, Milne Port and Mine Site.
- Stream Diversion Barrier Study, an initial study evaluating potential for fish barriers under natural conditions and due to Project-related stream diversions. This study has been deferred due to the low impact anticipated by the much reduced footprint of the Waste Rock Storage Area during the Early Revenue Phase of the Project.
- Environmental Effects Monitoring (EEM) Program, as required under the Metal Mining Effluent Regulations (MMER);

1.3 2017 Freshwater Workshop Agenda

The current agenda for the workshop is presented in Table 1 below.

TABLE 1 – 2017 MARY RIVER PROJECT FRESHWATER WORKSHOP AGENDA

Date	Topic	Time (HRS)
Day 1 – Nov 8, 2017	General introduction and objectives of workshop	9:00 – 9:30
	Overview of Baffinland freshwater monitoring programs and current feedback	9:30 – 10:30
	Coffee Break	10:30 – 10:45
	Review of AEMP monitoring trends (including 2017 preliminary results)	10:45 – 12:00
	Lunch	12:00 – 13:00
	Review and discussion of AEMP Rev. 2 (CREMP)	13:00 – 15:00
	Coffee Break	15:00 – 15:30
	Review and discussion of AEMP Rev. 2 (CREMP) cont'd	15:30 – 17:00
Day 2 – Nov 9, 2017	Introduction and parking lot items	9:00 – 9:15
	EEM Phase 1 Study Design and 2017 Field Program	9:15 – 10:00
	Coffee Break	10:00 – 10:15
	EEM Phase 1 Study Design and 2017 Field Program cont'd	10:15 – 12:00
	Lunch	12:00 – 13:00
	Discussion of current Project sedimentation monitoring	13:00 – 13:30
	Discussion of surface water management and monitoring associated with the Mine Site Waste Rock Stockpile	13:30 – 14:00
	Discussion of water quality monitoring along Tote Road	14:00 – 15:00
	Coffee Break	15:00 – 15:30
	Discussion on next steps and approval process for revised AEMP (Rev. 2 or 3)	15:30 – 16:00
	Discussion of community based monitoring and traditional knowledge	16:00 – 16:30
	Discussion on possible formation of a Freshwater Working Group; Conclusion	16:30 – 17:00

2 Document Contents

This document contains the following documentation.

Appendix 1 - Aquatic Effects Monitoring Plan (AEMP), Revision 2 - Submission Package (April 11, 2016)

Revision 2 of the AEMP was submitted to the Nunavut Water Board for review and approval on April 11, 2016. The submission package included the following:

- Baffinland Cover Letter
- Minnow Letter – Mary River Project CREMP Recommendations for Future Monitoring (March 17, 2016)
- Baffinland Response to ECCC Comments on AEMP, Rev. 1
- AEMP Revision 2 Document (excluded from Appendix 1 due to file size)

The purpose of submitting Revision 2 of the AEMP was to incorporate revisions to the CREMP suggested by Baffinland's AEMP consultant, Minnow Environmental (Minnow), following the 2015 field season. Minnow's letter dated March 17, 2017, included in the AEMP Rev. 2 submission package (Appendix 1), clearly presents the proposed revisions to the CREMP.

Due to the file size, the AEMP Rev. 2 document has not been included in this information circular. The AEMP Rev. 2 document is available on the Nunavut Water Board's registry using the following link:

ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-MRY1325%20BIMC/3%20TECH/9%20MONITORING%20(I)/AEMP/2016%20AEMP/

Baffinland plans to incorporate current feedback (see Appendix 2) and feedback received during the 2017 Freshwater Workshop and resubmit a revised Revision 2 of the AEMP to the NWB for final review and approval.

Appendix 2 - Baffinland Response to ECCC and INAC Comments on AEMP Rev. 2

Appendix 2 includes ECCC and INAC comments on the AEMP Rev. 2 submission and Baffinland's responses.

Appendix 3 - Environmental Effects Monitoring – Phase 1 Study Design (EEM Phase 1 Study Design)

Appendix 3 provides the current EEM Phase 1 Study Design (July 2016) which addresses ECCC's comments outlined in Appendix 4.

Appendix 4 - Baffinland Response to ECCC Comments on EEM Phase 1 Study Design

Appendix 4 provides ECCC's comments on the EEM Study Design included in the AEMP Rev. 2 submission and Baffinland's responses.

Appendix 5 – ECCC Approval Letter for Current EEM Phase 1 Study Design

Appendix 5 includes ECCC's letter of approval of the current EEM Study Design (July 2016) following ECCC's receipt of Baffinland's response to comments (refer to Appendix 4).

Appendix 6 – 2017 Freshwater Workshop – AEMP Workshop Slide Decks

Appendix 6 includes two slide decks that will be presented during 2017 Freshwater Workshop. The first slide deck discusses the general CREMP design and provides a summary of key monitoring results from the 2015 and 2016 field seasons. The second slide deck discusses the proposed revisions to the CREMP included in the AEMP Rev. 2 submission.

Appendix 7 – 2017 Freshwater Workshop – EEM Phase 1 Study Design Workshop Slide Decks

Appendix 7 includes two slide decks that will be presented during 2017 Freshwater Workshop. The first slide deck discusses the EEM Phase 1 Study Design and addresses ECCC's comments (refer to Appendix 4). The second slide deck reviews the preliminary finding from the first iteration of conducting the EEM Phase 1 Study Design which occurred in August 2017.

3 FREQUENTLY ASKED QUESTIONS (FAQS)

1. **How does Baffinland intend to use attendees' comments and input moving forward?**

   Input and comments from the workshop will be compiled into meeting minutes and distributed for review and final comments by participants. Once the meeting minutes are finalized, Baffinland will incorporate this feedback into future proposed revisions of Project freshwater monitoring programs (i.e. AEMP Rev. 2) and proposed corrective actions.

2. **What follow up can be expected from the workshop?**

   Based on feedback from the workshop, Baffinland expects to submit a revised AEMP (Rev. 2) for approval and further refine the EEM study design.

3. **Will Baffinland be recording the workshop or keep formal minutes. Will the formal meeting minutes be provided to workshop participants?**

   Baffinland will be documenting workshop discussions and input. Formal meeting minutes will be available for workshop participants once finalized.

4. **Will Baffinland be paying for workshop participants' hotel costs?**

   Baffinland has reserved rooms at hotels in Iqaluit to ensure accommodations for workshop participants travelling to Iqaluit, however Baffinland will not be paying for the hotel costs for participants.

Appendices

Appendix 1

Aquatic Effects Monitoring Plan (AEMP), Revision 2 - Submission Package

(April 11, 2016)

(Excludes AEMP Rev. 2 Document)

April 11, 2016

Nunavut Water Board
PO Box 119
Gjoa Haven, NU, Canada
X0B 1J0

Re: Revised Aquatic Effects Monitoring Plan - Mary River Project Type A Water Licence 2AM-MRY1325 (Amendment No. 1)

Mr. Joseph:

Baffinland Iron Mines Corporation (Baffinland) is pleased to submit the enclosed electronic document, *Baffinland Iron Mines Corporation Mary River Project, Aquatic Effects Monitoring Plan, BAF-PH1-830-P16-0039, rev 2.* An index of major changes made to rev 2 are presented on Page ii of the document. This letter follows the submission of the 2015 AEMP reports which were included as Appendix E.10 in the Baffinland's 2015 QIA and NWB Annual Report, submitted to the NWB on March 31, 2016. .

Our consultant for the 2015 AEMP was Minnow Environmental Inc. (Minnow). Based on the results presented in the 2015 Core Receiving Environment Monitoring Program (CREMP) report, Minnow submitted 19 recommended modifications to the CREMP for implementation during the 2016 field season. The recommended modifications are intended to provide greater efficiencies to the program, as well as to improve the ability of the program to meet the overall objectives, that is to evaluate short- and long-term effects of the project on aquatic ecosystems. Minnow's recommendation letter is provided as Attachment A to this letter.

Baffinland also provides a response to Environment Canada's comments on the AEMP rev 1 document. These comments were provided to Baffinland after the NWB comment period for the rev 1 document had expired. Baffinland has addressed those comments as part of this submission, through responses presented in Attachment B, as well as in changes to the AEMP document, where those changes were warranted.

Should the NWB require any additional information or points of clarification, please do not hesitate to contact the undersigned at jim.millard@baffinland.com or Allan Knight at allan.knight@baffinland.com.

Yours sincerely,

Baffinland Iron Mines Corporation
James Millard, M.Sc., P.Geo.
Environmental Manager

Encl:
Attachment A: Letter sent to Baffinland from Minnow Environmental Inc.: Mary River Project CREMP Recommendations for Future Monitoring.
Attachment B: Baffinland response to Environment Canada's comments on AEMP, Rev 1.

Cc Erik Allain, Scott Burgess, Justin Hack (AANDC); Erik Madsen, Jennifer St. Paul Butler, Allan Knight (Baffinland), Anne Wilson, Mark Dahl (Environment Canada)

minnow environmental inc.
2 Lamb Street
Georgetown, Ontario
L7G 3M9
Tel: 905-873-3371
Fax: 905-873-6370

March 17, 2016

Mr. Jim Millard
Environmental Manager
Baffinland Iron Mines Corporation
Mary River Project
2275 Upper Middle Road East, Suite 300
Burlington, Ontario L6H 0C3

Dear Mr. Millard,

Re: Mary River Project CREMP Recommendations for Future Monitoring

In 2015, the Mary River Project CREMP was implemented to evaluate potential mine-related influences on chemical and biological conditions at aquatic environments located near the mine following the first full year of mine operation. The 2015 study was conducted with no deviations from the original CREMP study design (KP 2014; NSC 2014). The key findings of the CREMP suggested a mine-related influence to water and/or sediment quality at Camp Lake system water bodies, and to water quality at a tributary to Sheardown Lake, but no influence to water and sediment quality of Sheardown Lake, Mary River and Mary Lake. In addition, no adverse mine-related influences on phytoplankton, benthic invertebrates or fish (Arctic charr) populations were indicated at any of the Camp Lake, Sheardown Lake and Mary River/Mary Lake systems based on comparisons to reference conditions and to baseline information.

The CREMP was designed as an iterative system of monitoring and interpretation stages, with the results of previous studies used to inform the direction of future monitoring. Therefore, based on the results of the 2015 study, this letter outlines 19 recommendations for modifications of the CREMP design. The suggested modifications are not only intended to provide greater efficiencies to the program, but will also improve the ability of the program to meet the overall objectives (i.e., to evaluate short- and long-term effects of the project on aquatic ecosystems). Accordingly, the following recommendations applicable to stream water quality monitoring, lake water quality monitoring, stream sediment quality and benthic invertebrate community monitoring, lake sediment and benthic invertebrate community sampling and lake fish population monitoring are provided in separate sub-sections herein.

Stream Water Quality Monitoring

1) **Discontinue water quality monitoring at Station L1-09 (Camp Lake Tributary 1)**. Currently, four water quality monitoring stations are located on the main stem of Camp Lake Tributary 1 (CLT1), with Stations L1-09 and L1-05 both located on the portion of the main stem between the confluence with the north branch and the mine tote road crossing. Monitoring conducted during the 2015 CREMP indicated that water chemistry at these stations was very similar, which can be expected since no sources of dilution occur between these stations. Therefore, the monitoring of two stations within this segment of the CLT1 is redundant.

2) **Add a water quality monitoring station to the lower Tom River**. Currently, water quality monitoring stations are located in the tributary exiting Camp Lake (Station J0-01) and on the Tom River upstream of the confluence with this tributary (Station I0-01), but not on the Tom River downstream of this confluence. Therefore, the addition of a water quality monitoring station on the Tom River downstream of the Camp Lake outlet stream confluence would provide information on potential mine-related influence on water quality of the Tom River (Figure 1).

3) **Add a water quality monitoring station to each of Sheardown Lake Tributary 12 and Sheardown Lake Tributary 9**. Although benthic invertebrate community sampling is conducted at both of these Sheardown Lake tributaries, no water quality monitoring is conducted on either tributary. Therefore, the addition of a water quality monitoring station on the lower segment of each of these tributaries would provide supporting information important to the interpretation of potential mine-related effects to benthic invertebrate communities of these tributaries (Figure 1).

4) **Discontinue water quality monitoring at Station D1-05 (Sheardown Lake Tributary 1)**. Currently, two water quality monitoring stations, upstream Station D1-05 and downstream Station D1-00, are located on Sheardown Lake Tributary 1 (SDLT1). Water quality monitoring data collected at the downstream station is sufficient for evaluating mine related effects to water quality of SDLT1. Therefore, water quality monitoring at upstream station D1-05 does not provide additional information important to evaluating effects at SDLT1.

5) **Discontinue water quality monitoring at upstream Mary River Stations G0-09A and G0-09B**. The G0-09 series of stations, including G0-09A, G0-09 and G0-09B, are located on Mary River well upstream of the area of mine influence, and thus act as reference stations. Due to the close proximity of all three G0-09 series stations to one another, the water quality data provided from all three stations is redundant. The sampling of a single station at this upstream area is sufficient for interpreting potential effects of the Mary River Project on water quality of Mary River.

6) **Discontinue water quality monitoring at Station C0-01 (Mary River)**. Because no substantial sources of dilution to Mary River occur between the current C0-05 and C0-01 water quality monitoring stations, Station C0-01 does not provide any additional, useful, information for the evaluation of potential mine influence on Mary River or Mary Lake.

Lake Water Quality Monitoring

7) **Reduce the number of water quality monitoring stations to three (3) in each of Camp, Sheardown NW and Sheardown SE lakes, and four (4) in Mary Lake**. No consistent spatial differences in water chemistry were evident in any of the mine-exposed or reference lakes in 2015, nor during any of the baseline studies. In addition, *in-situ* water quality profile data collected in 2015 indicates that all lakes are generally well mixed both laterally and vertically, and as a result, water chemistry is likely to be relatively uniform throughout these lakes during most sampling conditions. Therefore, the sampling of several water quality monitoring stations within these lakes is redundant. Accordingly, it is recommended that for each study lake, only three existing water quality monitoring stations be sampled at each lake using the locations provided in the table below and illustrated in Figure 2.

Lake	Station ID	Depth (m)	Description
Reference Lake 3	REF03-01	15.1	East end of southeast basin
	REF03-02	30.4	Centre of southeast basin
	REF03-03	37.5	Centre of northwest basin
Camp Lake	JLO-02	12.3	Littoral station near primary lake inlet (CLT1, CLT2)
	JLO-07	32.7	Deep basin, near centre of lake
	JLO-09	14.3	Near lake outlet
Sheardown Lake NW	DD-Hab9-Stn1	10.3	Near inlet from SDLT1
	DLO-01-2	17.5	Deep location, near centre of northwest basin
	DLO-01-7	11.4	Near lake outlet
Sheardown Lake SE	DLO-02-6	7.1	Near inlet from Sheardown Lake NW
	DLO-02-3	13.7	Deep location, near centre of southeast basin
	DLO-02-4	8.05	Near inlet from SDLT9
Mary Lake	BLO-1A	14.65	Deepest location at the north basin
	BLO-5	21	Near inlet from Mary River
	BLO-9	30	Deepest location at the south basin
	BLO-6	6.8	Near lake outlet

8) **Conduct water quality profiling at only a single station in each of Camp, Sheardown NW and Sheardown SE lakes, and two stations at Mary Lake**. No consistent spatial differences in *in-situ* water quality depth profiles were evident among stations at each mine-exposed and reference lake in 2015, nor would they be expected under typical mixing patterns driven by density gradients (Wetzel 2001). Therefore, it is recommended that water quality profiling be conducted only at the main (i.e., deepest) basin of each study lake, except at Mary Lake where water quality profiling is recommended at the north and south basins, to provide information on lake stratification. Stations recommended for the implementation of water quality profiling include:

   Camp Lake Station JL0-07;
   Sheardown Lake NW Station DL0-01-2;
   Sheardown Lake SE Station DL0-02-3;
   Mary Lake (north basin) Station BL0-1A;
   Mary Lake (south basin) Station BL0-9; and,
   Reference Lake 3 (northwest basin) Station REF03-3.

9) **Collect water samples only from mid-water column at each lake water quality monitoring station**. Currently, water chemistry and chlorophyll a samples are collected from approximately 1 m below the surface and 1 m above the bottom at each lake monitoring station (i.e., 2 samples per station). Water chemistry data collected during the 2015 CREMP, as well as during baseline studies, has generally shown only minor (i.e., <2-fold higher) differences in water chemistry and chlorophyll a concentrations between the surface and bottom at each station. Therefore, the collection of a single water sample from approximately mid-column will be sufficient for evaluating average water quality conditions at each lake water quality monitoring station unless it is determined that the lake is thermally (or otherwise) stratified, in which case the same sampling convention from previous studies will be applied (i.e., top-bottom). Interpretation of *in-situ* water quality profile data collected at the main basin of the lake will be used as the basis for determination of whether one or two water samples will be collected from each respective lake station during each winter, summer or fall sampling event.

Stream Sediment and Benthic Invertebrate Community Monitoring

10) **Discontinue stream sediment quality monitoring as part of the CREMP**. Stream sediment sampling was included in the Mary River Project CREMP to provide qualitative information to support the lake sediment quality data analysis (KP 2014, 2015). Streams and rivers in the Mary River Project local study area (LSA) contain very limited depositional habitat suitable for the collection of fine sediments. The general absence of any substantial accumulation of fine sediments within these watercourses precluded any meaningful assessment of potential mine-related influences on sediment quality within, along and/or between watercourses during the 2015 CREMP, as well as during baseline studies (KP

2015). Because the current sediment sampling program provides no ecologically meaningful information considered useful for the evaluation of potential mine-related effects, it is recommended that stream sediment sampling be discontinued.

11) **Add a benthic invertebrate community study area to the CLT1 upper main stem**. Elevated concentrations of chloride, iron, nitrate and other parameters were observed at the upper main stem area of CLT1 (Station L2-03) in 2015 compared to reference conditions and the mine baseline period, with iron concentrations above water quality guidelines and AEMP benchmarks at this area. Mine-related influence on water quality of CLT1 was consistent with blasting/quarrying activity at the QRM2 pit. Therefore, the addition of a benthic invertebrate community study area to CLT1 near Station L2-03 is recommended to evaluate potential biological effects associated with mine activity in the upper portion of the CLT1 watershed. The benthic invertebrate community sampling will follow the same approach as that employed elsewhere for the stream program (Figure 3).

12) **Discontinue benthic invertebrate community sampling at the two upper reaches of Sheardown Lake Tributary 1 (SDLT1)**. Currently, three benthic invertebrate community study areas are situated on SDLT1. Similar to sampling conducted at Sheardown Lake Tributary 9 and Tributary 12, one study area is sufficient for evaluating mine related effects to the benthic invertebrate community of SDLT1. This study area should be situated at the lower creek reach (Reach 1) to provide temporal continuity with previous studies, and because water chemistry data is also collected at this location (i.e., Station D1-00).

13) **Add a stream reference benthic invertebrate community study area**. No stream reference study area has been established for the stream benthic invertebrate community component of the CREMP (NSC 2014). Therefore, in order to provide a stronger basis for evaluating mine-related effects to biota residing in the mine-exposed tributaries of Camp and Sheardown lakes, it is recommended that a reference study area be incorporated into the program. The ideal reference area should share similar habitat features with the mine-exposed tributaries (e.g., similar width, water velocity, substrate size, etc.) and be outside the area of mine influence. It is recommended that one of the watercourses used as a lotic reference for water monitoring (i.e., CLT-REF4, MRY-REF2, MRY-REF3) also serve as a reference area for the stream benthic invertebrate community assessment (Figure 3). The determination of the most suitable reference watercourse, based on similarity in habitat characteristics to the mine-exposed tributaries, can be selected during the next CREMP biological field study (i.e., August 2016).

<u>**Lake Sediment and Benthic Invertebrate Community Monitoring**</u>

14) **Consider updating the AEMP sediment quality benchmarks**. On average, arsenic, copper and iron concentrations were elevated above respective AEMP sediment quality benchmarks within Reference Lake 3 littoral and/or profundal station sediment during the 2015 CREMP. In turn, this suggested that the AEMP benchmarks for these metals may

be overly conservative. Because reference lake information had not been available at the time of AEMP benchmark development, it is recommended that reference sediment quality data be factored into the derivation of AEMP benchmarks for arsenic, copper and iron to improve the applicability of these benchmarks as a tool for evaluating potential mine effects for the Mary River Project CREMP.

15) **Focus the lake benthic invertebrate community (benthic) survey only on the littoral zone**. Benthic invertebrate density, richness and relative abundance of dominant groups, including metal-sensitive taxa, differed significantly between littoral (shallow) and profundal (deep) stations of the reference lake during the 2015 CREMP, which is consistent with general distribution patterns of benthic invertebrates with depth in lakes (Ward 1992). Thus, the sampling of benthic invertebrates at profundal depths limits the ability to evaluate the occurrence and/or magnitude, of mine-related effects on biota due to natural factors being more important drivers of community structure than mine-related contaminants of concern at these depths (e.g., naturally lower oxygen and food resources with depth). Therefore, it is recommended that benthic sampling at mine-exposed lakes focus solely on littoral sampling depth (i.e., approximately 8 – 10 m depth). Consistent with Environmental Effects Monitoring (EEM) guidance under the Metal Mining Effluent Regulations (MMER), it is recommended that five stations be sampled at each mine-exposed lake (Environment Canada 2012) at littoral sampling depths. To the extent possible, the littoral sampling stations will be established at existing benthic stations at Camp, Sheardown NW, Sheardown SE and Mary mine-exposed lakes, as well as at Reference Lake 3 (Figures 2 and 3). However, in some cases, new stations will be need to be established to ensure sufficient coverage of the lake, and to ensure that substrate properties are comparable among and within lakes. Under this recommendation, benthic sampling would be discontinued at all profundal stations, resulting in a total of 25 lake benthic stations in the CREMP rather than 50 currently (Figures 2 and 3).

16) **Harmonize the lake sediment quality and benthic invertebrate community monitoring stations.** Currently, sediment chemistry data is not collected at all benthic invertebrate community sampling stations, limiting the ability to establish linkages between sediment metal concentrations and potential effects on benthic invertebrates. Therefore, it is recommended that sediment samples be collected at all benthic invertebrate community stations and analyzed for particle size, total organic carbon (TOC), and total metals concentrations as part of the CREMP.

17) **Restructure the lake sediment quality monitoring program to reflect changes in the benthic invertebrate community survey sampling station locations.** To accommodate the recommended changes to the lake benthic invertebrate community survey, it is recommended that sediment quality monitoring station locations be re-located to the same five littoral benthic sampling depths/stations per lake discussed above (Recommendation 15). In addition, to maintain proper coverage of each study lake and

ensure temporal continuity, it is recommended that three profundal sediment sampling stations be maintained in the program for each mine-exposed lake, resulting in a total of eight sediment quality monitoring stations at all mine-exposed lakes except Sheardown Lake SE, where the majority of the lake is less than 12 m deep (i.e., representative of littoral habitat). Under this approach, the total number of sediment quality monitoring stations sampled would be reduced from 33 currently to 29. The profundal sediment quality stations recommended for inclusion in the CREMP are provided in the table below, and are shown on Figures 2 and 3.

Lake	Station ID	Depth (m)	Sediment Profundal Station Description
Camp Lake	JLO-14	26.5	Central basin – east (inlet area)
	JLO-07	32.7	Central basin – middle
	JLO-11	28.8	Central basin – west (outlet area)
Sheardown Lake NW	DLO-01-5	23.1	Central basin – north
	DLO-01	20.8	Central basin – middle
	DLO-01-2	18.6	Central basin – south
Mary Lake	BLO-12	21.7	South basin – near Mary River inlet
	BLO-10	18.7	South basin – middle
	BLO-08	26.7	South basin – near lake outlet

Lake Fish Population Monitoring

18) **Reduce the non-lethal adult Arctic charr sample size to 50 fish per lake**. The adult Arctic charr fish population survey currently targets 100 fish from each study lake using a 'non-lethal' sampling approach (KP 2014, 2015). Based on data acquired during the 2015 CREMP, power analysis indicated that total sample sizes can be reduced by half (i.e., 50 fish) while still maintaining the ability to detect changes between lakes and/or between study periods with sufficient power. Therefore, it is recommended that sample sizes for adult Arctic charr be reduced from 100 to 50 in future CREMP studies. By doing so, the number of incidental mortalities would be reduced substantially. A total of 57 adult Arctic charr incidental mortalities were encountered during the 2015 CREMP under normal sampling conditions, and therefore, by reducing the amount of effort applied, the number of incidental mortalities may be reduced to less than 25 without affecting the ability of the program to meet study objectives.

19) **Focus the current collection gear for optimal capture rates for adult Arctic charr**. Currently, gang index gill nets with net mesh sizes ranging from 25 – 127 mm are prescribed to capture adult Arctic charr at all study lakes under the CREMP (NSC 2014, 2015). During the 2015 CREMP, the majority of Arctic charr were captured in net mesh

sizes ranging from 38 – 64 mm, which was also similar to the most efficient mesh size used to capture adult Arctic charr during the previous baseline studies. Therefore, it is recommended that the 38 – 64 mm mesh size be adopted as the 'standard' size used to collect fish samples for the CREMP. In doing so, it is anticipated that fewer incidental mortalities will be encountered (e.g., reduced handling time) and additional sampling efficiencies will be gained.

As mentioned previously, we believe the 19 suggested modifications outlined above will not only provide greater efficiencies to the CREMP, but are also scientifically defensible and will maintain and, in some cases, improve the ability of the program to meet the overall objectives set out under the AEMP. Should you have any questions, or require additional supporting information regarding these recommendations, please to not hesitate to contact me.

Sincere regards,

Minnow Environmental Inc.

Paul LePage, M.Sc.
Senior Project Manager

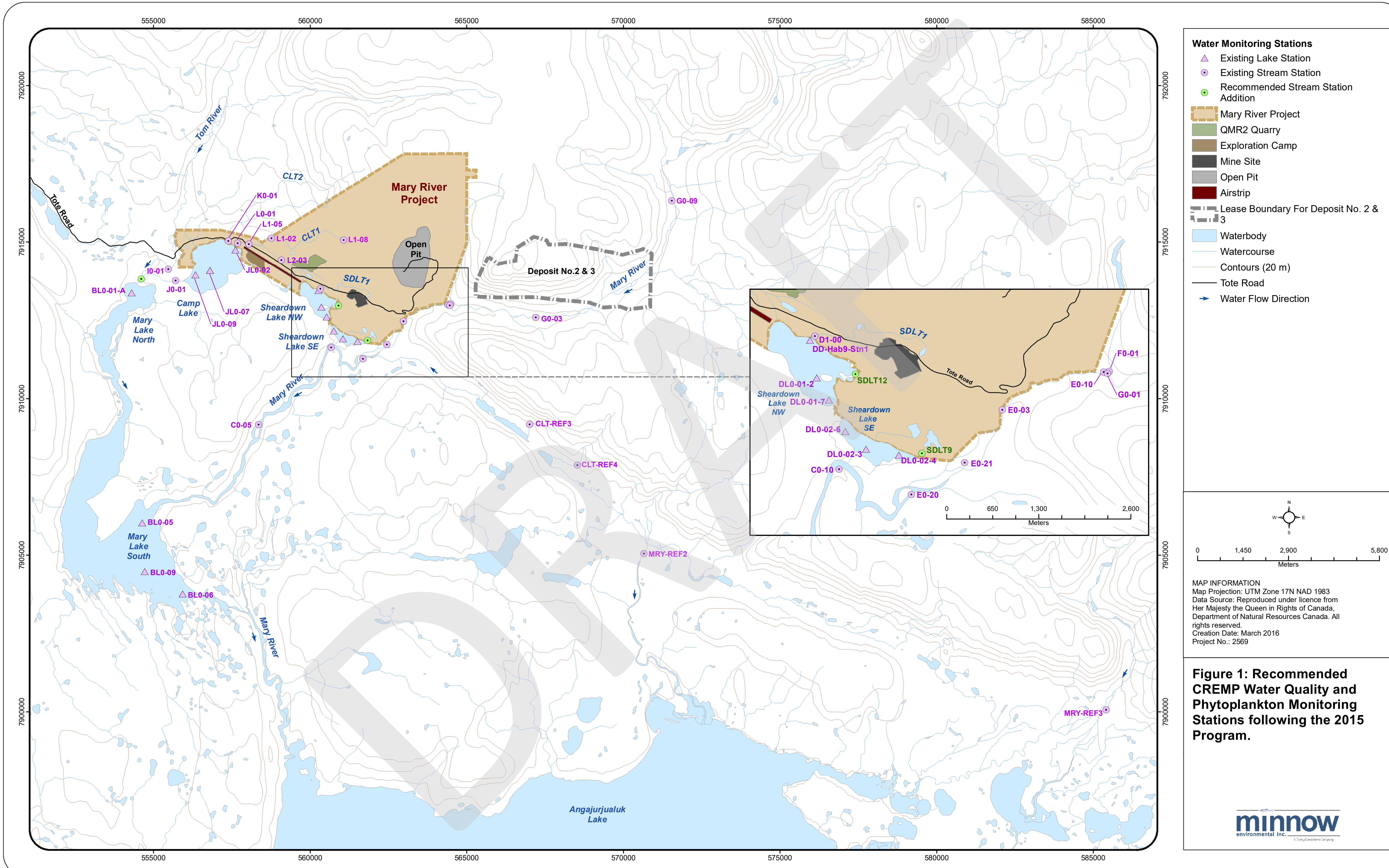

Figure 1: Recommended CREMP Water Quality and Phytoplankton Monitoring Stations following the 2015 Program.

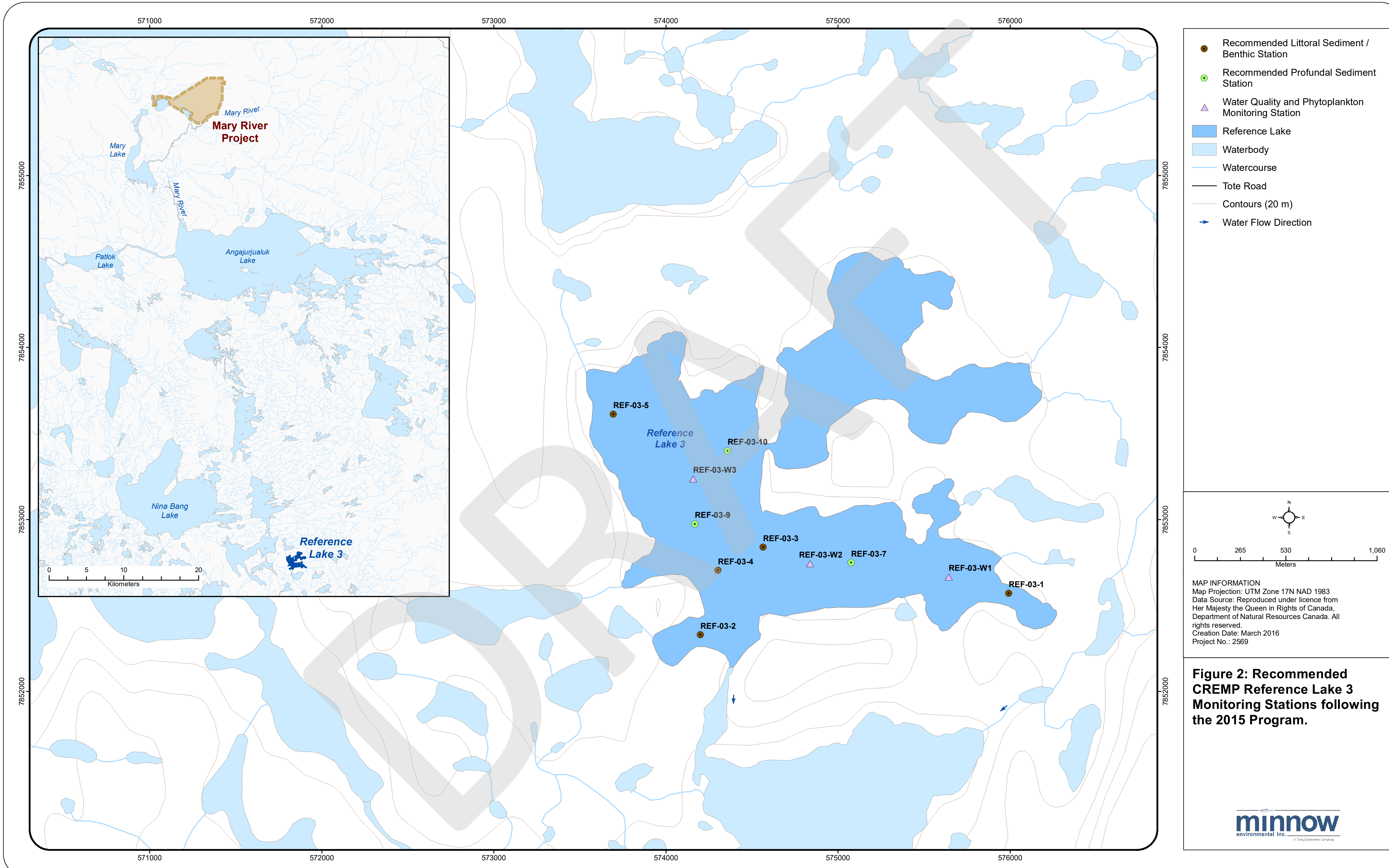

Figure 2: Recommended CREMP Reference Lake 3 Monitoring Stations following the 2015 Program.

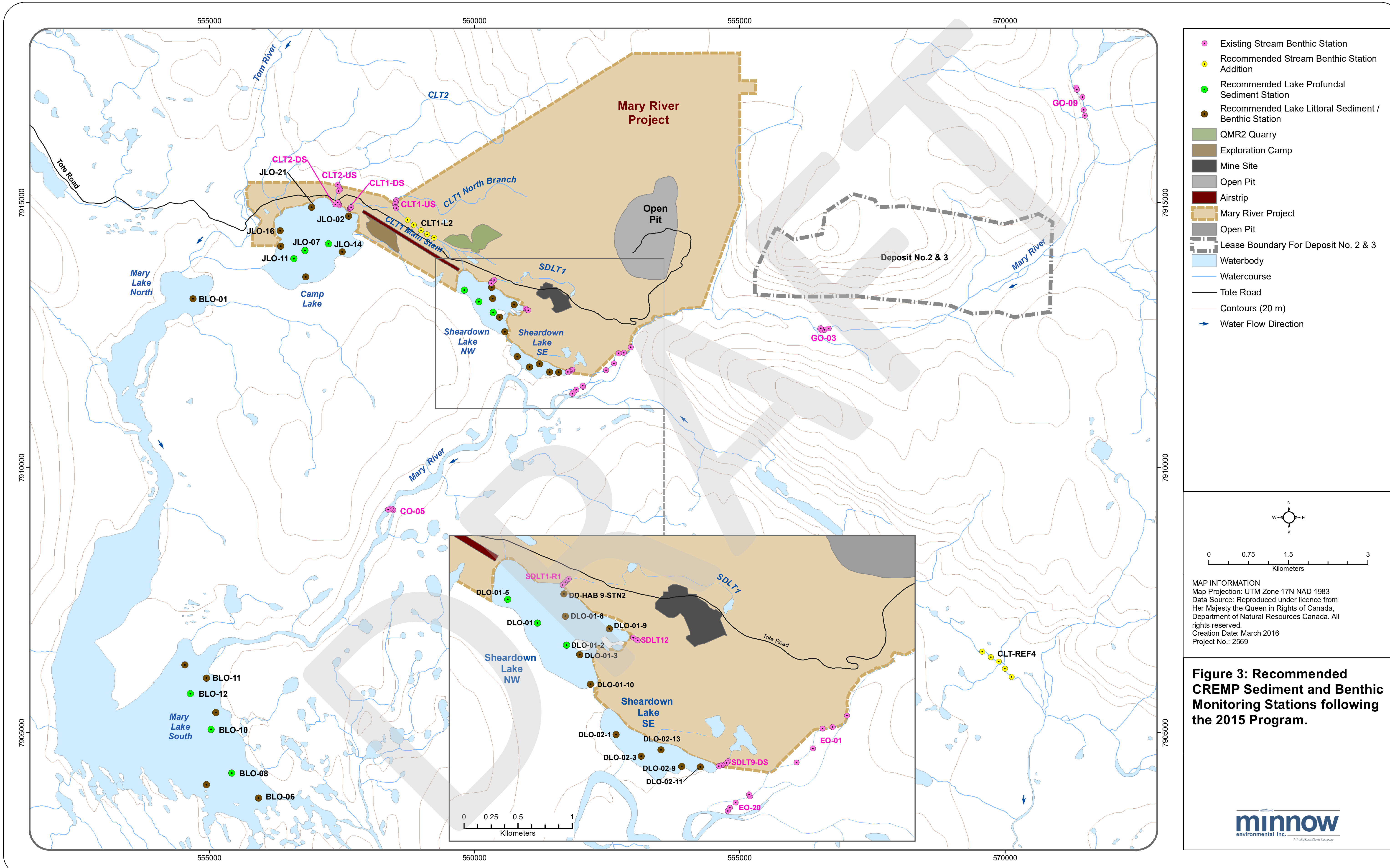

Figure 3: Recommended CREMP Sediment and Benthic Monitoring Stations following the 2015 Program.

Baffinland Responses on AEMP - Environment and Climate Change Canada Technical Comments - 160122 ECCC Outstanding 2014 Comments - AEMP			
Topic	**Comment**	**Recommendation**	**Baffinland Response**
Review history	On Nov. 2014 ECCC staff provided comments on the 2014 AEMP submission (main document and supporting appendices) for the Baffinland Mary River project. The AEMP was again circulated for review in May 2015, at that time ECCC noted that the 2015 version did not contain any revisions or updates. Baffinland advised ECCC that a revised version would be submitted following licence issuance and that the new version would consider the comments that had been received to date (email, Oliver Curran to ECCC May 11, 2015). The updated AEMP was submitted on Oct. 30th, 2015 and was circulated by the NWB for review in November 2015. This version does include several updates, primarily around monitoring stations and the new licence. It was not apparent in the updated AEMP that ECCC's comments or concerns were included. The outstanding concerns from the previous review can be found in the attached Excel table and additional comments on the EEM section of the AEMP are provided below.	Provide a response to comments and concerns raised in Nov. 2014 review.	Refer to Sheet 2 for Baffinland's responses to the outstanding comments from the November 2014 review..
Additional data collection and evaluation in 2014	The Sediment Quality Study Design section notes that additional pre-mining sediment sampling was needed to improve baseline data for future comparisons, and to include depositional areas. The additional work was to be done in 2014, with appropriate new stations to be identified.	Provide a summary of 2014 field investigations and an update of the study design based on the new data.	As discussed in the CREMP Sediment Quality Study Design, additional pre-mining sediment sampling was conducted in 2014. The 2014 AEMP Report along with its appendices was supplied to EC in March 2015. The 2014 AEMP Report includes a summary of the 2014 sediment quality monitoring as well as discusses how the final sediment quality benchmarks were derived in Sections 2.3.2 and 2.3.3, respectively. Additional more in depth details are provided in Appendix C for the Sediment Quality Monitoring performed and in Appendix D for the proposed Final Sediment Quality Benchmarks. Also based off of the 2015 AEMP Report CREMP and field studies, Minnow Environmental Inc. (Minnow) contracted to assist Baffinland in completing the field work and reporting requirements of several of the AEMP component studies, has proposed several amendments to the Sediment Quality Study Design detailed in their Letter of Recommendations attached with the Cover Letter of this submission .
EEM Requirements	The EEM submission outline was included in the AEMP. The EEM study design for this facility is still outstanding. The objective of the EEM program is to evaluate the effects of mine effluent on fish, fish habitat and the use of fisheries resources. Section 7 of the MMER obligates the mine to conduct EEM studies, submit reports within prescribed timelines and use generally accepted standards of good scientific practice to conduct studies and interpret results. Section 23 of the MMER instructs mines to submit their data to Environment Canada (now ECCC) electronically where a format is provided, or in writing if no such format is provided. Schedule 5 of the MMER presents the specific EEM requirements and is divided into 2 parts, Effluent and Water Quality Monitoring and Biological Monitoring. The main MMER biological monitoring study components have been included in the AEMP but elements of the effluent and water quality monitoring studies appear to be missing. ECCC supports further discussion on how the current effluent and water quality monitoring program outlined in the AEMP could support the information required under the MMER. The facility should include sublethal monitoring in their sampling schedule as per MMER requirements. Annual Effluent and Water Quality Monitoring Studies The components of effluent and water quality monitoring studies are effluent characterization, sublethal toxicity testing, and water quality monitoring. Schedule 5, Sections 4 - 7 of the MMER outline the required parameters and frequency of monitoring for these components. Note that effluent and water quality monitoring must be conducted 4 times per calendar year not less than one month apart and sublethal toxicity testing must be conducted twice per year (for the first three years, then once per year thereafter) not less than 1 month apart. Note that the first effluent characterization, sublethal toxicity testing and water quality monitoring must be conducted not later than six months after the day on which the Mine became subject to the MMER. Under Schedule 5, Part 1, Section 8, mines must submit not later than March 31st, a report on the effluent and water quality monitoring studies conducted during the previous calendar year. Refer to Schedule 5, Section 8 of the MMER for details on effluent and water quality monitoring reporting requirements. Effluent characterization, water quality, and sublethal toxicity testing information should be reported electronically through the Regulatory Information Submission System (RISS) https://www.risssitdr. ec.gc.ca/riss/Global/Index.aspx. Information that cannot be reported in RISS must be provided in a hard copy report, including: ▯ Quality Assurance/Quality Control (QA/QC) measures, methodologies, and detection limits for chemical parameters ▯ QA/QC measures and methodologies for sublethal toxicity testing. The hard copy submission should be made to the Authorization Officer. In addition, the inclusion of laboratory sheets/certificates of chemical parameter results within the hard copy submission would be appreciated to facilitate our verification of submitted RISS data.	ECCC recommends that Baffinland's AEMP outline how and when the requirements described above will be met.	The Mary River Project became subject to the MMER on July 10, 2015. During the 2015 open water season Baffinland completed the required effluent characterization and water quality monitoring outlined in Schedule 5 of the MMER, including acute and sublethal toxicity testing. Additionally, all effluent and water quality data collected during 2015 has been submitted to Environment Canada electronically using the Regulatory Information Submission System (RISS). Attached is the annual MMER report submitted to Environment Canada on March 31, 2016. The current anticipated timeline for milestones associated with the MMER requirements is provided below: **July 10, 2015** - Mine became subject to MMERs (effluent discharge reached 50 m^3/day) **September 9, 2015** - Submission of Identifying Information & Final Discharge Points to Environment Canada **July 10, 2016** - Submission of Cycle One Study Design to Environment Canada **August - September, 2017** - Conduct Cycle One Biological Monitoring Study **January 10, 2018** - Submission of Cycle One Interpretive Report to Environment Canada

EEM Cycle One Study design	ECCC conducted a high level review of this draft EEM Study Design and has the following comments: - facilities are only required to do biological sampling downstream of one FDP, typically from the FDP with the most adverse environmental impact. - Total and dissolved aluminum are very high in CLT-Ref 3 and CLT-Ref 4. Account for this and its potential to confound future sampling programs. - This facility may have the data required to conduct a BACI analysis as part of its EEM program. - It does not appear that the fish sampling program is designed to address any of the endpoints around reproduction. As these are required to be assessed under the MMER further discussion may be required. - Consider looking at YOY surveys in the lakes independently of the adult fish data in the rivers.	ECCC requests further development of the fish sampling program to address reproduction endpoints and also requests that the study design be updated to address the elevated aluminum levels at reference sites.	An updated EEM Cycle One Study Design will be submitted to Environment Canada for review before July 10, 2016. The updated study design will address Environment Canada's comments regarding high levels of aluminum in reference streams and reproduction endpoints in the fish sampling program.

Baffinland Responses on AEMP - ECCC Outstanding June 2014 Comments

Topic	Comment	Recommendation	Baffinland Response
Site Map	There is no map included in the report that depicts the entire site including mine and both ports.	EC recommends the inclusion of a map or figure that includes the entire site footprint, including both ports, in order to gain a more thorough understanding of the site infrastructure.	Baffinland has updated the AEMP (Rev. 2) to include a site map (Figure 2.1) showing the location of each Project site as well as three maps showing the footprint and infrastructure layouts of each Project site including, the Mine Site (Figure 3.2), Milne Port (Figure 3.3) and Steensby Port (Figure 3.4).
Table 2.1 Run of mine ore stockpile water and ore stockpile contact water	Blasting residue could also be an issue in the water quality coming off of the ore stockpiles, as similarly noted for the waste rock pile runoff. Ammonia is noted with blasting residues, and nitrate would also be of concern.	EC recommends that blasting residue also be included as a key issue	Blasting residue (ammonia, nitrate) has been added Table 2.1 of the latest AEMP revision (Rev. 2)
Table 2.1Duplication of cells	The continuation of Table 2.1 on page 12 includes a duplication of the first 10 cells in the table.	EC recommends that the duplication be deleted.	Baffinland has deleted the duplicated/repeated rows in Table 2.1 in the latest AEMP revision (Rev. 2).
Section 3.4.2 - Effluent Quantity and Quality	The report states that the water license requires the reporting of monthly and annual volumes of effluents and wastes discharged by the project. These will provide loading information for the various receiving environments	EC recommends that future AEMP reports include the quantities of effluent for each discharge location, along with characterization.	Effluent discharge locations, volume quantities and characterization (water chemistry) are provided in the NWB and NIRB Annual Report.
Table 4.1 EEM and SNP Sampling Stations	The sampling stations for EEM and the SNP are provided in different units. For clarity, both should be expressed in using the same system. Currently EEM sampling stations are listed in latitude and longitude while the SNP sampling stations are in UTM.	EC recommends standardization of EEM and the SNP location coordinates.	Coordinates in Table 4.1 have been converted to UTM format in the latest AEMP revision (Rev. 2).
Figure 4.2 - Candidate Reference Areas	Several of the candidate reference areas are in close proximity to the tote road and the proposed railway alignment. Water bodies in close proximity to the road and railway could be impacted by mine activities, affecting their use for reference comparisons. As noted in Appendix B Table 2.1 Reference Lakes are to be determined, with further work done in 2014 to be evaluated. Appendix F notes differences between the current candidate reference lakes, and has identified several alternatives to be investigated further.	EC recommends that there be further discussion and qualification on the use of reference sites once the 2014 data for the additional candidate reference lakes have been evaluated.	The 2014 Reference Lake Evaluation report written by North South Consultants after the 2014 CREMP field program is included as Appendix F in the latest AEMP revision (Rev. 2). In 2015, Reference Lake 3 was established as the CREMP reference lake for future studies. Baffinland believes that current candidate reference areas for the EEM study are adequate for the infrastructure associated with the Early Revenue Phase (ERP).

Section 4.1.5 Summary and Schedule Fish in Exposure/Reference	Baseline monitoring of fish population data between the reference and exposure areas show significant differences within and between all groups. Baffinland suggests further data analysis may be performed.	EC supports the suggestion of further evaluations and discussions on suitable reference areas for the fish component of EEM.	An updated EEM Cycle One Study Design will be submitted to Environment Canada for review before July 10, 2016. The updated study design will address Environment Canada's comments regarding the differences in fish populations between exposure and reference areas.
Section 4.2.2 Sampling Frequencies	Although the proposed sampling frequencies are listed there is a lack of clarity in the actual frequency of sampling events. The report states that lakes will have "three sampling events in each available season" while streams will have "four samples (one set of seasonal samples) per year". Appendix B Section B.3.3 recommends "three yearly samples" for lakes. This raises questions of timing (notably for the fourth stream sample) and how data will be analysed.	EC requests that sampling frequency and handling of seasonal data be clarified.	The latest AEMP revision (Rev. 2) has reworded sections discussing the sampling frequency and schedule of the CREMP water quality program. Water quality stations are monitored three (3) times per year. Stream water quality will be monitored during the spring, summer and fall, whereas, lake water quality monitoring will take place during the winter (late April), summer and fall.

Section 5.3.2 - Water Quality Benchmarks	The report states that "all samples that were non-detect were assumed to equal the detection limit for statistical calculations. Where detection limits were elevated compared to later sampling events, they were substituted with lower detection limits." Use of the MDL will bias the mean concentrations upwards, while standardizing detection limits downwards will bias the mean concentrations downwards. This will not affect use of the 97.5th percentile, which is a rank-based estimate, unless there are greater than 97% of non-detects in the data; in this case anything less than 5% does not have percentiles calculated.	Baffinland has taken a reasonable approach in their handling of below-detection data points and variable detection limits, for the proposed analyses and use of defined thresholds. EC notes that any statistical test of change from baseline should be reviewed in the context of baseline concentrations being overstated, acknowledging this will not affect absolute concentrations and action thresholds.	Baffinland will ensure that any statistical test of change from baseline water quality will be reviewed in the context of baseline concentrations being overstated.
Section 5.3.3 Sediment Quality Benchmarks	Sheardown Lake sediment quality may be exhibiting upward trends in Cr, Cu and Ni, although this has not been confirmed statistically. The statement is made that influenced data would be removed from final AEMP benchmark calculations.	Please clarify how "influenced data" would be defined, and how trends could be evaluated for sediment chemistry results.	As discussed in the CREMP Sediment Quality Study Design, additional pre-mining sediment sampling was conducted in 2014. The 2014 AEMP Report includes a summary of the 2014 sediment quality monitoring as well as discusses how the final sediment quality benchmarks were derived in Sections 2.3.2 and 2.3.3, respectively. Additional details on the development of final sediment quality benchmarks are also provided in Appendix C and Appendix D.
Table 5.3 - Sediment Quality Benchmarks	Pending further data collection in 2014, sediment benchmarks are considered interim. As noted in Appendix C, while lab methods were consistent, collection methods and locations varied. The dataset was screened for substrate composition in selecting what would be included in the baseline chemistry dataset. The benchmarks were developed without inclusion of the Sheardown tributaries, as those data differed for most parameters.	EC supports the further development of sediment benchmarks with additional 2014 and forward sampling data. Consideration should be given to developing separate benchmarks for the tributary sites, given that there will be effluent exposure.	As discussed in the CREMP Sediment Quality Study Design, additional pre-mining sediment sampling was conducted in 2014. The 2014 AEMP Report includes a summary of the 2014 sediment quality monitoring as well as discusses how the final sediment quality benchmarks were derived in Sections 2.3.2 and 2.3.3, respectively. Additional detail is also provided in Appendix C and Appendix D. In 2015, Minnow Environmental Inc. (Minnow) was contracted to assist Baffinland in completing the field work and reporting requirements of several of the AEMP component studies, including the CREMP. After completing the CREMP in 2015, Minnow proposed several modifications to the CREMP to provide greater efficiencies to the program and improve the program's ability to achieve its objectives (i.e. to evaluate short and long term effects of the Project on aquatic ecosystems). Included in their list of proposed modifications to the CREMP, Minnow recommended that the CREMP sediment monitoring program focus solely on depositional lake environments and that CREMP sediment monitoring stations in streams and rivers be discontinued in future CREMP studies, This recommendation was based on the observation that the majority of streams and rivers in the Mary River Project local study area (LSA) contain very limited depositional habitat suitable for the collection of fine sediments. As observed during the 2015 CREMP and baseline studies (KP, 2015), the general absence of any substantial accumulation of fine sediments within these watercourses preclude any meaningful assessment of potential mine-related influences on sediment quality within, along and/or between watercourses. As a result, all sediment quality stations in streams and rivers near the Mine Site have been removed from future CREMP studies.
Table 5.3 - Sediment Quality Benchmarks	It is not clearly identified in the table what Benchmark Method A, B and C are for "Benchmark Methods" in the last row of Table 5.3. These methods should be defined below the table in order to increase clarity for the reader. The reader can infer how methods A and B were arrived at but method C is less clear.	EC recommends that the benchmark methods be defined in the legend below the table .	Table 5.3 has been updated in the latest revision of the AEMP (Rev. 2) to reflect the final sediment quality benchmarks established in 2015. Additional foot notes have been added to clarify the different methods (A, B, C) used in developing the benchmarks.

Section 5.3.5 Benthic Macroinvertebrate Indicators and Benchmarks	A number of BMI metrics are listed for inclusion in the CREMP, including: abundance, composition, Shannon's Evenness, Simpson's Diversity Index, and Richness. If maintaining consistency with the EEM program, the Bray Curtis Index would be another metric that could be incorporated into the statistical tests.	EC recommends that the Bray Curtis Index be added as an indicator for benthic macroinvertebrates.	The Bray Curtis Index has been added to the list of BMI metrics used to assess CREMP benthic invertebrate data in the latest AEMP revision (Rev. 2). Additionally, the Bray Curtis Index was used in the most recent 2015 CREMP Report to analyze and test 2015 BMI data.

Appendix 2

Baffinland Response to ECCC and INAC Comments on AEMP Rev. 2

October 27, 2017

Sean Joseph
Senior Technical Advisor, Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0

**RE: Baffinland Response to ECCC and INAC Comments on Revision 2 of the Mary River Project Aquatic Effects Monitoring Plan (AEMP)
Type A Water Licence (2AM-MRY1325) – Amend. 1;
NIRB Project Certificate No. 5 – Amend. 1;**

On April 11, 2016, Baffinland Iron Mines Corporation (Baffinland) submitted a proposed Revision 2 of the Mary River Project (Project) Aquatic Effects Monitoring Plan (AEMP) to the Nunavut Water Board (NWB) for review and approval. Revisions included in the revised AEMP were recommended by Baffinland's consultant for the AEMP, Minnow Environmental, following the completion of the 2015 field season. The recommended revisions are intended to provide greater efficiencies to the AEMP, as well as to improve the ability of the program to meet the overall objectives, that is to evaluate short- and long-term effects of the Project on aquatic ecosystems.

On May 25, 2016 Environment and Climate Change Canada (ECCC) and Indigenous and Northern Affairs Canada (INAC) provided their review and comments on Revision 2 of the Project's AEMP. Comments made by ECCC and INAC on the revised AEMP are provided as Attachments 1 and 2 of this letter. Baffinland wishes to thank the ECCC and INAC for their review and comments. Baffinland's response to the comments are provided in Attachment 3 of this letter.

We look forward to further discussing the revised AEMP as well as other subjects relating to freshwater monitoring at the Project during the upcoming freshwater workshop on November 8 & 9, 2017 in Iqaluit, NU.

Regards,

Christopher Murray,
Environmental & Regulatory Compliance Manager

Attachments:

Attachment 1: ECCC Comments on Revision 2 of the Project's AEMP (letter dated May 25, 2016)
Attachment 2: INAC Comments on Revision 2 of the Project's AEMP (letter dated May 25, 2016)
Attachment 3: Baffinland Response to ECCC and INAC Comments on Revision 2 of the AEMP

Cc: Stephen Williamson Bathory (QIA)
David Hohnstein (NWB)
Sarah Forté, Karen Costello (INAC)
Anne Wilson, Erik Allen (ECCC)
Andrew Vermeer, William Bowden, Allan Knight (Baffinland)

Attachment 1

ECCC Comments on Revision 2 of the AEMP (letter dated May 25, 2016)

Environmental Protection Operations
Prairie and Northern Region (PNR)
P.O. Box 2310
5019 - 52nd St,
Yellowknife, NT
X1A2P7

May 25, 2016

EC file: 6100 000 011 /035
NWB File: 2AM-MRY1325

Solomon Amuno
Technical Advisor
Nunavut Water Board

Via email: licensing@nunavutwaterboard.org

RE: 2AM-MRY1323 Aquatic Effects Monitoring Plan, BAF-PH1-830-P16-0039, rev 2.

Attention: Mr. Amuno,

Environment and Climate Change Canada (ECCC) has reviewed the above-mentioned Aquatic Effects Monitoring Plan, comments can be found in the attached table. ECCC's specialist advice is provided based on our mandate in context of the *Canadian Environmental Protection Act* and the pollution prevention provisions of the *Fisheries Act*. The Proponent must ensure that they remain in compliance with legislation during all phases and in all undertakings related to the project.

Should you require further information, please do not hesitate to contact Mark Dahl at (204) 983-4815 or via email at mark.dahl@canada.ca.

Sincerely,

Francois Huppe,
A/Manager, Environmental Assessment and Marine Programs
Prairie and Northern Region

cc: Wade Romanko, Head, Environmental Assessment North (NT and NU).
Mark Dahl, Environmental Assessment Coordinator, PNR.
ECCC Review Team

Attachments: 2AM-MRY1323 - Environment Canada Technical Review Comments Regarding Baffinland Iron Mines Corporation Mary River Project, Aquatic Effects Monitoring, Plan, BAF-PH1-830-P16-0039, rev 2.

ECCC comments regarding Baffinland Iron Mines Corporation Mary River Project, Aquatic Effects Monitoring Plan, BAF-PH1-830-P16-0039, rev 2.

Comment Number	Topic / Reference	Comment	Recommendation
1	Figures (throughout document)	The low resolution of some of the figures provided in the document makes it difficult to read text and discern map details.	The quality of the figures and maps in the Plan should be enhanced to make the details clear to the reader.
2	Final Discharge points (Section 4.1.2)	The document indicates that mine effluent will be discharged into the Mary River at three locations: east pond discharge, run-of-mine and crusher stockpile discharge, and the main ore stockpile discharge. However, the discharge locations are not well described nor are they shown on a map so it is difficult to determine if the locations of the discharge points into the Mary River were considered when selecting sampling locations.	ECCC recommends that sampling locations in the Mary River be clearly identified and located such that impacts resulting from each individual discharge point can be identified and assessed.
3	Reference Areas	The Plan indicates that a number of reference areas including lakes, tributaries, and upstream locations have been identified. However, the proponent does not indicate which reference areas will be used for which receiving environments.	Please provide a table that specifies what type of sampling will be done at each sampling location and the corresponding reference location. The study design should identify how reference area data will be used in comparisons to exposure site data.
4	Water Quality Monitoring (Section 4.2.2)	Minnow Consulting has recommended that the AEMP should reduce the number of water quality monitoring stations to three in each of Camp, Sheardown NW, and Sheardown SE Lakes, and to four in Mary Lake. This reduction is recommended by Minnow based in their assessment of the baseline data that which suggests that the lakes are well mixed making additional sampling stations redundant. ECCC notes that many of these sampling locations were added to the program based on a power analysis completed in 2014 by Knight Piesold Consulting.	ECCC requests additional rationale for the removal of sampling stations given that the power analysis completed in 2014 identified the need for additional sampling stations in Mary Lake and Sheardown Lake. ECCC recommends that the number of sampling locations be maintained until sufficient data is collected to ensure that these water bodies are well mixed and are not being impacted by the project.
5	Water Quality Monitoring (Section 4.2.2)	Minnow Consulting has recommended that the AEMP discontinue water quality monitoring at stations L1-09 (Camp Lake Tributary), D1-05 (Sheardown Lake Tributary 1) and G0-09A, G0-09B, and C0-01 on the Mary River. The reason for discontinuation of sampling at these locations is redundancy (L1-09 and C0-01), with the rationale that a single reference sampling location in the Mary River is adequate (G0-09A and G0-09B), and that an upstream sampling location is not necessary (D1-05). ECCC notes that many of these sampling locations were added to the program based on a power analysis completed in 2014 by Knight Piesold Consulting.	ECCC requests additional rationale for the removal of sampling stations given that the power analysis completed in 2014 identified the need for additional sampling stations in these areas. ECCC recommends that stream water quality sampling locations be maintained until sufficient data is acquired to determine if there are any potential impacts to these water bodies. In addition, the removal of the upstream reference sampling locations may be inappropriate as an accurate understanding of the reference (upstream) conditions is essential to determine if impacts are occurring in the receiving environment.

6	Sediment Quality Study Design (Section 4.2.3)	Based on recommendations from Minnow Consulting, all sediment quality monitoring in streams and lakes has been removed from the sediment monitoring program. According to the rationale provided this is due to the limited depositional habitat and minimal accumulation of fine sediments.	ECCC recommends maintaining periodic sediment quality monitoring in rivers and streams that are directly receiving discharge. At a minimum this should tie in with the frequency required under the MMER EEM (every 3 years).
7	Fish (Section 4.2.5)	Minnow Consulting has recommended that the fish sampling program be modified to reduce the non-lethal adult Arctic Char sample size to 50 per study lake instead of 100.	A sample size of 100 fish is required under the Environmental Effects Monitoring of the Metal Mining Effluent Regulations. Fish sampling for the EEM and AEMP programs should be harmonized to reduce any duplication of effort without reducing the sample size.
8	Sediment Benchmarks - Sheardown Lake NW (Table 5.3)	The table presents a number of interim AEMP benchmarks for Sheardown Lake SE, which are based on either the sediment quality guideline, 97.5% of the baseline data or 3x the MDL. However, there are some suggested benchmarks that need further clarification.	Please provide further rationale for the following suggested benchmarks: Cadmium 97.5% measured baseline = <0.5 mg/kg, CCME guideline is 0.6 mg/kg. Suggested benchmark = 1.5 mg/kg Arsenic, Chromium, Copper, Iron, Manganese, Nickel, Phosphorus – the Plan states that the benchmarks for these metals are based on 97.5% of the baseline but the numbers do not correspond to numbers listed in table for Sheardown Lake NW 97.5% baseline.
9	Benthic Macroinvertebrate Indicators (Section 5.3.5)	A number of BMI metrics are listed for inclusion in the CREMP, including: abundance, composition, Shannon's Evenness, Simpson's Diversity Index and Richness. Environment Canada had previously commented that that the Bray Curtis Index be added as an indicator to which the proponent had agreed to, however it is not included on the list.	ECCC recommends that the Bray Curtis Index be added as an indicator for benthic macroinvertebrates.

Attachment 2

INAC Comments on Revision 2 of the AEMP (letter dated May 25, 2016)

Indigenous and Northern Affairs Canada | Affaires autochtones et du Nord Canada

Water Resources
Nunavut Regional Office
P.O. Box 100
Iqaluit, NU, X0A 0H0

Your file - Votre référence
2AM-MRY1325

May 25, 2016

Our file - Notre référence
CIDM#1068332

Ida Porter
Licence Administrator
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU, X0A 1J0

Re: 2AM-MRY1325 – Mary River Project – Baffinland Iron Mines Corporation – Aquatic Effects Monitoring Plan

Dear Ms. Porter,

Thank you for your April 25, 2016 invitation for written submissions on the above referenced Aquatic Effects Monitoring Plan (AEMP).

Indigenous and Northern Affairs Canada (INAC) has conducted a technical review of the AEMP submitted by Baffinland Iron Mines Corporation and the results of our review are presented in the attached memorandum for the Nunavut Water Board's consideration.

Comments have been provided pursuant to INAC's mandated responsibilities for the enforcement of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Department of Indian Affairs and Northern Development Act*.

INAC appreciates the opportunity to participate in this review. If there are any questions or concerns, please contact me at (867) 975-3876 or by e-mail at sarah.forte@aandc-aadnc.gc.ca.

Sincerely,

Sarah Forté
Water Management Coordinator

cc. Scott Burgess, David Abernethy, Erik Allain, INAC

Technical Review Memorandum

To: Ida Porter, Licence Administrator, Nunavut Water Board

From: Sarah Forté, Water Management Coordinator, Water Resources Division, INAC

Date: May 25, 2016

Re: Review of Baffinland Iron Mines Corporation's Aquatic Effects Monitoring Plan for Type A Water Licence #2AM-MRY1325

Applicant: Baffinland Iron Mines Corporation
Project: Mary River Project
Region: Qikiqtani

A. BACKGROUND

On April 25, 2016, the Nunavut Water Board (NWB or Board) provided notification of Baffinland Iron Mines Corporation's (the licensee or Baffinland) submission of an updated Aquatic Effects Monitoring Plan (AEMP) (BAF-PH1-830-P16-0039 Rev 2), dated April 2016.

The AEMP is a monitoring plan for the Mary River Project designed to:

- Detect short-term and long-term effects of the Project's activities on the aquatic environment resulting from the Project.
- Evaluate the accuracy of impact predictions.
- Assess the effectiveness of planned mitigation measures.
- Identify additional mitigation measures to avert or reduce environmental effects.

The NWB requested interested parties review the plan and make representations by May 25, 2016.

B. RESULTS OF REVIEW

Indigenous and Northern Affairs Canada (INAC) has reviewed version 2 of the AEMP and is encouraged to see the integration of newly collected water and sediment quality data into the document. The Department has some concerns with a few of the proposed changes to the Core Receiving Environment Monitoring Plan (CREMP), which is a component of the AEMP, as well as for the AEMP sediment quality benchmarks and the sampling protocol for dissolved metal water samples.

1. Reducing number of CREMP lake water quality monitoring stations

Reference:

- o Baffinland cover letter Re: Revised Aquatic Effects Monitoring Plan - Mary River Project Type A Water Licence 2AM-MRY1325 (Amendment No. 1), , April 11, 2016, Attachment A: Mary River Project CREMP Recommendations for Future Monitoring, produced by Minnow Environmental Inc.
- o Aquatic Effects Monitoring Plan (BAF-PH1-830-P16-0039 Rev 2), April 8, 2016, Section 4.2.2

Comment:
The revised AEMP, following recommendation #7 from Minnow Environmental, proposes to reduce the number of water quality monitoring stations on the mine area lakes according to the following table:

Lake	Number of stations	
	AEMP R1	AEMP R2
Camp	5	3
Sheardown NW	6	3
Sheardown SE	5	3
Mary	11	4

Two reasons are given as justification:

1) *No consistent spatial differences in water chemistry were evident in any of the mine-exposed or reference lakes in 2015, nor during any of the baseline studies; and*
2) *In-situ water quality profile data collected in 2015 indicates that all lakes are generally well mixed both laterally and vertically.*

The Department is of the opinion that reducing the number of sampling stations at this stage may be premature. INAC notes that though the mine was in operation in 2015, it was not at the fully planned Early Revenue Phase operating capacity. The third crusher was not operating until the end of 2015 so its impact would not have been measurable in the 2015 data.

Additionally, though the data indicate the lakes are well mixed, to our knowledge, the lake replenishment rates have not been discussed and therefore the impacts of a future point source are uncertain. It would be relevant to keep the initially determined number of water quality monitoring stations to help detect possible future point sources.

Recommendation:
INAC recommends that the number of water quality monitoring stations for Camp, Sheardown NW, Sheardown SE and Mary lakes be maintained.

2. Collecting CREMP lake water samples from mid-water column

Reference:

- Baffinland cover letter Re: Revised Aquatic Effects Monitoring Plan - Mary River Project Type A Water Licence 2AM-MRY1325 (Amendment No. 1), , April 11, 2016, Attachment A: Mary River Project CREMP Recommendations for Future Monitoring, produced by Minnow Environmental Inc.
- Aquatic Effects Monitoring Plan (BAF-PH1-830-P16-0039 Rev 2), April 8, 2016, Section 4.2.2 & Appendix B (Water and Sediment Quality review and CREMP Study Design NB102-181/33-1 r3)
- Baffinland Final Environmental Impact Statement, Appendix 7B,Surface Water and Sediment Quality Baseline report (NB102-181/30-5), December 22, 2011, Section 3.2

Comment:
The revised plan proposes to "*Collect a single water quality sample at mid-depth instead of collecting two samples, surface and bottom, at each lake water quality monitoring station*" (Minnow Environmental recommendation #9). The justification given is that "*Water chemistry data collected during the 2015 CREMP, as well as during baseline studies, has generally shown only minor (i.e., <2-fold higher) differences in water chemistry and chlorophyll a concentrations between the surface and bottom at each station*." A note in the Minnow Environmental recommendation is made that if the lakes are determined to be stratified based on *in-situ* water quality profile data, two samples (top & bottom) would be taken. This does not appear in the main text of the AEMP R2 but is found in Appendix A of Appendix B.

The Final Environmental Impact Statement discussion states than *in-situ* water quality depth profiles indicated the lakes were thermally stratified in summer 2011 and not in fall 2011. Therefore, though not permanent, lake stratification does occur and the Department is of the opinion that it would be prudent to continue sampling with the top-bottom approach rather than using an average mid-water column sample.

Recommendation:
INAC recommends that continuing lake water quality sampling at two depths (1 m below surface and 1 m above bottom) rather than at a single depth (mid-water column).

3. Discontinuation of CREMP stream sediment quality monitoring

Reference:

- o Baffinland cover letter Re: Revised Aquatic Effects Monitoring Plan - Mary River Project Type A Water Licence 2AM-MRY1325 (Amendment No. 1), , April 11, 2016, Attachment A: Mary River Project CREMP Recommendations for Future Monitoring, produced by Minnow Environmental Inc.
- o Aquatic Effects Monitoring Plan (BAF-PH1-830-P16-0039 Rev 2), April 8, 2016, Section 4.2.3

Comment:
The revised plan proposes to discontinue stream sediment quality monitoring (Minnow Environmental recommendation #10) because the streams and rivers in the study area "*contain very limited depositional habitat suitable for the collection of fine sediments*." Two streams in the area are expected to experience flow reductions; Camp Lake Tributary 2 (CLT-2), during the full scale project, and Sheardown Lake Tributary 1 (SDLT-1), due to diversions associated with West Pond and the open pit. It is not clear if these flow reductions would be such that suitable depositional habitat may be created.

Recommendation:
INAC recommends that Baffinland discuss whether depositional habitats may be created by flow reductions on streams CLT-2 and SDLT-1, and if so, confirm these would be sampled.

4. AEMP sediment quality benchmarks

Reference:

- o Aquatic Effects Monitoring Plan (BAF-PH1-830-P16-0039 Rev 2), April 8, 2016, Section 5.3.3.3
- o 2015 Qikiqtani Inuit Association (QIA) and Nunavut Water Board (NWB) Annual Report, March 2016, appendix E.10.1 2015 Core Receiving Environment Monitoring Plan
- o Baffinland cover letter Re: Revised Aquatic Effects Monitoring Plan - Mary River Project Type A Water Licence 2AM-MRY1325 (Amendment No. 1), , April 11, 2016, Attachment A: Mary River Project CREMP Recommendations for Future Monitoring, produced by Minnow Environmental Inc.

Comment:
The sediment quality benchmarks developed for Sheardown Lake NW are interim due to confounding factors in the collected data. Further study was recommended for 2015. It is not clear whether the data presented in the 2015 annual report meets this recommendation and the information has not yet been integrated, or if there is still work to do.

Recommendation #14 by Minnow Environmental is to consider updating the AEMP sediment quality benchmarks because "*On average, arsenic, copper and iron concentrations were elevated above respective AEMP sediment quality benchmarks within Reference Lake 3 littoral and/or profundal station sediment during the 2015*

CREMP." Given that to date, sediment quality benchmarks have been developed on a lake by lake basis, using data from Reference Lake 3 to modify existing benchmarks in mine site lakes appears as a change in methodology. The Department notes that it did not find reference to this recommendation in the AEMP document.

Recommendation:
INAC recommends that Baffinland:

1) Provide an update on work done to remove the interim status of the Sheardown NW quality benchmarks; and
2) Clarify if and how they would modify previously developed sediment quality benchmarks for mine site lakes.

5. Water sample filtration for metal analyses

Reference:

- o Aquatic Effects Monitoring Plan (BAF-PH1-830-P16-0039 Rev 2), April 8, 2016, Appendix B (Water and Sediment Quality review and CREMP Study Design NB102-181/33-1 r3)

Comment:
Field sampling protocols for water sampling are presented in Appendix B which includes several appendices itself. The protocol for filtering water samples for dissolved metal analyses does not appear consistent between the appendices.

Section 2.2.2 of Appendix A (Water and Sediment Quality Sampling Protocol R1) states: *"Prior to the addition of preservative, samples for dissolved metals are field filtered using Acrodisc® 32 mm Syringe Filters with 0.45 μm Supor® membrane filter."*

Section 4.3.1 of Appendix B (Sampling Program – Quality Assurance and Quality Control Plan BAF-PH16-001 R1) states: *"For dissolved metals analyses, if possible, the water sample will be filtered in the field immediately after sampling using a 0.45μm disposable filter and syringe. A fresh syringe and filters must be used at each monitoring station. Alternatively, sample filtration can be carried out by the analytical laboratory."*

Recommendation:
INAC recommends that the water sample filtration protocol for dissolved metal analyses be consistent, and that if samples are filtered at the laboratory instead of in the field, it be clearly indicated in the notes. Ideally, filtration should always occur in the same place to ensure results are as comparable as possible.

Attachment 3

Baffinland Response to ECCC and INAC Comments on Revision 2 of the AEMP

Environment and Climate Change Canada (ECCC) Comments and Baffinland Responses

ECCC Comment No.	Topic/Reference
1	Figures (throughout document)
2	Final Discharge Points (Section 4.1.2)
3	Reference Areas
4	Water Quality Monitoring (Section 4.2.2)
5	Water Quality Monitoring (Section 4.2.2)
6	Sediment Quality Study Design (Section 4.2.3)
7	Fish (Section 4.2.5)
8	Sediment Benchmarks – Sheardown Lake NW (Table 5.3)
9	Benthic Macroinvertebrate Indicators (Section 5.3.5)

ECCC Comment 1:
The low resolution of some of the figures provided in the document makes it difficult to read text and discern map details.

ECCC Recommendation:
The quality of the figures and maps in the Plan should be enhanced to make the details clear to the reader.

Baffinland Response:
Acknowledged. The quality of figures and maps presented in Revision 2 of the AEMP will be enhanced to ensure clearer interpretation by the reader.

ECCC Comment 2:
The document indicates that mine effluent will be discharged into the Mary River at three locations: east pond discharge, run-of-mine and crusher stockpile discharge, and the main ore stockpile discharge. However, the discharge locations are not well described nor are they shown on a map so it is difficult to determine if the locations of the discharge points into the Mary River were considered when selecting sampling locations.

ECCC Recommendation:
ECCC recommends that sampling locations in the Mary River be clearly identified and located such that impacts resulting from each individual discharge point can be identified and assessed.

Baffinland Response:
Acknowledged. The location of current and planned future discharge locations that drain into the Mary River system, as described in Table 1, will be incorporated as part of all maps in Revision 2 of the AEMP.

To date, intermittent discharges that have been released at the Project to the Mary River system include effluent from the current waste rock sedimentation pond ("East Pond", MS-08) that discharges overland to an unnamed tributary to the Mary River (i.e., Mary River Tributary-F), effluent from a sedimentation pond that collects run-of-mine and crusher stockpile runoff, and effluent from the mine sewage treatment plant, the latter two effluents of which each discharge from the same location (MS-06) directly to the Mary River. The main ore stockpile pond, which is associated with the Southern corridor railway and is expected to be discharged directly into the Mary River upstream of the MS-06 discharge, has not yet been constructed. Similarly, the West Pond (MS-09), which is associated with the future development of the open pit and is expected to be discharged to upper Camp Lake Tributary 1, has not yet been constructed.

Existing AEMP locations used to monitor potential effects from the MS-08 discharge include water and phytoplankton monitoring stations FO-01 on Mary River Tributary-F, and EO-10 and EO-03 on Mary River, and benthic invertebrate community survey area EO-01 on the Mary River (Table 1). Additional benthic invertebrate community monitoring is conducted on Mary River Tributary-F and additional water quality and fish population monitoring is conducted on Mary River (e.g., Station MS-08 DS) in fulfilment of federal Environmental Effects Monitoring (EEM) requirements under the Metal Mining Effluent Regulations (MMER). Existing AEMP locations used to monitor potential effects from the MS-06 discharge include water and phytoplankton monitoring stations EO-20 and EO-21 and benthic invertebrate community survey area EO-20 on the Mary River (Table 1).

Existing AEMP locations that will be used to monitor potential effects from the future main ore stockpile discharge, if commissioned, include water and phytoplankton monitoring stations EO-03 and EO-21, and benthic invertebrate community survey area EO-01, on Mary River (Table 1). Similarly, existing AEMP locations that will be used to monitor potential effects from the future West Pond discharge include water and phytoplankton monitoring stations L1-08 and/or L1-02 and benthic invertebrate community study area CLT1-US on Camp Lake Tributary 1 (Table 1).

ECCC Comment 3:

The Plan indicates that a number of reference areas including lakes, tributaries, and upstream locations have been identified. However, the proponent does not indicate which reference areas will be used for which receiving environments.

ECCC Recommendation:

Please provide a table that specifies what type of sampling will be done at each sampling location and the corresponding reference location. The study design should identify how reference area data will be used in comparisons to exposure site data.

Baffinland Response:

Acknowledged. A table that specifies the reference station/area corresponding to each mine-exposed sampling location, together with the type of sampling applicable for each pairing, is attached (Table 2) and will be included in Revision 2 of the AEMP. Please note that certain mine-exposed stations/areas can also be used as comparative locations for the evaluation of cumulative downstream effects. However, only the locations of reference stations/areas (i.e., those that are not, or are minimally, influenced by Baffinland operations), are indicated in this table. Reference data will be used to provide a basis for both relative and statistical comparisons to the mine-exposed station/area information as dictated by station replication. A description of how the reference data will be used in comparisons to the mine-exposed area data will included in Revision 2 of the AEMP.

ECCC Comment 4:
Minnow Consulting has recommended that the AEMP should reduce the number of water quality monitoring stations to three in each of Camp, Sheardown NW, and Sheardown SE Lakes, and to four in Mary Lake. This reduction is recommended by Minnow based in their assessment of the baseline data which suggests that the lakes are well mixed making additional sampling stations redundant. ECCC notes that many of these sampling locations were added to the program based on a power analysis completed in 2014 by Knight Piesold Consulting.

ECCC Recommendation:
ECCC requests additional rationale for the removal of sampling stations given that the power analysis completed in 2014 identified the need for additional sampling locations in Mary Lake and Sheardown Lake. ECCC recommends that the number of sampling locations be maintained until sufficient data is collected to ensure that these water bodies are well mixed and are not being impacted by the Project.

Baffinland Response:
The original baseline water quality power analysis conducted by Knight Piesold (KP) in 2014 identified the number of water chemistry samples required to determine a difference between concentrations during baseline and half the AEMP benchmark ($\alpha = 0.1$, and probability $[1-\beta] = 0.8$) *at a given station*. This analysis indicated that, for certain parameters, five samples at a station were adequate to determine differences between the baseline and commercial mine operation periods. For the KP power analysis, seasonal data were grouped together and therefore it follows that data collected through the year be included in the analysis. Since commercial mine operations commenced in 2015, nine water quality monitoring (surface) samples have been collected at each lake and stream station (three per year), which is adequate for testing differences to baseline conditions. Because within-lake data have shown very little spatial variability during each sampling event, station data can be grouped together for each lake. With the proposed three stations established at each lake, the grouping of the resulting nine samples per year for each lake will also be sufficient for determining annual differences from baseline concentrations while meeting conditions of the KP power analysis. Notably, as indicated in the KP design, with the availability of data from the commercial mine operation period, a linear regression approach is now appropriate for evaluating significant changes in parameter concentrations over time and assisting with management decisions. The 2017 Freshwater Workshop will be used to discuss the objectives and methods of the initial power analysis regarding sample size (i.e., the assumptions used) and provide further rationale for the adequacy of three stations per lake in meeting these goals. Until sufficient support is provided for a reduction in sample size through this (or other) analysis, sampling will continue at the same water quality sampling locations at the same frequency as established historically (i.e., Aquatic Effects Monitoring Plan, BAF-PH1-830-P16-0039 Rev 1).

ECCC Comment 5:
Minnow Consulting has recommended that the AEMP discontinue water quality monitoring at stations L1-09 (Camp Lake Tributary), D1-05 (Sheardown Lake Tributary 1) and G0-09A, G0-09B, and C0-01 on the Mary River. The reason for discontinuation of sampling at these locations is redundancy (L1-09 and C0-01), with the rationale that a single reference sampling location in the Mary River is adequate (G0-09A and G0-09B), and that an upstream sampling location is not necessary (D1-05). ECCC notes that many of these sampling locations were added to the program based on a power analysis completed in 2014 by Knight Piesold Consulting.

ECCC Recommendation:

ECCC requests additional rationale for the removal of sampling stations given that the power analysis completed in 2014 identified the need for additional sampling locations in these areas. ECCC recommends that stream water quality sampling locations be maintained until sufficient data is acquired to determine if there are potential impacts to these waterbodies. In addition, the removal of the upstream reference sampling locations may be inappropriate as an accurate understanding of the reference (upstream) conditions is essential to determine if impacts are occurring in the receiving environment.

Baffinland Response:

The original baseline water quality power analysis conducted by Knight Piesold (KP) in 2014 identified the number of water chemistry samples required to determine a difference between concentrations during baseline and half the AEMP benchmark ($\alpha = 0.1$, and probability $[1-\beta] = 0.8$) at a given station. Therefore, the same rationale provided above applies to station-level data collected for the stream water quality monitoring stations. Because data are assessed only at the station level, the suggested removal of mine–exposed stations L1-09, D1-05 and CO-01 indicated above will not take away from the ability of the program to evaluate effects in the affected waterbodies given that other existing stations maintained in the program provide the same information (i.e., no dilution between stations). Further discussion to this effect will be presented at the 2017 Freshwater Workshop.

Upon further review of the Mary River GO-09 series reference stations, relatively high variability in concentrations of non-conservative parameters (e.g., aluminum, iron) related to natural turbidity differences was shown among the three GO-09 stations. Therefore, the three GO-09 stations will be maintained in the program to better capture the influence of natural turbidity on parameter concentrations in the Mary River system.

ECCC Comment 6:

Based on recommendations from Minnow Consulting, all sediment quality monitoring in streams and lakes has been removed from the sediment monitoring program. According to the rationale provided this is due to the limited depositional habitat and minimal accumulation of fine sediments.

ECCC Recommendation:

ECCC recommends maintaining periodic sediment quality monitoring in rivers and streams that are directly receiving discharge. At a minimum this should tie in with the frequency required under MMER EEM (every 3 years).

Baffinland Response:

As per recommendations by Minnow, sediment quality will continue to be monitored at mine-exposed and reference lakes as part of the Baffinland AEMP. In previous studies, sediment chemistry data had not been collected at all lake stations in which benthic invertebrate community samples were taken. Therefore, the recommendations suggested harmonization of sediment quality and benthic invertebrate community sampling to allow linkages to be evaluated between sediment metal concentrations and potential effects on benthic invertebrates in studies moving forward. The recommendations also included sediment quality monitoring at the main basins of each mine lake to provide temporal continuity with previous studies so as to allow the long-term tracking of changes in sediment quality at each study lake.

The utility of monitoring sediment chemistry at lotic environments (i.e., streams and rivers) as part of the Baffinland AEMP is tenuous. Lotic environment sediment sampling was originally included in the Mary River Project CREMP by Knight Piesold to provide qualitative information to support the lake sediment chemistry data analysis. However, streams and rivers in the Mary River Project area contain very limited depositional habitat suitable for the collection of fine sediments. Substrate within the Camp Lake tributaries and Sheardown Lake tributaries is almost entirely composed of boulder and cobble-gravel, and that of Mary River almost exclusively of boulder and cobble (e.g., habitat characterization conducted during the 2015 and 2016 studies indicated that sand composed less than 5% of available surficial substrate). During the 2014 KP study, sufficient amounts of sediment were available for sampling at only 3 of 23 stations, and for those stations at which sediment was able to be collected, coarse sand typically composed greater than 95% of sample material. The general absence of any substantial accumulation of fine sediments in lotic habitats of the area precludes any meaningful assessment of potential mine-related influences on sediment chemistry within, along and/or between watercourses, and among studies.

Moreover, the applicability of lotic sediment chemistry monitoring data to the interpretation of lotic benthic invertebrate community data is moot given the facts that fine sediment composes much less than 5% of available substrate at the lotic environments (extrapolation of the data suggests that silt and clays compose less than 0.5% of available habitat) and that benthic invertebrates collected for the AEMP do not inhabit these fine sediments. By extension, because fish species inhabiting lotic environments of the area (i.e., Arctic charr and ninespine stickleback) largely rely on benthic invertebrates as a food source, the applicability of sediment chemistry monitoring data to understanding effects on fish is also minimal. Therefore, the inclusion of sediment chemistry monitoring at lotic environments as part of the Baffinland AEMP does not constitute a scientifically meaningful allocation of resources, and thus sediment chemistry monitoring is not recommended at watercourses to which the current AEMP applies.

Notably, coarse sediment samples (sand/gravel) were collected from all stream benthic invertebrate community stations during the CREMP 2017 field study. Given Minnow's above rationale regarding the relevance of such sampling, comparison of the metal chemistry data to sediment quality guidelines/AEMP benchmarks will not be conducted as part of the data analysis.

ECCC Comment 7:
Minnow Consulting has recommended that the fish sampling program be modified to reduce the non-lethal adult Arctic charr sample size to 50 per study lake instead of 100.

ECCC Recommendation:
A sample size of 100 fish is required under the Environmental Effects Monitoring of the Metal Mining Effluent Regulations. Fish sampling for the EEM and AEMP programs should be harmonized to reduce any duplication of effort without reducing the sample size.

Baffinland Response:
Power analysis results for comparisons between baseline and 2015 and 2016 adult Arctic charr health for the primary non-lethal endpoint of condition (i.e., length-at-weight relationship) are presented in Table 3 for each mine lake. Based on generally accepted Critical Effect Sizes (CES) for EEM fish studies of

10% for condition, reduced sample sizes for adult Arctic charr are justified for all mine lakes (Table 3). By reducing the number of adult Arctic charr targeted from 100 to 50 at each of the AEMP mine lakes, it is anticipated that the number of incidental mortalities will be reduced by half, the influence of which on the population is likely greater than any other potential mine-related effect. This reduction in sample size, as supported through the power analysis using the 2015 and 2016 data, will not affect the ability of the program to meet study objectives (i.e., to determine effects on fish population health) while conserving fish populations of the study lakes. Because the results of previous power analysis has been used as justification for determination of appropriate sample sizes for the AEMP water quality sampling component by ECCC (i.e., Comments 4 and 5), a similar rationale can be used for the AEMP fish monitoring component.

ECCC Comment 8:

The table presents a number of interim AEMP benchmarks for Sheardown Lake SE, which are based on either the sediment quality guideline, 97.5% of the baseline data or 3x the MDL. However, there are some suggested benchmarks that need further clarification.

ECCC Recommendation:

Please provide further rationale for the following suggested benchmarks:
Cadmium 97.5% measured Baseline = <0.5 mg/kg
CCME guideline is 0.6 mg/kg
Suggested benchmark = 1.5 mg/kg

Arsenic, chromium, copper, iron, manganese, nickel, phosphorus - the Plan states that the benchmarks for these metals are based on 97.5% of the baseline but the numbers do not correspond to numbers listed in table for Sheardown Lake NW 97.5% baseline.

Baffinland Response:

In the case of sediment cadmium concentrations at Sheardown Lake SE, only 2 of 74 samples collected up until the end of 2014 field season showed concentrations above laboratory Method Detection Limits (MDL) of 0.5 mg/kg. The higher of the SQG, baseline 97.5%tile, or 3x MDL was criteria for the AEMP benchmark for cadmium at Sheardown Lake SE. In this case, 3x MDL was used as the benchmark (3 x 0.5 = 1.5 mg/kg). Baffinland will consider a review of this AEMP benchmark. Notably, sediment cadmium concentrations at Sheardown Lake SE in 2016 were below 0.6 mg/kg (interim CCME SQG).

The determination of final sediment quality benchmarks is outlined in Appendix D: Establishment of Final Sediment Quality Aquatic Effects Monitoring Program Benchmarks (Intrinsik, 2015) of the submitted Revision 2 of the AEMP. Based on the available data following the 2014 CREMP field program, Intrinsik recommended the following:

- Sheardown Lake SE would have lake-specific benchmarks, based on the dataset of 2007 - 2014;
- Mary Lake and Camp Lake would have combined, lake-specific benchmarks, based on the dataset of 2007 - 2014;
- Due to complicating factors related to the Sheardown Lake data set, it is difficult to determine, based on the available dataset, whether recent construction-related activities have influenced sediment chemistry of this lake. The main factors include the change in sediment sampling protocol (ponar grab of top 5 cm in early years, versus a 0 - 2 cm coring approach since 2012),

the lack of monitoring of several long standing stations in 2014, which limits temporal comparisons at specific locations.

Therefore, the benchmarks presented from the original 2014 study were maintained for Sheardown Lake NW, though the 97.5%tile data presented included data collected in 2014, resulting in the confusion. Better clarity on the topic will be provided in future AEMP revisions.

ECCC Comment 9:
A number of BMI metrics are listed for inclusion in the CREMP, including: abundance, composition, Shannon's Evenness, Simpson's Diversity Index and Richness. Environment Canada had previously commented that the Bray Curtis index be added as indicator to which the proponent had agreed to, however it is not included on the list.

ECCC Recommendation:
ECCC recommends that the Bray Curtis index be added as an indicator for benthic macroinvertebrates.

Baffinland Response:
Acknowledged. Revision 2 of the AEMP will include Bray-Curtis Index on the list of BMI community metrics to be assessed. Notably, although not included in the list of endpoints provided in the AEMP, the Bray Curtis Index was included in the analysis of BMI communities in the 2015 and 2016 CREMP monitoring reports.

Table 1: Mary River Project current and anticipated effluent discharge descriptions.

Discharge Source	Effluent Final Discharge Point Identifier	Coordinates (NAD 83)		Receiving Waterbody	Existing AEMP Receiving Environment Downstream Monitoring Locations				
		Latitude	Longitude		Water Quality	Sediment Quality	Phyto-plankton	Benthic Invertebrates	Fish
East Pond[a]	MS-08	71˚20'24.7"	79˚13'18.4"	Unnamed Tributary to Mary River (Mary River Tributary-F)	Mary River Tributary-F (FO-01) Mary River (MS-08-DS, EO-10)	Mary Lake	Mary River Tributary-F (FO-01) Mary River (EO-10)	Mary River (E0-01) Mary River Tributary-F (EEM only)	Mary River (EEM only) and Mary Lake
Crusher Ore Stockpile	MS-06	71˚18'06.4"	79˚15'29.7"	Mary River	Mary River (EO-20 and EO-21)	Mary Lake	Mary River (EO-20 and EO-21)	Mary River (EO-20)	Mary River (EEM only) and Mary Lake
Main Ore Stockpile[b]	-	Not Applicable	Not Applicable	Mary River	Mary River (EO-03 and EO-21)	Mary Lake	Mary River (EO-03 and EO-21)	Mary River (EO-01)	Mary River (EEM only) and Mary Lake
West Pond[c]	MS-09	Not Applicable	Not Applicable	Camp Lake Tributary 1	CLT1 Stations	Camp Lake	CLT1 Stations	CLT1 US	Camp Lake

[a] A temporary sedimentation pond has been constructed to contain runoff from the waste rock stockpile generated during Early Revenue Phase operations.

[b] Infrastructure is not associated with the Early Revenue Phase of the Project and therefore has not been constructed to date.

[c] Infrastructure is not associated with the Early Revenue Phase of the Project and therefore has not been constructed to date.

Table 2: Mary River Project AEMP study stations/areas and corresponding reference stations/areas used for comparisons.

Study System	Water Body	Representative Water Quality Station [d]			Reference Area used for each Study Component [a, b, c]				
		Station Identifier	Easting	Northing	Water Quality	Sediment Quality	Phytoplankton	Benthic Invertebrates	Fish
Reference Areas	Lotic Reference	CLT-REF3	567004	7909174	Y	-	Y	-	-
		CLT-REF4	568533	7907874	Y	-	Y	Y	-
		MRY-REF3	585407	7900061	Y	-	Y	-	-
		MRY-REF2	570650	7905045	Y	-	Y	-	-
	Reference Lake 3	REF-03-W1	575642	7852666	Y	Y	Y	Y	Y
		REF-03-W2	574836	7852744	Y		Y		
		REF-03-W3	574158	7853237	Y		Y		
Camp Lake System	Camp Lake Tributaries	I0-01	555470	7914139	Lotic Reference Average	Not Applicable	Lotic Reference Average	Not Applicable	Not Applicable
		J0-01	555701	7913773					
		K0-01	557390	7915030				CLT-REF4	
		L0-01	557681	7914959					
		L1-02	558765	7915121					
		L1-05	558040	7914935					
		L1-08	561076	7915068					
		L1-09	558407	7914885					
		L2-03	559081	7914425					
	Camp Lake	JL0-01	557108	7914369	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3
		JL0-02	557615	7914750					
		JL0-07	556800	7914094					
		JL0-09	556335	7913955					
		JL0-10	557346	7914562					
Sheardown Lake System	Tributary 1	D1-00	560329	7913512	Lotic Ref. Avg.	Not Applicable	Lotic Ref. Avg.	CLT-REF4	Not Applicable
		D1-05	561397	7913558					
	Tributary 9	-	-	-	Not Applicable	Not Applicable	Not Applicable	CLT-REF4	Not Applicable
	Tributary 12	-	-	-					
	Sheardown Lake NW	DD-Hab9-Stn1	560259	7913455	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3
		DL0-01-1	560080	7913128					
		DL0-01-2	560353	7912924					
		DL0-01-4	560695	7913043					
		DL0-01-5	559798	7913356					
		DL0-01-7	560525	7912609					
	Sheardown Lake SE	DL0-02-3	561046	7911915	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3
		DL0-02-4	561511	7911832					
		DL0-02-6	560756	7912167					
		DL0-02-7	560952	7912054					
		DL0-02-8	561301	7911846					
Mary River and Mary Lake System	Mary River	G0-09-A	571264	7917344	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
		G0-09	571546	7916317					
		G0-09-B	571248	7914682					
		G0-03	567204	7912587	Mary River GO-09 Average		Mary River GO-09 Average	Mary River GO-09 Average	
		G0-01	564459	7912984					
		F0-01	564483	7913015					
		E0-21	562444	7911724					
		E0-20	561688	7911272					
		E0-10	564405	7913004					
		E0-03	562974	7912472					
		C0-10	560669	7911633					
		C0-051	558352	7909170					
		C0-01	556305	7906894					
	Mary Lake (North Basin)	BL0-01	554691	7913194	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3	Not Applicable
		BL0-01-A	554300	7913378					
		BL0-01-B	554369	7913058					
	Mary Lake (South Basin)	BL0-03	552680	7906651	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3	Reference Lake 3
		BL0-04	553817	7904886					
		BL0-05	554632	7906031					
		BL0-06	555924	7903760					
		BL0-05-A	554530	7906478					
		BL0-05-B	555034	7905692					
		BL0-09	554715	7904479					

[a] Lotic Reference Average (Lotic Ref. Avg.) based on mean of Reference Stations CLT-REF3, CLT-REF4, MRY-REF2 and MRY-REF3 station data.

[b] Station GO-09 Average (GO-09 Avg.) based on mean of upper Mary River GO-09, GO-09A and GO-09B station data.

[c] Not applicable indicates no sampling completed for specified study component at the study area indicated.

[d] Station identifiers and coordinates presented are applicable only to the water quality monitoring component. Different stations may have been used for the remaining study components.

Table 3: Sample sizes required to detect differences in adult Arctic charr non-lethal population endpoints between baseline and 2015 and 2016 data for mine lakes with power = 0.90 and alpha = 0.10. Highlighted values indicate sample sizes sufficient to meet Critical Effect Sizes used for EEM studies.

Mine Lake	Data Set	Minimum Sample Size (Increase[a] / Decrease[b])							
		i=5%	i=10%	i=20%	i=25%	i=30%	i=40%	i=50%	i=100%
		d=4%	d=9%	d=17%	d=20	d=23%	d=29%	d=33%	d=50%
Camp Lake	2015	46	13	4	3	3	2	2	1
	2016	103	28	8	6	5	3	3	2
Sheardown Lake NW	2015	48	13	5	3	3	2	2	1
	2016	100	27	8	6	5	3	3	2
Sheardown Lake SE	2015	52	14	5	4	3	2	2	1
	2016	73	20	6	5	4	3	2	2
Mary Lake	2015	79	21	7	5	4	3	2	2
	2016	120	32	10	7	5	4	3	2

[a] Increase relative to reference mean using log transformed data

[b] Decrease relative to reference mean using log transformed data

Indigenous and Northern Affairs Canada (INAC) Comments and Baffinland Responses

INAC Comment No.	Topic/Reference
1	Reducing number of CREMP lake water quality stations
2	Collecting CREMP lake water samples from mid-water column
3	Discontinuation of CREMP stream sediment quality monitoring
4	AEMP sediment quality benchmarks
5	Water sample filtration for metal analyses

INAC Comment 1:

The Department is of the opinion that reducing the number of sampling stations at this stage may be premature. INAC notes that though the mine was in operation in 2015, it was not at the fully planned Early Revenue Phase operating capacity. The third crusher was not operating until the end of 2015 so its impact would not have been measureable in the 2015 data.

Additionally, though the data indicates the lakes are well mixed, to our knowledge, the lake replenishment rates have not been discussed and therefore the impacts of a future point source are uncertain. It would be relevant to keep the initially determined number of water quality monitoring stations to help detect possible future point sources.

INAC Recommendation:

INAC recommends that the number of water quality monitoring stations for Camp, Sheardown NW, Sheardown SE and Mary Lakes be maintained.

Baffinland Response:

For the reasons originally provided (i.e., no consistent spatial differences in water chemistry have ever been shown, and lakes are generally well mixed), the lower number of stations proposed by Minnow (i.e., 3 – 4) would be sufficient to evaluate changes in water quality over time, taking changes in mine operation and lake replenishment rates into account. Lake replenishment rates will be presented in the 2017 CREMP annual monitoring report. The same rationale provided in response to ECCC Comments 4 and 5 apply. Additional information on lake mixing is provided in response to INAC Comment 2 below.

INAC Comment 2:

The revised plan proposes to "collect a single water quality sample at mid-depth instead of collecting two samples, surface and bottom, at each lake water quality monitoring station" (Minnow Environmental recommendation #9). The justification given is that "water chemistry data collected during the 2015 CREMP, as well as during baseline studies, has generally shown only minor (i.e., <2-fold higher) differences in water chemistry and chlorophyll a concentrations between the surface and bottom at each station." A note in the Minnow Environmental recommendation is made that if the lakes are determined to be stratified based on in-situ water quality profile data, two samples (top & bottom) would be taken. This does not appear in the main text of the AEMP R2 but is found in Appendix A of Appendix B. The Final Environmental Impact Statement discussion states than in-situ water quality depth profiles indicated the lakes were thermally stratified in summer 2011 and not in fall 2011. Therefore, though not permanent, lake stratification does occur and the Department is of the opinion that it would be prudent to continue sampling with the top-bottom approach rather than using an average mid-water column sample.

INAC Recommendation:

INAC recommends that continuing lake water quality sampling at two depths (1 m below surface and 1 m above bottom) rather than at a single depth (mid-water column).

Baffinland Response:

The revised (Rev. 2) AEMP suggested that water quality samples be collected from mid-water column at each lake station based on the rationale that only minor differences in water chemistry and chlorophyll a concentrations have been observed between surface and bottom prior to, and since, the onset of mine operations. However, a provision that such sampling be conducted only once it is determined that the lake is not thermally stratified during the sampling event should have been included in the main text of the AEMP document, together with confirmation that in the event that the lake is determined to be thermally stratified, a conventional top-bottom sampling approach will be employed. This water quality sampling approach will therefore ensure that limnological factors most important in driving potential differences between surface and bottom (e.g., dissolved oxygen regimes) are captured in the water chemistry data. The decision framework and approach for lake water quality sampling will be expanded to reflect the information above in Revision 2 of the AEMP.

Please note that it should be recognized that, because lake water quality monitoring stations are established at various depths under the current design, some stations may occur at depths shallower than the depth at which thermocline development occurs. In such cases, the 'bottom' water chemistry continues to represent epilimnion 'shallow' or 'surficial' water quality, and thus, once again, the collection of top-bottom samples is somewhat redundant at these stations. As an example, and as in 2011, sampling conducted in 2016 showed that mine lakes become thermally stratified. In 2016, the upper thermocline was generally apparent at a depth of approximately 10 m. Thus, for stations established at depths shallower than 10 m, top and bottom samples would both equate to the epilimnion layer. Therefore, the evaluation of any differences in top and bottom water chemistry should take station depth and the depth at which various lake layers become established into consideration during data interpretation.

INAC Comment 3:

The revised plan proposes to discontinue stream sediment quality monitoring (Minnow Environmental recommendation # 10) because the streams and rivers in the study area "contain very limited depositional habitat suitable for the collection of fine sediments". Two streams in the area are expected to experience flow reductions: Camp Lake Tributary 2 (CLT-2), during the full scale project, and Sheardown Lake Tributary 1 (SDLT-1), due to diversions associated with West Pond and the Open Pit. It is not clear if these flow reductions would be such that suitable depositional habitat may be created.

INAC Recommendation:

INAC recommends that Baffinland discuss whether depositional habitats may be created by flow reductions on streams CLT-2 and SDLT-1, and if so, confirm these would be sampled.

Baffinland Response:

Some streams will potentially be subject to flow reductions due to mine operations in the future (e.g., Camp Lake Tributary 2, Sheardown Lake Tributary 1). Currently, no substantial alteration of watershed flow has occurred within any of the Mary River Project mine site watercourses. In the future, should reductive diversion of flow occur in watercourses as a result of Mary River Project mine operations, affected watercourses will routinely be assessed to determine changes in depositional features. Visual surveys, conducted at the time of water sampling and/or during other sampling events (e.g., benthic invertebrate community sampling), will be used to ascertain the occurrence of fine sediment deposits (e.g., silts, clays). In the event that fine sediment deposits are observed at these watercourses, stream sediment sampling for metals analysis will be included as a means to track changes in sediment chemistry over time at the affected watercourse(s). Revision 2 of the AEMP will include wording to this effect.

INAC Comment 4:

The sediment quality benchmarks developed for Sheardown Lake NW are interim due to confounding factors in the collected data. Further study was recommended for 2015. It is not clear whether the data presented in the 2015 annual report meets this recommendation and the information has not yet been integrated, or if there is still work to do. Recommendation # 14 by Minnow Environmental is to consider updating the AEMP sediment quality benchmarks because "on average, arsenic, copper and iron concentrations were elevated above respective AEMP sediment quality benchmarks within Reference Lake 3 littoral and/or profundal station sediment during the 2015 CREMP. Given that to date, sediment quality benchmarks have been developed on a lake by lake basis, using data from Reference Lake 3 to modify existing benchmarks in mine site lakes appears as a change in methodology. The Department notes that it did not find this recommendation in the AEMP document.

INAC Recommendation:

INAC recommends that Baffinland:

1) Provide an update on work done to remove the interim status of the Sheardown NW quality benchmarks: and
2) Clarify if and how they would modify previously developed sediment quality benchmarks for mine site lakes.

Baffinland Response:

Baffinland continues to collect sediment quality data at Sheardown Lake NW and, as of 2015, at a comparable reference lake (Reference Lake 3) as outlined in the current revision of the AEMP (Rev. 1). Because baseline data collection can no longer occur at Sheardown Lake NW, only data from reference lakes can be used to update the AEMP Sediment Quality Benchmarks. Sediment sampling at Reference Lake 3 has showed naturally elevated concentrations of arsenic, copper, iron and manganese compared to AEMP benchmarks, which suggests that AEMP benchmarks for these metals may be overly conservative should they be used for inferring biological responses. If Sheardown Lake NW sediment quality guidelines are to be updated, sediment quality data from Reference Lake 3 should be incorporated into the model.

INAC Comment 5:
Field sampling protocols for water sampling are presented in Appendix B which includes several appendices itself. The protocol for filtering water samples for dissolved metal analyses does not appear consistent between the appendices.

Section 2.2.2 of Appendix A (Water and Sediment Quality Sampling Protocol R1) states:

"Prior to the addition of preservative, samples for dissolved metals are field filtered using Acrodisc 32 mm Syringe Filters with 0.45 um Supor membrane filter."

Section 4.3.1 of Appendix B (Sampling Program - Quality Assurance and Quality Control Plan BAF-PH16-001 R1) states:

"For dissolved metals analyses, if possible, the water sample be filtered in the field immediately after sampling using a 0.45 um disposable filter and syringe. A fresh syringe and filters must be used at each monitoring station. Alternatively, sample filtration can be carried out by the analytical laboratory".

INAC Recommendation:
INAC recommends that the water sample filtration protocol for dissolved metal analyses be consistent, and that if samples are filtered at the laboratory instead of in the field, it be clearly indicated in the notes. Ideally, filtration should always occur in the same place to ensure results are comparable as possible.

Baffinland Response:
Acknowledged. Baffinland agrees with INAC that the water filtration protocol for dissolved metal sample collection should be consistent between and among sampling stations and sampling events as part of the AEMP. Similarly, methods presented regarding the collection of dissolved metals samples should also be consistent among the various Baffinland AEMP documents. Baffinland will ensure protocols for the filtration process during dissolved metal sampling will be consistently described among all submitted AEMP Revision 2 documents.

Appendix 3

Environmental Effects Monitoring – Phase 1 Study Design
(EEM Phase 1 Study Design)

Mary River Project Environmental Effects Monitoring Phase 1 Study Design

Prepared for:
Baffinland Iron Mines Corporation
Mary River Project
Oakville, ON

Prepared by:
Minnow Environmental Inc.
Georgetown, ON

July 2016

Mary River Project
Environmental Effects Monitoring
Phase 1 Study Design

Prepared for:

Baffinland Iron Mines Corp.
Mary River Project

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July 2016

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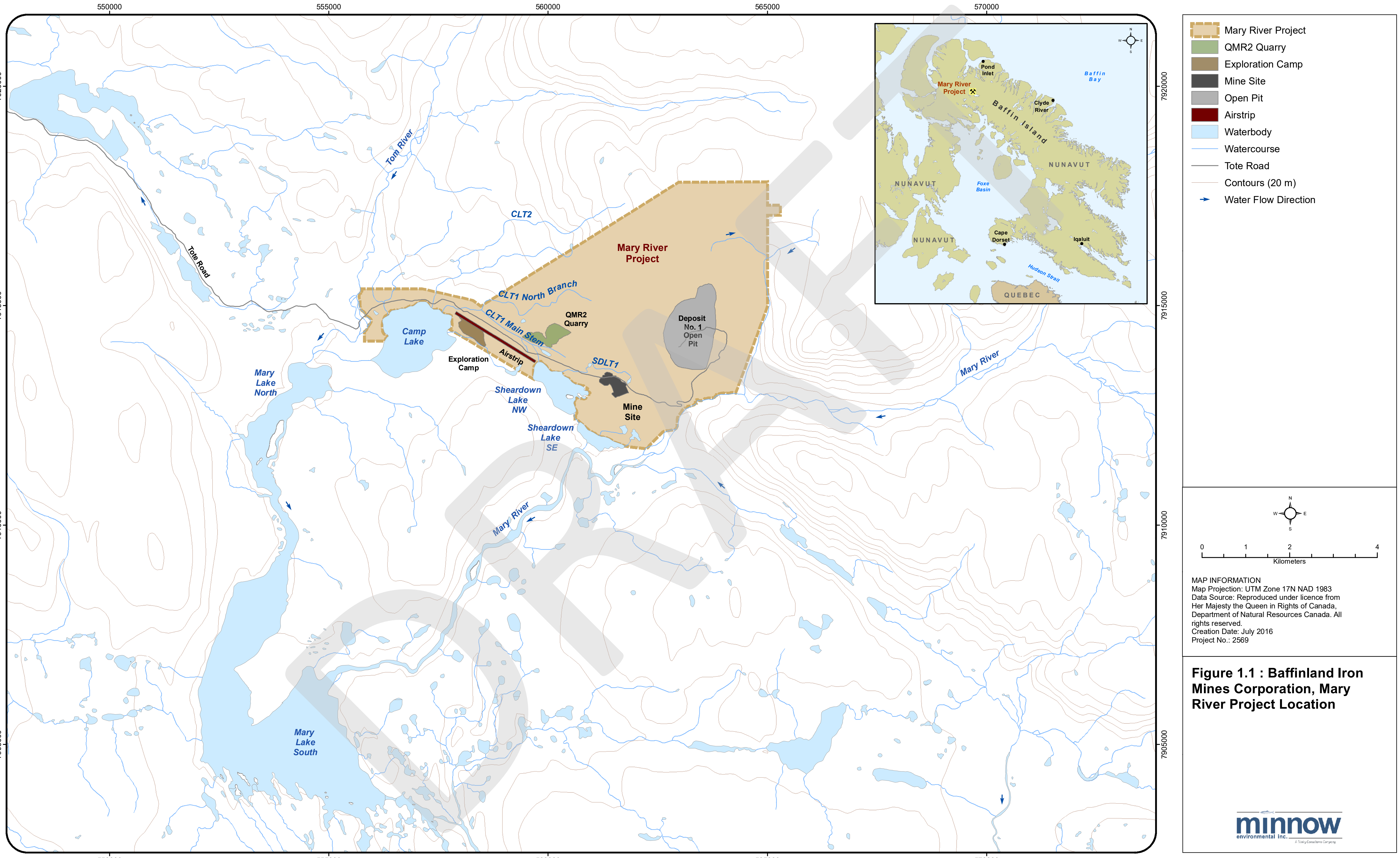
1.0 INTRODUCTION

1.1 Background

The Mary River Project, owned and operated by Baffinland Iron Mines Corporation (Baffinland), is a high-grade iron ore mining operation located in the Qikiqtani Region of northern Baffin Island, Nunavut (Figure 1.1). Surface (contour strip) mining at the Mary River Project commenced in mid-September 2014, and has since included pit bench development, ore haulage and stockpiling, and the crushing and screening of high-grade iron ore at the mine site. No milling or additional processing of the ore is conducted on-site. For the initial mining stages at the Mary River Project, approximately 4.2 million tonnes (Mt) of crushed/screened ore will be transported annually by truck to Milne Port, which is located approximately 100 km north of the mine site. At Milne Port, the ore is stockpiled before being loaded onto bulk carrier ships for transport to European markets during the summer ice-free period. No tailings are produced during ore processing, and therefore mine waste management facilities at the Mary River Project include a waste rock dump and surface runoff collection ponds currently situated near the mine waste rock pad/disposal and ore stockpile areas.

On July 10, 2015, the Mary River Project became subject to the Metal Mining Effluent Regulations (MMER) under the *Fisheries Act* as a result of the discharge of effluent in excess of 50 cubic meters (m^3) from a temporary mine waste rock settling pond. The MMER outline requirements for routine effluent and water quality monitoring and for biological monitoring, collectively referred to as Environmental Effects Monitoring (EEM) studies, as a condition governing the authority to discharge effluent (Environment Canada 2012; Government of Canada 2016). The objective of EEM is to determine whether mine effluent is causing an effect on the fish population, the use of fisheries resources (i.e., mercury accumulation in fish tissues) and/or benthic invertebrate communities. Under the MMER, an EEM Study Design is required within 12 months of a mine becoming subject to the MMER, and at least 6 months prior to conducting the biological monitoring field study. In accordance with the MMER, this Study Design provides detailed site characterization information and outlines the approach to the Mary River Project's first (Phase 1) EEM biological study, the field component of which is scheduled for August 2017. This Phase 1 EEM Study Design supersedes a draft EEM Study Design that was developed in anticipation of the mine becoming subject to the MMER, which was drafted so that EEM principles could be incorporated as part of a broader aquatic effects monitoring program for the Mary River Project (i.e., Baffinland 2014).



MAP INFORMATION
Map Projection: UTM Zone 17N NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.
Creation Date: July 2016
Project No.: 2569

Figure 1.1 : Baffinland Iron Mines Corporation, Mary River Project Location

minnow environmental Inc.

1.2 Objective

The objective of this Mary River Project Phase 1 EEM Study Design is to provide a detailed site characterization and a description of the biological monitoring that will be conducted at the Mary River Project in 2017 to assess effluent-related effects to receiving environment biota. This study design incorporates site characterization and biological information collected as part of mine feasibility studies as well as previous aquatic studies to meet other monitoring objectives outside of the EEM program (Baffinland 2014; KP 2014a,b,c, 2015; NSC 2014, 2015; Minnow 2016). Relevant information from these studies is reflected in this report and help form the basis from which this initial biological monitoring Study Design was developed.

1.3 Report Organization

The content of this report reflects the requirements outlined under the EEM portion of the MMER (Government of Canada 2016) and the Technical Guidance Document for Metal Mining EEM (Environment Canada 2012). Site characterization information is provided in Section 2.0, including information from studies completed at the Mary River Project that are relevant to the development of this effects assessment monitoring study. Section 3.0 outlines the approach to the initial biological monitoring (effects assessment) study, including identification of the proposed study areas, detailed methodology for sample collection and sample analysis, methods used for data interpretation and reporting, and a schedule for the biological monitoring study. Finally, references cited throughout the document are listed in Section 4.0.

2.0 SITE CHARACTERIZATION

Site characterization provides the critical background information that forms the foundation for the design of each study phase within the EEM framework (Environment Canada 2012). This mine closure EEM site characterization summarizes available information regarding mine operations, effluent characteristics and sub-lethal toxicity, and receiving environment/ reference area physical, chemical and biological features relevant to the development of the Phase 1 EEM biological study.

2.1 Mine Site Characterization

2.1.1 Mine History and Operations

High grade iron ore was discovered at the Mary River Project site (Nuluujak Mountain) in July 1962 during airborne reconnaissance prospecting across central and northern Baffin Island. However, only limited exploration of the site occurred prior to 2004, at which time Baffinland, then a publically traded junior exploration company, acquired surface rights to the project site and began more advanced exploration and development of the Mary River Project. In March 2011, Baffinland was acquired by 1843208 Ontario Inc., a corporation owned 70% by ArcelorMittal and 30% by Iron Ore Holdings LP. Iron Ore Holdings LP (IOH) is a limited partnership formed under the laws of Delaware (USA) between the former Baffinland owners and a Houston-based private investment firm (The Energy & Minerals Group). In 2012, the proportion of Baffinland's ownership changed to 50%-50% between the two partners, with ArcelorMittal remaining as the operator responsible for the overall leadership and management of the Mary River Project. Construction of the Mary River Project mine commenced in spring 2013, with commercial production initiated in 2014 and the first shipment of iron ore to world markets occurring in July 2015. Reserves at the primary deposit (referred to as Deposit No. 1) presently consist of approximately 380 million tonnes of ore grading an average of 66% iron based on measured and indicated categories. The mine life is anticipated to span 21 years based on a reserve calculation conducted using an ore cut-off grade of 59% iron.

The Mary River Project operates as a surface (contour strip) mine. The initial, early revenue phase (ERP) development of the primary deposit (Deposit No. 1) involves the mining of a hill crest outcrop. The ERP is anticipated to produce up to 4.2 million-tonnes of ore annually for the initial five years of mine operation, after which Approved Project annual production of 18 million-tonnes is anticipated. No physical "mine pit" will be created at the site until future, larger scale, Approved Project operations commence. Based on preliminary designs, the final open pit will be approximately 2.0 km long and 1.2 km wide, with the depth ranging from 465 m (northern side) to 195 m (southern side).

Conventional open-pit mining techniques, consisting of drill, blast and excavation of ore using 7.5 m benches with access via ramps, are employed at the Mary River Project. The ore and waste rock is transported using a fleet of 90 tonne haul trucks on dedicated haul roads. Ore processing at the Mary River Project includes crushing and screening, with no further milling or processing required due to the high grades of iron (i.e., approximately 67%). The crushing and screening assembly, located approximately 2.5 km south of the mine and connected by a 7 km haul road, includes two mobile units equipped with one jaw crusher, one cone crusher, one primary screen and one secondary screen, which are designed to operate year round. Primary crushing is conducted using a gyratory (jaw) crusher that reduces ore to 178 mm (top size of 250 mm) at a design rate of 3,333 tonnes per hour (tph). This material is then conveyed for secondary crushing using a 7 foot (1,000 horsepower) cone crusher to produce a bulk crushed ore of 43 mm (top size of 75 mm). Crushed ore from the secondary crushers is recovered at a design rate of 3,333 tph. Lump (6.3 - 31.5 mm diameter) and fines (<6.3 mm diameter) products produced through the crushing/screening process at approximately a 3:1 ratio are transferred to local stockpiling areas using respective conveyor systems. These products are then reclaimed and loaded into 150 tonne tractor-trailer units for haulage to Milne Port without further processing. From Milne Port, the lump and fines products are stockpiled to await transport by ship during the ice-free season to Europe for additional refining.

2.1.2 Ore Mineralization

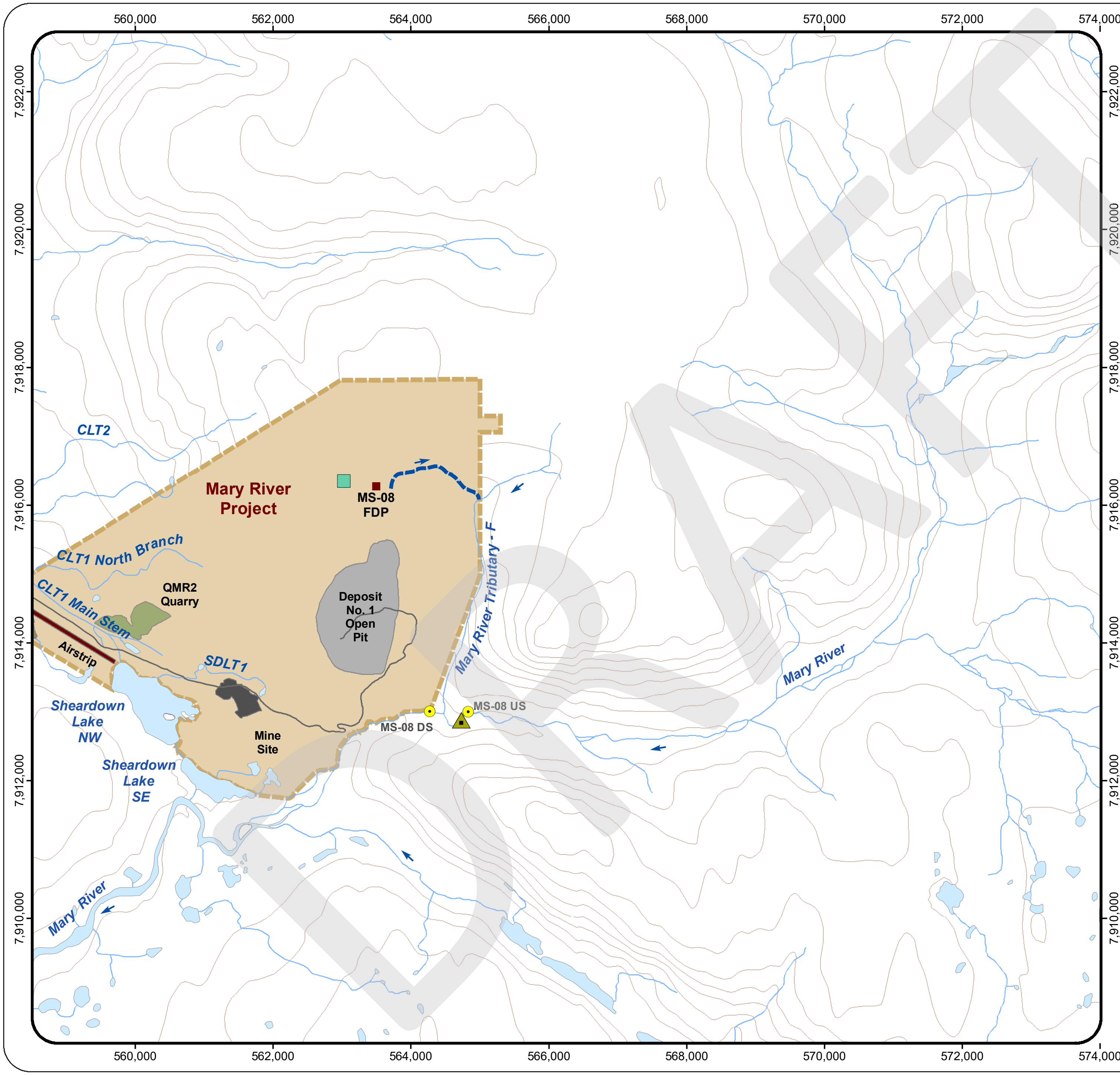
The Mary River Project area is situated within the Committee Belt, which includes an assemblage of granite-greenstone terrains, and rift basin sedimentary and volcanic rocks. Deposits of high grade iron formation at the Mary River Project are hosted within the Mary River Group, which comprises late Archean mixed metasedimentary–metavolcanic successions that are tightly folded and structurally complex. The Mary River Project Deposit No. 1 has a total strike length of approximately 4 km and comprises the axial culmination of the Mary River Group synform. Outcrops of high grade iron ore in Deposit No. 1 consist of hematite, magnetite and specularite, which are exposed along the margin and crest of Nuluujak Mountain at elevations ranging from 250 m to 690 m. The deposit is divided into an approximately 3 km long northern portion (“North Limb”) and an approximately 1 km long southern portion (“Fold Axis” and “South Limb”).

2.1.3 Waste Management

Acid-base Accounting (ABA) and kinetic testing conducted on waste rock samples have indicated that approximately 86% of waste rock material is classified as non-acid generating (NAG), and the remaining 14% is classified as potentially acid-generating (PAG). On average, it is estimated that NAG and PAG waste rock material will total approximately 14.8 and 4.8

million tonnes in the initial five years of mine operation. Low quantities of PAG material have also been identified in Deposit No. 1 pit walls, with this material also showing slow sulphide reactivity. Waste rock from the mining operation is used to upgrade/construct mine haul roads (NAG material), or is trucked to waste rock piles located west and north of the mine pit for disposal (NAG and/or PAG material) according to its geology. Waste rock classified as PAG is stored in designated areas within the waste rock stockpile to limit its potential for contact with meteoric water and its exposure to oxidizing conditions. Due to the low quantities of PAG material and slow sulphide reactivity, management of PAG materials involves encapsulation by permafrost within the constructed waste rock pile. Because of the cold Arctic climate, the majority of waste rock material is expected to become permanently frozen through conduction, and that only the upper surficial material will be subject to seasonal freezing and thawing. The frozen material is anticipated to form a barrier for acid-forming reactions due to unavailability of liquid water, in turn limiting the potential for formation and transport of sulphide oxidation products. It is expected that a permanently frozen impermeable subsurface layer will form in the lower layer of the waste rock storage area within the first few years of emplacement. Under the current mine plans, the total capacity of the waste rock stockpiles is expected to be on the order of 640 million tonnes.

The waste rock dump surface runoff management system includes the use of berms around the stockpile perimeter and surface water sedimentation ponds. The berm system is designed to allow non-contact (clean) water to be diverted away from the waste rock dump to minimize the volume of water that comes into contact with the waste rock (contact water). A temporary sedimentation pond measuring 28 m x 23 m x 2 m (1,288 m^3 capacity) was constructed in 2014 to capture contact surface water from the waste rock pile. Wastewater (i.e., effluent) accumulated in the settling pond was treated for solids removal via pond-based settling. Upon reaching 75% (or 0.5 m freeboard) capacity, effluent from the settling pond was pumped overland to a Final Discharge Point (FDP) located approximately 475 m east of the settling pond, referred to as Station MS-08. A permanent sedimentation pond designed for the long-term capture and treatment of contact water originating from the waste rock pile was constructed in spring 2016. Station MS-08 will also serve as the planned point of discharge for the permanent sedimentation pond. At Station MS-08, mine effluent is discharged overland (i.e., no defined channel) and flows into an intermittent, unnamed tributary to the Mary River approximately 2 km east to northeast of the discharge point (Figure 2.1). From this confluence, the unnamed tributary flows south approximately 3.3 km before discharging into Mary River.



Water Quality Monitoring Station
Final Discharge Point (FDP)
Temporary Sedimentation Pond Location
Mary River Cascade Barrier
Overland Effluent Path
Mary River Project
QMR2 Quarry
Exploration Camp
Mine Site
Open Pit
Airstrip
Waterbody
Watercourse
Tote Road
Contours (20 m)
Water Flow Direction

N W E S

0 0.75 1.5 3
Kilometers

MAP INFORMATION
Map Projection: UTM Zone 17N NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.
Creation Date: July 2016
Project No.: 2569

Figure 2.1 : Baffinland Effluent Discharge Location and MMER Receiving Environment Water Quality Monitoring Station Locations

minnow environmental inc.

Because the Mary River Project ore is very high-grade, a process plant (or mill) is not required for ore processing. Thus, no tailings material is generated, and no tailings pond is required, at the Mary River Project site.

2.2 Effluent Management, Quality and Mixing

2.2.1 Applicable Regulations

As per MMER requirements, Baffinland conducted weekly monitoring of the MS-08 effluent for deleterious substances and pH and monthly effluent acute toxicity testing throughout the period of discharge in 2015. Effluent was released for only a short portion of the year (i.e., July and August) in 2015, and therefore effluent characterization and effluent sub-lethal toxicity testing were conducted at the minimum frequency of not less than 30 days apart stipulated by the MMER (Government of Canada 2016). The results of this sampling were reported to Environment Canada on a quarterly (effluent monitoring and acute toxicity) and annual basis (effluent characterization, sublethal toxicity). In addition to the MMER, effluent discharge limits applicable to the Mary River Project include a Type "A" Water Licence (No. 2AM-MRY1325) for water use and disposal issued under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* by the Nunavut Water Board. Under this licence, final effluent quality must meet limits for pH, arsenic, copper, lead, nickel, zinc and total suspended solids concentrations, have no visible oil and/or grease sheen, and be non-acutely lethal (rainbow trout and *Daphnia magna* tests; Table 2.1). Monitoring of several other parameters must also be conducted monthly during the open water (summer) period (Table 2.1).

2.2.2 Effluent Volume and Quality

Effluent from the waste rock settling pond (MS-08) is discharged overland into an unnamed tributary of Mary River, henceforth referred to as Mary River Tributary-F (Figure 2.1). A total of 2,217 cubic meters (m^3) of effluent was discharged at Station MS-08 during July and August, 2015 (Figure 2.2). Over this duration, effluent was discharged intermittently on an as-needed basis (i.e., upon the temporary sedimentation pond reaching 75%, or 0.5 m, of freeboard capacity), with discharge occurring on a total of 16 days since the mine became subject to the MMER (Figure 2.2). On average, during periods of discharge, approximately 148 m^3 was discharged daily at Station MS-08, with the maximum daily discharge totalling 293 m^3 over the initial year of mine operation (i.e., 2015; Figure 2.2).

Final effluent quality for the Station MS-08 discharge met MMER monthly mean limits for deleterious substances and pH since becoming subject to MMER in 2015 (Table 2.2; Appendix Table A.1). In addition, mercury concentrations in the mine final effluent have been below the EEM fish tissue survey trigger concentration of 0.10 µg/L (Table 2.2; Appendix Table A.1).

Table 2.1: Applicable MMER and ECA effluent monitoring requirements and limits for the Mary River Project.

Variables		Units	MMER[a,c]		Type A Water Licence[b,c]	
			Monthly mean	Grab Sample	Frequency[d]	Maximum Concentration in Grab Sample
Field Measures	pH	pH units	6.0 - 9.5	6.0 - 9.5	w	6.0 - 9.5
	conductivity	uS/cm	m	m	-	-
Laboratory Analytes	total suspended solids	mg/L	15	30	w	15
	hardness	mg/L	m	m	-	-
	alkalinity	mg/L	m	m	-	-
	total ammonia	mg/L	m	m	-	-
	nitrate	mg/L	m	m	-	-
	aluminum	mg/L	m	m	-	-
	arsenic	mg/L	0.5	1	w	0.5
	cadmium	mg/L	m	m	-	-
	copper	mg/L	0.3	0.6	w	0.3
	iron	mg/L	m	m	-	-
	lead	mg/L	0.2	0.4	w	0.2
	mercury	mg/L	m	m	-	-
	molybdenum	mg/L	m	m	-	-
	nickel	mg/L	0.5	1	w	0.5
	selenium	mg/L	m	m	-	-
	zinc	mg/L	0.5	1	w	0.5
	oil and grease	mg/L	-	-	w	no visible sheen
Biological Tests	acute toxicity: rainbow trout	%	no greater than 50% mortality in 100% effluent		mth	Not acutely toxic
	acute toxicity: *Daphnia magna*	%			-	-

[a] Metal Mining Effluent Regulations (MMER) issued under Canada's *Fisheries Act*

[b] Type A Water Licence issued under the *Nunavut Waters and Nunavut Surface Rights Tribunal Ac* t by the Nunavut Water Board.

[c] m denotes parameter that must be monitored, but has no specified limit

[d] monitoirng frequencies include weekly (w), monthly (mth) and bimonthly (b-mth)

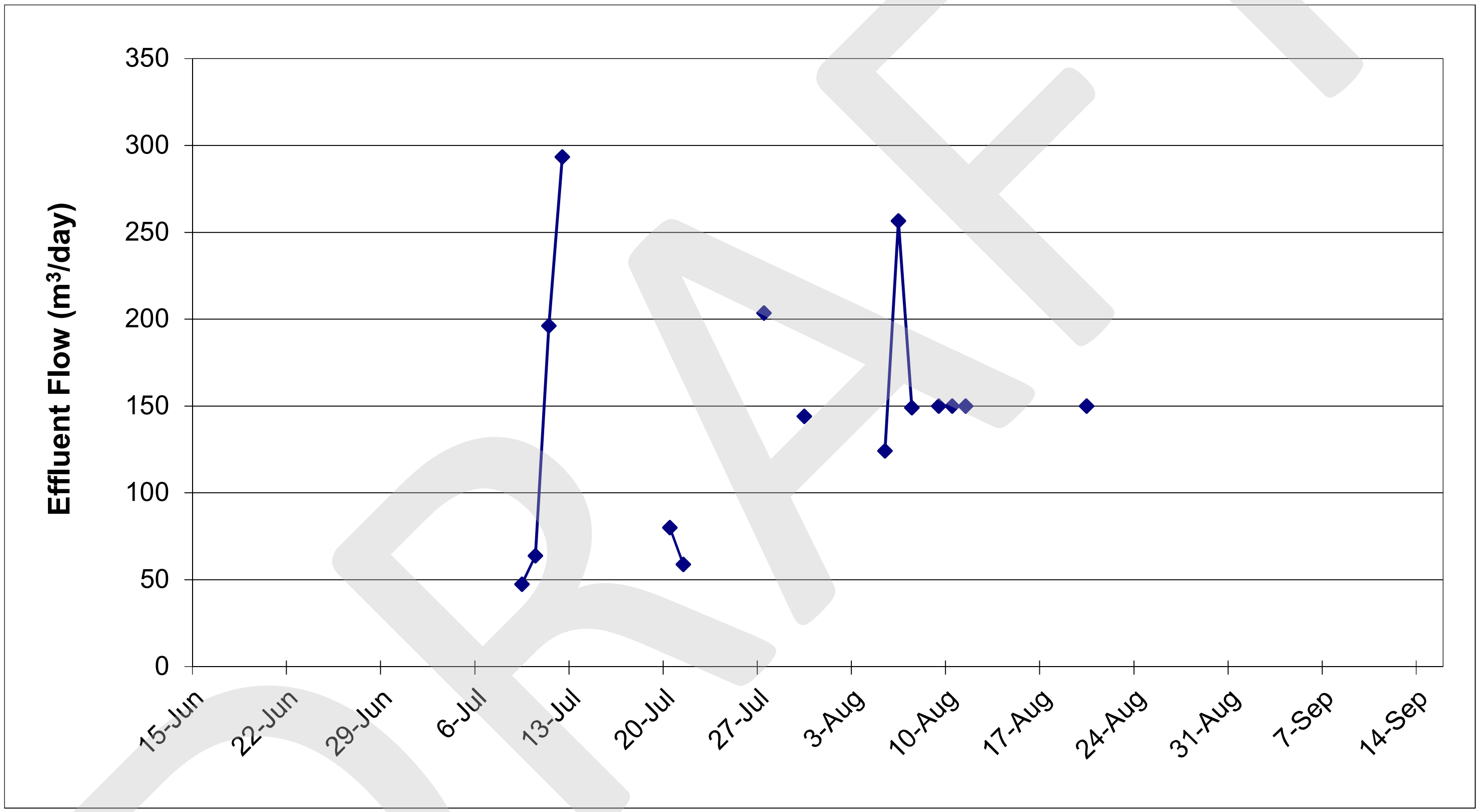


Figure 2.2: Mary River Project effluent discharge (Stn. MS-08; m^3/day) during the 2015 open-water period.

Table 2.2: Summary of routine MMER and effluent monitoring data (Station MS-08)[a] for the Mary River Project Phase 1 EEM period, 2015.

	Variable	Units	MMER Monthly Mean Limit[d]	2015 July (n = 3)	2015 August (n = 2)
Routine Monitoring[b]	Volume (m^3/day)	m^3	-	1,088	1,130
	pH	pH units	6.0 - 9.5	7.51	7.61
	TSS	mg/L	15	11.0	7.2
	Arsenic (As)	mg/L	0.5	0.0004	0.0001
	Copper (Cu)	mg/L	0.3	0.0012	0.0013
	Lead (Pb)	mg/L	0.2	0.00059	0.00019
	Nickel (Ni)	mg/L	0.5	0.012	0.023
	Zinc (Zn)	mg/L	0.5	0.0037	0.0033
	Radium-226	Bq/L	1	<0.010	0.013
Acute Toxicity	Rainbow Trout[e]	% Pass (N)[1]	NL	NL	NL
	Daphnia magna[e]	% Pass (N)[1]	NL	NL	NL
Effluent Characterization[c]	Conductivity	µS/cm	-	948	1,320
	Hardness	mg/L (as $CaCO_3$)	-	465	724
	Alkalinity	mg/L (as $CaCO_3$)	-	32	44
	Ammonia (NH_4^+)	mg/L	-	0.40	0.47
	Nitrate (NO_3)	mg/L	-	3.8	4.9
	Aluminum (Al)	mg/L	-	0.312	0.117
	Cadmium (Cd)	mg/L	-	0.00007	0.00016
	Iron (Fe)	mg/L	-	0.474	0.329
	Mercury (Hg)	mg/L	0.00010	<0.00001	<0.00001
	Molybdenum (Mo)	mg/L	-	0.0002	0.0003
	Selenium (Se)	mg/L	-	0.0014	0.0026

[Grey box] Indicates monthly mean value that exceeds applicable limit for deleterious substances and/or pH *or* sample concentration that exceeded fish usability assessment trigger value *or* acute toxicity test failure based on individual test result.

[a] In cases where parameter concentrations were less than Method Detection Limits (MDL), the MDL was used for calculation of mean values.

[b] Deleterious substances and pH as defined under Schedule 4 of the MMER (Government of Canada 2016).

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MMER (Government of Canada 2016).

[d] Limits indicated refer to maximum authorized monthly mean concentrations as per Schedule 4 of the MMER (Government of Canada 2016) except the limit for mercury, which has been included as a fish usability assessment trigger limit based on a grab sample concentration of 0.0001 mg/L.

[e] Indicates that all acute toxicity tests must 'pass' test criteria (i.e., an effluent at 100% concentration that kills less than 50% of test organisms over a 96-hour [rainbow trout] or 48-hour [D. magna] period when tested in accordance with Environment Canada protocols). "NL" refers to a non-lethal 'pass' test result, "L" refers to a lethal 'failure' test result.

Final effluent from Station MS-08 was also non-acutely lethal to rainbow trout (96 hr pass/fail) and *Daphnia magna* (48 hr pass/fail) in all tests conducted since the mine became subject to the MMER.

2.2.3 Effluent Sublethal Toxicity

Sublethal toxicity tests conducted on the Station MS-08 final effluent in 2015 indicated no effects on fathead minnow (*Pimephales promelas*) survival and growth, *Ceriodaphnia dubia* survival and reproduction, or green algae (*Pseudokirchneriella subcapitata*) growth (Table 2.3). Effects on duckweed (*Lemna minor*) frond weight and production occurred at effluent effect concentrations of 2.4% and 8.5%, respectively (Table 2.3).

Table 2.3: Sublethal toxicity test results[a] (as % effluent) for the Mary River Project Station MS-08 mine final effluent, 11 August 2015.

Test Organism	Test Endpoint	Test Result (% Effluent)
Fathead Minnow	Survival LC_{50}	>100
	Growth IC_{25}	>100
Ceriodaphnia dubia	Survival LC_{50}	>100
	Reproduction IC_{25}	>100
Lemna minor	Dry Weight IC_{25}	2.6 (1.3 - 4.2)
	Frond Increase IC_{25}	8.5 (6.0 - 11.7)
Pseudokirchneriella subcapita	Growth IC_{25}	>91

[a] LC_{50} represents the effluent concentration causing 50% mortality among exposed organisms; IC_{25} represents the effluent concentration at which a 25% inhibition/reduction in endpoint was observed among effluent-exposed organisms relative to the control group.

2.2.4 Effluent Dilution

Estimates of effluent dilution in the mine receiving environment were conducted using the 2015 final effluent discharge data together with watershed discharge rates pro-rated using data from six Mary River Project mine site stream gauging stations over the period from 2006 to 2014. Based on estimated annual average flow by watershed and average daily effluent discharge (i.e., 148 m^3/day during periods of discharge; see Section 2.2.2), the MS-08 effluent was estimated to constitute an average of 1.3% and 0.03% of flow during periods of effluent discharge in 2015 (i.e., July and August) at the effluent stream confluence with Mary River Tributary-F and Mary River, respectively (Figure 2.3). Assuming the maximum daily effluent volume discharged in 2015 (i.e., 293 m^3 on July 12, 2015), the MS-08 effluent was estimated to constitute approximately 2.5% and 0.065% of flow at the effluent stream confluence with Mary River Tributary-F and Mary River, respectively, during the July-August period of

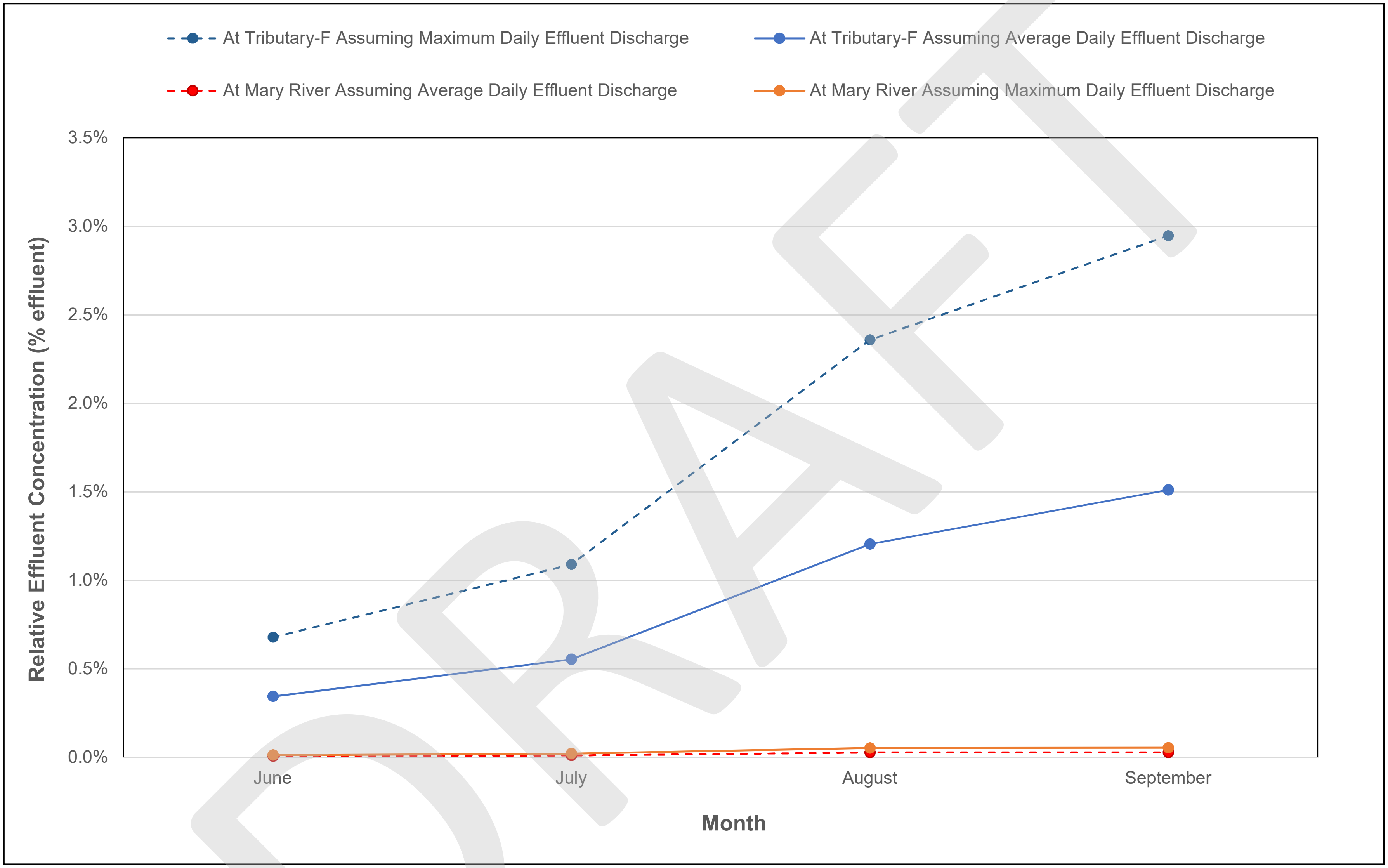


Figure 2.3: Estimated effluent concentrations by month at Mary River Tributary-F and Mary River assuming 2015 average and maximum daily effluent discharge (148 m^3 and 293 m^3, respectively) and average monthly stream flow (pro-rated using hydrological stream gauge data).

discharge in 2015, assuming average regional monthly flow conditions on the day of maximum discharge (Figure 2.3).

Extrapolation of the 2015 effluent sublethal toxicity effect concentration data and the estimated proportion of Station MS-08 effluent in the mine receiver suggested no effects on any of the laboratory test organisms, including duckweed, were likely to occur in the mine receiver under average flow conditions (i.e., minimum effect concentrations were greater than 2% effluent, which was greater than the average proportion of mine effluent at Mary River Tributary-F immediately at the confluence with mine effluent).

2.3 Receiving Environment Biophysical Characteristics

The Mary River Project EEM effluent-exposed study area includes an Unnamed Tributary of the Mary River (herein referred to as Mary River Tributary-F) and Mary River downstream of the Station MS-08 effluent discharge (Figure 2.1). Areas of Mary River Tributary-F and Mary River upstream of the confluence with effluent-exposed waters will serve as reference areas for each of these effluent-exposed study areas, respectively (Figure 2.1). General climatology, meteorology, physiography and terrestrial vegetative community information, as well as hydrology and key habitat attributes, water quality information and biological community characteristics of the effluent-exposed watercourses are summarized and, where applicable, compared to reference conditions, in the sections below.

2.3.1 Climate and Meteorological Conditions

The Mary River Project is situated in the Northern Arctic ecozone, which is characterized by long, cold winters experiencing near-continuous darkness from November through February, and short, cool summers with near-continuous daylight from May through August (Ecological Stratification Working Group 1996). During winter (December through February), the mean daily air temperature is approximately -30˚C, and the occurrence of fine powdery snow often results in restricted visibility under blowing snow conditions. Rivers and creeks, with the exception of the very largest systems, freeze entirely during winter. The ground is typically covered with snow from September to June, and although frost-free conditions generally occur from June to August, periods of snow can occur throughout the year. During summer (June through August), the mean daily air temperature is approximately 6˚C near the mine site. In 2015, the annual average temperature at Mary River Project was -13˚C, which was generally consistent with a long term average of -16˚C for the Northern Baffin Island region.

Mary River Project area climate is semi-arid, with the amount of precipitation ranging from 100-400 mm annually and generally occurring as snow during the winter, spring and fall seasons. Historically, mean annual precipitation of approximately 200 mm has occurred at regional climate stations located closest to the Mary River Project (e.g., Pond Inlet, Hall Beach), and these locations are believed to closely reflect precipitation at the mine site. Highest monthly amounts of precipitation (approximately 30 mm), occurring mostly as rain, occur during July and/or August due to maritime influences from the south. Greatest amounts of snow, averaging approximately 30 cm, are typically received in October for the Mary River Project area. As a consequence of vigorous wind transport, a significant portion (5 % - 50 %) of Arctic snow cover is estimated to return to the atmosphere by sublimation of the wind-borne snow particles.

Wind records for the Mary River Project site indicate southeast winds occur most frequently (15.5 % of the time) followed by winds from the east-southeast (9 % of the time). On average, light winds (i.e., 1.1 to 5.8 km/hr) and calm winds (i.e., 0.0 to 1.1 km/hr) occur most frequently (26% and 22% of the time, respectively), and strong (i.e., 39 to 50 km/hr) and near-gale (i.e., 50 to 62 km/hr) winds occur occasionally (5% and 1.4% of the time, respectively) at the Mary River Project site.

2.3.2 Regional Geology

The North Baffin Island region and Mary River Project area lies within the Committee Belt, a granite-greenstone terrain with intermixed rift basin sediments and volcanic rocks, bounded by Precambrian mountains to the east and Palaeozoic lowland plateaus to the west. The belt lies within the Churchill Province, extending from Baker Lake to Greenland, and is divided into five main assemblages: the Archean, the Mary River Group, the Piling Group, the Bylot Supergroup, and the Turner Cliffs-Ship Formation (Aker Kvaerner 2008). The Mary River Project iron ore deposits are located within an assemblage of Late-Archean metasedimentary to metavolcanic rocks that have been folded and preserved in greenstone belts, referred to as the Mary River Group. The Mary River Group greenstone belts are present as fragmented remnants stretching from Bylot Island (northwest of Baffin Island) south to Eqe Bay (south-central Baffin Island), and can reach a thickness of approximately 4,000 m. Primary sequences within the Mary River Group consist of a lower series of metavolcanic rocks and an upper series of turbidite pelitic-greywacke. Quartzite, conglomerate, minor marble, and volcanic breccia units can also occur within the belts. Iron formations occur in varying thicknesses discontinuously within the Mary River Group meta-sedimentary units, but are typically not present in economically extractable thicknesses or configurations except at the Mary River Project area. High-grade iron ore deposits at Mary River Project occur as a hematite (Fe_2O_3), magnetite (Fe_3O_4) and specularite mineralized zone interlayered with thin bands of chlorite-actinolite schist, staurolite-garnet-mica schist, amphibolite and banded iron formation across the strike width, with this assemblage occurring at thicknesses as great as 400 m.

The surficial geology of the area generally consists of thick unconsolidated deposits of glacial till that lie relatively undisturbed on slopes, hillsides and valley floors. Locally abundant Holocene glacio-lacustrine sediments, alluvial sediments (alluvial deposits), marine and glacio-marine deltaic sediments and end moraine till comprise the majority of surficial material, although occasional outcrops of pre-Quaternary bedrock and sedimentary rock formations often occur as high ridges, escarpments and canyons. The Holocene glacio-lacustrine sediments typically range from 1 to 10 m thick, and consist of proglacial sand and gravel outwash that commonly form braided floodplains, terraces, and fans. In addition, early Holocene and Wisconsinan till materials occur as veneers and blankets. Discontinuous till veneers, approximately 0.5 to 2 m thick, are often reinforced with boulders due to subglacial meltwater washing or permafrost processes that, in turn, restrict outcrop exposures. Till blankets 2 to 10 m thick undulate with drumlins and ribbed moraines. The Mary River Project site area is located in a major glaciofluvial outwash deposit occurring as a “U’ shaped valley. In addition to the glaciofluvial deposits, direct glacial deposition consisting of kames, moraines, and eskers occurs in and around the southeastern portion of mine camp, near Sheardown Lake. The outwash valley occurs as a relatively flat plane with little local relief, with key exceptions including adjacent to bodies of water, esker deposits and valley edges.

Permafrost coverage is continuous to a depth of 400 - 700 metres at the Mary River Project area (KP 2010). The active permafrost layer is 1 to 2 m deep, but may be greater in areas of loose sandy soil and at the edges of lakes or ponds, or less in areas with significant layer of wet organics at surface. In general, drainage in the region is poor on the till plains, and as a result, vast areas may be water saturated during the snow melt period, particularly on high plateaus. In contrast, alluvial benches and kame terraces of sand and coarse gravel, typically associated with canyon walls and/or stream valleys along pre-Quaternary (Precambrian) mountains, are generally well drained.

2.3.3 Physiography, Surficial Soils and Vegetation

The Mary River Project is situated near the border of the Melville Peninsula Plateau and Baffin Island Uplands ecoregions. Topography of the area is characterized by broad, gently warped, old erosion surface composed of crystalline Precambrian rocks, which can be shallowly etched by erosion along joint systems and zones of weakness, particularly within the Baffin Island Uplands ecoregion. At the Mary River Project mine site, Deposit No. 1 (Nulujaak Mountain) rises quickly to 679 meters above sea level (masl) from the fairly flat and sandy outwash plain at which the mine camp is located, approximately 188 masl. Nulujaak Mountain forms part of a northwest-southeast trending ridge which separates mountainous, rolling hill, and high plateau areas formed by sedimentary deposits to the east, and relatively poorly drained, undulating outwash plains characterized by relatively flat areas and/or low rolling hills to the west.

Regionally, soil formation is controlled and limited by year-round low soil temperatures, low precipitation rates and near-surface permafrost. Soil formation occurs in the thin layer overlying the permafrost that is subject to seasonal thawing (i.e., the “active” layer). The thickness of the active layer varies substantially across the region with topography, depth to bedrock, and vegetative or water cover, but is typically between 1 to 2 m thick in the Mary River Project area depending on the local soil cover (Veldhuis 2010). In locations where well drained, dry sand and gravels are present, the permafrost thaw depth can extend to 2 to 4 m depth. Soils at the Mary River Project area are primarily comprised of cryosols (permanently frozen soils or soils with permafrost within 1–2 m of soil surface) and brunisols (soils with weak B horizon development; Veldhuis 2010). In general, soils near the mine show weakly developed horizons, general absence of organic material accumulation, and low nutrient levels (Veldhuis 2010). Fine- to medium-textured soil materials are generally cryoturbated, and patterned ground phenomena related to permafrost and freeze-thaw cycling are commonly observed (e.g., ice wedge patterned ground, pingos, palsas, massive ground ice, thermokarst, and solifluction mass wasting). Soil development is discontinuous, with turbic cryosols occurring on sparse, thin, colluvial and moraine deposits, or on hummocky, thin sandy moraine deposits representing the dominant soils. Bedrock outcroppings are also common.

The vegetation community of the Mary River Project area, extending from Milne Port in the north to Steensby Port in the south, was extensively characterized during mine baseline studies (Baffinland 2012). Within this area, 163 vascular plant species were identified, which was similar to 147 species identified by Duclos et al. (2006) for nearby Sirmilik National Park. None of the species identified represented endangered, threatened or special concern species (COSEWIC 2015). In general, vegetative cover is discontinuous and sparse in the area (e.g., 15% coverage), and is dominated by low growing herbs and shrubs such as saxifrages (*Saxifraga* spp.), *Dryas* sp., willows (*Salix* spp.) and arctic poppy (*Papaver laestadianum*), lichens, and foxtail (*Alopecurus* spp.), wood rush (*Luzula* spp.), *Kobresia* sedge and other graminoids, in dry habitats. Saturated habitats can have a continuous cover of sedge (*Carex* spp.), cottongrass (*Eriophorum* spp.), rushes and mosses. Plant growth and diversity is generally greater along sheltered valleys and river banks where moisture and nutrients are more abundant. Upland areas tend to have more limited vegetation due to harsher environmental conditions during most of the year.

2.3.4 Hydrological Description

In 2015, treated effluent released from the Mary River Project temporary sedimentation pond at Station MS-08 was discharged overland (i.e., no defined channel), and flowed east north-east approximately 270 m over boulder-cobble till material before meeting a defined depression. The gradient of this depression continued eastward, eventually forming a clearly defined channel approximately 970 m down gradient of the MS-08 final discharge point. In August 2015, continuous surficial flow (i.e., areas without sections of underground/interstitial) from natural sources was not observed up gradient of the defined channel. From this point, the channel flows southeast approximately 740 m before discharging into Mary River Tributary-F. From this confluence, Mary River Tributary-F flows south approximately 3.3 km before discharging into Mary River. Mary River Tributary-F is non-fish bearing, likely as a result of the combination of complete freeze-up during winter (i.e., lack of any overwintering habitat) and high gradient limiting fish colonization during the ice-free period. Thus, Mary River represents the initial fish bearing waters reached by mine effluent, and was proposed as the Mary River Project's receiving water body for MMER water quality monitoring.

In the Mary River Project area, surface water (stream) flow usually begins in early to mid-June as air temperatures climb above freezing, and terminates in late September to early October with freeze-up. Infiltration, evaporation and transpiration are very limited in the mine receiving environment as a result of shallow permafrost, cool temperatures, minimal vegetative cover and high gradient, resulting in almost instantaneous flow response and relatively high proportion of runoff associated with rain events. In larger watersheds, peak instantaneous flows are typically produced by snowmelt during spring freshet. In smaller watersheds (less than a few hundred square kilometres), rainfall (or rain on snow) may produce the largest flow events, which can occur at any time during the non-freeze period.

Hydrologic stream gauge (flow) data has been routinely collected by Baffinland since 2006 at six watercourses within the Mary River Project study area (Appendix Figure A.1). These data indicate highest seasonal flows are typically associated with snowmelt freshet in June (Appendix Table A.2). The average of mean monthly discharge for Mary River Tributary-F and Mary River near the Mary River Tributary-F confluence, pro-rated using the Baffinland hydrological station data, indicate annual flow of approximately 0.26 m^3/s (average high of 0.50 m^3/s in June) and 14.3 m^3/s (average high of 27 m^3/s in June), respectively, under average discharge conditions during the open-water period (Figure 2.4).

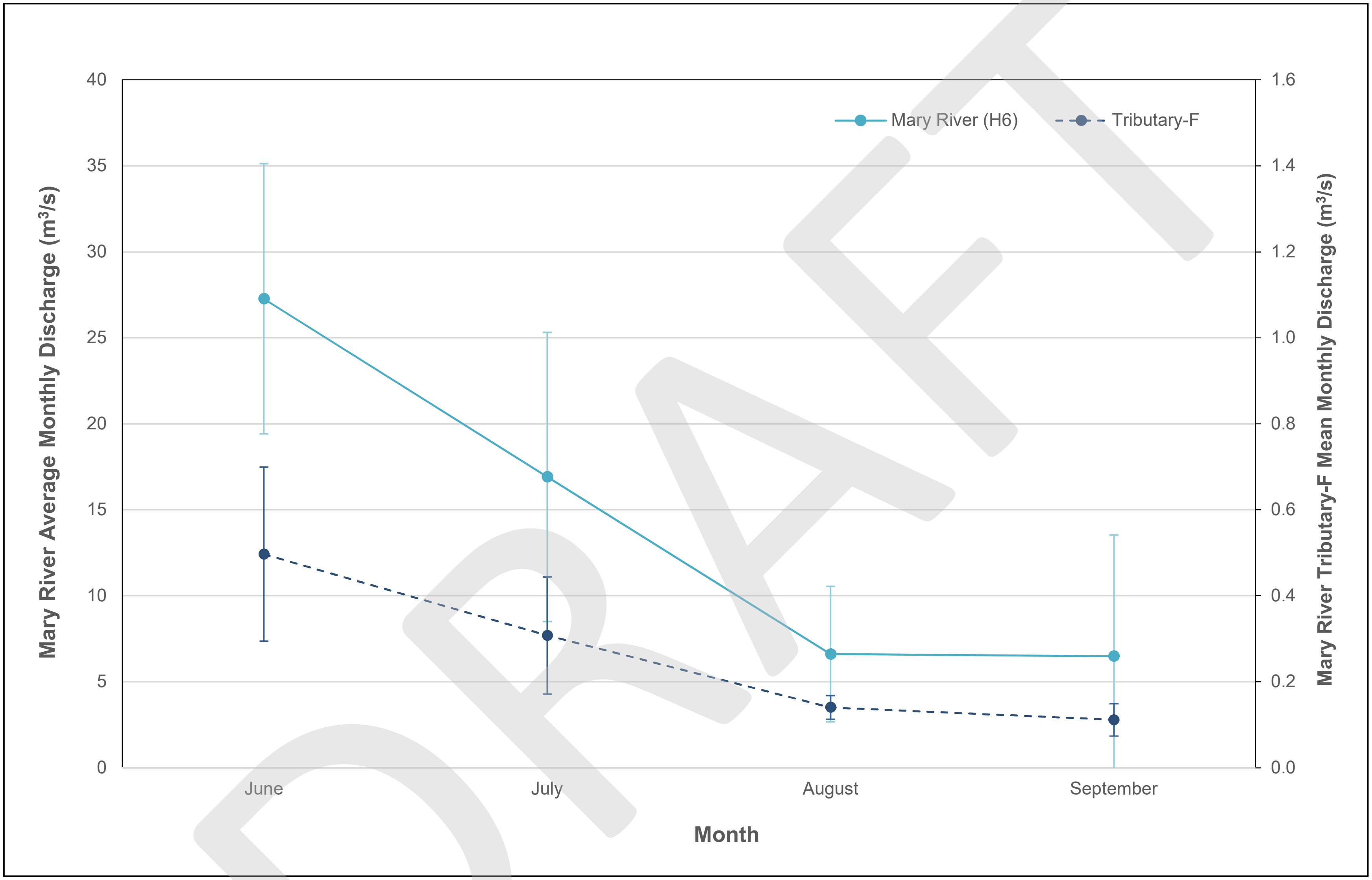


Figure 2.4: Mean monthly effluent discharge for Mary River and Mary River Tributary-F at mine effluent confluence points estimated using Mary River Project hydrological (stream gauge) stations, 2006 - 2015 data.

2.3.5 Habitat Description

Mary River Tributary-F originates approximately 2.8 km upstream of the confluence with the mine effluent stream from Station MS-08 (Figure 2.1). A number of small first- and second-order streams feed into Mary River Tributary-F along its 6.1 km length, although individually, none of these feeder streams represent a dominant source of flow. The lower 3.3 km of Mary River Tributary-F represents the mine effluent-exposed area. Mary River Tributary-F is a relatively high gradient (i.e., average gradient of 5.2%), seasonally-flowing riverine system characterized mainly by meandering, riffle-cascade stream morphology with minor amounts of pool and run habitat (Photo Plate 2.1). The wetted and bankfull width of Mary River Tributary-F was approximately 2.1 and 12 m, respectively, during field reconnaissance conducted in August 2015. Although pools greater than 0.5 m deep exist in the Mary River Tributary-F system, run-riffle areas with an average water depth of approximately 0.2 m under summer flow represents the predominant habitat. Natural substrate of Mary River Tributary-F is comprised mainly of boulder and large cobble (Photo Plate 2.1), with small cobble and/or gravel substrates present in low abundance. In-stream vegetation is represented only by limited periphyton growth.

Mary River originates to the north and west of the Mary River Project (Figure 2.1). The portion of Mary River located downstream of the Mary River Tributary-F confluence represents the mine effluent-exposed area. Mary River is a moderate gradient (i.e., average gradient of 0.9%), seasonally flowing riverine system based on the Cowardin et al. (1979) classification. The river is characterized mainly by meandering riffle-run morphology, with some rapid/cascade habitat that includes an approximately 20 m high natural cascade located approximately 400 m upstream of the confluence with Mary River Tributary-F. The wetted channel width of Mary River decreases from an average of approximately 47 m to 19 m from upstream to downstream of this cascade, respectively, under summer flow conditions, reflecting the occurrence of a deep gorge below the cascade (Photo Plate 2.1). Commensurate with these changes in wetted width, average stream depth and water velocity are lower upstream of the cascade than downstream (0.30 and 0.48 m deep, and 0.43 and 0.85 m/s water velocity, respectively, in August 2015; Appendix Table A.3). Mary River is represented almost entirely by unconsolidated bottom and shore classes based on Cowardin et al. (1979) categorization. Cobble-boulder is the predominant substratum (60% and 30% of stream surface area, respectively), with similar substrate composition observed upstream and downstream of the cascade (Appendix Table A.3). Aquatic vegetation, represented solely by periphyton, occurs sparsely on approximately 25% of substrate in the Mary River.

i) Overland effluent discharge pathway near Station MS-08.

ii) Mary River Tributary-F.

iii) Mary River upstream of Tributary-F and the cascade barrier.

iv) Mary River downstream of Tributary-F and cascade barrier.

Plate 2.1: Photographs of the effluent pathway, Mary River Tributary-F and Mary River, mid-July 2015.

2.3.6 Receiving Environment Water Quality

Under Mary River Project EEM obligations, receiving environment water quality monitoring for deleterious substances (as defined under MMER), pH and other required EEM analytes (see Environment Canada 2012) was conducted at Mary River effluent-exposed and reference stations (Stations MS-08-DS and MS-08-US, respectively) in 2015 commensurate with the discharge of effluent. Because effluent was released for only a short portion of the year (i.e., July and August) in 2015, receiving environment water quality monitoring was conducted at a frequency higher than the minimum of not less than 30 days apart stipulated by the MMER (Government of Canada 2016) to provide a greater number of data points for the evaluation of any effluent-related influence on water quality. Water quality monitoring for all EEM analytes, as well as dissolved metals, total dissolved solids (TDS), turbidity, organic carbon, total phosphorus, chloride and sulphate is also conducted in lower Mary River Tributary-F (Station FO-01), at four Mary River mine-exposed stations, and five Mary River reference stations three times a year during the open-water season (i.e., June-July-August) to satisfy territorial monitoring (Type A Water Licence) requirements.

Water quality at Mary River MMER monitoring stations showed no differences in parameter concentrations downstream and upstream of the Mary River Tributary-F confluence (Table 2.4). Despite average hardness, conductivity, alkalinity and sulphate concentrations greater than 50% higher, and average nitrate concentrations greater than 4.5 times higher, at Mary River Tributary-F compared to the Mary River Upstream reference station, no substantial differences in water quality were observed between the downstream and upstream stations on Mary River in August 2015 during routine monitoring conducted by Baffinland[1] (Appendix Table A.4). Collectively, these results suggested no substantial effluent-related influences on water quality at Mary River during the periods of effluent discharge. Total aluminum concentrations were above respective Canadian Water Quality Guidelines for the protection of aquatic life (CWQG; CCME 1999, 2016) at Mary River Tributary-F and all Mary River stations, and average total iron concentrations were above respective CWQG at Mary River upstream stations. However, because the Mary River downstream station total aluminum and iron concentrations were lower than, or similar to, those at stations located upstream, sources of these metals appeared to be unrelated to the mine effluent.

[1] Differences in concentrations of barium, beryllium, selenium and thallium between Mary River stations reflected differences in laboratory method detection limits.

Table 2.4: Routine receiving environment water quality monitoring data collected at Mary River MMER reference (MS-08-US) and effluent-exposed (MS-08-DS) stations, Mary River Project, 2015.

	Variable	Units	CWQG [a]	MS-08-US Mary River Reference		MS-08-DS Mary River Effluent-Exposed	
				20-Jul-15	11-Aug-15	20-Jul-15	11-Aug-15
Routine Monitoring [b]	pH	pH units	6.0 - 9.5	7.98	8.16	7.97	7.95
	TSS	mg/L	-	<2.0	<2.0	<2.0	<2.0
	Arsenic (As)	mg/L	0.005	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)	mg/L	0.002	0.0008	0.0011	0.0008	0.0011
	Lead (Pb)	mg/L	0.001	0.00022	0.00014	0.00019	0.00013
	Nickel (Ni)	mg/L	0.025	<0.00050	<0.0010	<0.00050	<0.0010
	Zinc (Zn)	mg/L	0.030	<0.0030	<0.0030	<0.0030	<0.0030
	Radium-226	Bq/L	-	<0.0100	<0.0100	<0.0100	<0.0100
Effluent Characterization [c]	Conductivity	µS/cm	-	75	-	78	-
	Hardness	mg/L (as $CaCO_3$)	-	36	68	38	71
	Alkalinity	mg/L (as $CaCO_3$)	-	36	65	38	66
	Ammonia (NH_4^+)	mg/L	-	<0.050	<0.050	<0.050	<0.050
	Nitrate (NO_3)	mg/L	13	<0.020	<0.020	<0.020	<0.020
	Aluminum (Al)	mg/L	0.100	0.390	0.233	0.383	0.227
	Cadmium (Cd)	mg/L	0.00012	<0.000010	<0.000010	<0.000010	<0.000010
	Iron (Fe)	mg/L	0.3	0.208	0.159	0.187	0.144
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.000010	<0.000010	<0.000010
	Molybdenum (Mo)	mg/L	0.073	0.0002	<0.00050	0.0002	<0.00050
	Selenium (Se)	mg/L	0.001	<0.0010	<0.000050	<0.0010	<0.000050
Other Parameters	Turbidity	NTU	-	-	4.4	-	2.0
	Total Dissolved Solids	mg/L	-	-	78	-	80
	Dissolved Organic Carbon	mg/L	-	-	<1.0	-	<1.0
	Total Organic Carbon	mg/L	-	-	<1.0	-	<1.0
	Total Kjeldahl Nitrogen	mg/L	-	-	0.21	-	<0.15
	Total Phosphorus	mg/L	0.02	-	0.0058	-	0.0051
	Fluoride (F)	mg/L	-	-	0.025	-	0.024
	Chloride (Cl)	mg/L	120	-	3.81	-	3.72
	Sulfate (SO4)	mg/L	218	-	3.26	-	3.19
	Antimony (Sb)-Total	mg/L	0.02	<0.00010	-	<0.00010	-
	Barium (Ba)-Total	mg/L	-	0.0076	-	0.0076	-
	Beryllium (Be)-Total	mg/L	0.011	<0.00050	-	<0.00050	-
	Bismuth (Bi)-Total	mg/L	-	<0.00050	-	<0.00050	-
	Boron (B)-Total	mg/L	-	<0.010	-	<0.010	-
	Calcium (Ca)-Total	mg/L	-	7.5	15.1	7.9	14.8
	Chromium (Cr)-Total	mg/L	0.0089	<0.00050	-	<0.00050	-
	Cobalt (Co)-Total	mg/L	-	<0.00010	-	<0.00010	-
	Lithium (Li)-Total	mg/L	-	<0.0010	-	<0.0010	-
	Magnesium (Mg)-Total	mg/L	-	4.23	8.38	4.44	8.44
	Manganese (Mn)-Total	mg/L	0.935	0.0019	0.0020	0.0022	0.0018
	Potassium (K)-Total	mg/L	-	0.93	1.11	0.94	1.10
	Silicon (Si)-Total	mg/L	-	1.40	-	1.39	-
	Silver (Ag)-Total	mg/L	0.00025	<0.000010	-	<0.000010	-
	Sodium (Na)-Total	mg/L	-	1.11	2.46	1.11	2.43
	Strontium (Sr)-Total	mg/L	-	0.0077	-	0.0077	-
	Thallium (Tl)-Total	mg/L	0.0008	<0.00010	<0.000010	<0.00010	<0.000010
	Titanium (Ti)-Total	mg/L	0.00010	0.012	-	0.011	-
	Uranium (U)-Total	mg/L	0.015	0.0008	0.0032	0.0008	0.0031
	Vanadium (V)-Total	mg/L	0.006	<0.0010	-	<0.0010	-

(Grey shading) Indicates value above applicable Canadian Water Quality Guideline for the protection of aquatic life.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 1999, 2016).

[b] Deleterious substances and pH as defined under Schedule 4 of the MMER (Government of Canada 2016) applicable to effluent quality

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MMER (Government of Canada 2016) applicable to effluent quality.

2.3.7 Benthic Invertebrate Community

Benthic invertebrate community sampling was conducted downstream (effluent-exposed; EO series stations) and upstream (reference; GO series stations) of the Mary River Tributary-F confluence on Mary River in 2015 as part of the Mary River Project aquatic effects monitoring program (Minnow 2016; Appendix Tables A.5 and A.6). Benthic invertebrate sampling for the Mary River Project aquatic effects monitoring program follows EEM recommendations in terms of replication (i.e. five stations per study area), mesh size (500 µm) and statistical approach, with shallow erosional riffle-run habitat targeted for field sampling. This study, and others, suggested that benthic invertebrate communities of the Mary River Project area lotic environments are naturally dominated by non-biting midges (family Chironomidae; e.g., ≥ 80 - 90% of community), with crane flies (family Tipulidae) and aquatic mites (Subclass Acari) generally subdominant.

Benthic invertebrate density at Mary River study areas was low to moderate for Arctic streams (i.e., within a range of 100 – 1,000 individuals per m^2; Craig and McCart 1975), but no significant differences in density were indicated among study areas upstream and downstream of the Mary River Tributary-F confluence in August 2015 (Appendix Tables A.5 and A.6). In addition, no consistent differences in richness (number of taxa), and relative abundance (i.e., percent of community) of dominant/subdominant groups, functional feeding groups or habitat preference groups were observed between the effluent-exposed and reference study areas of the Mary River in August 2015 (Appendix Tables A.5 and A.6). These results suggested no effluent-related influences on the Mary River benthic invertebrate community associated with the Mary River Project following the initial year of mine operations (Minnow 2016).

2.3.8 Fish Community and Population

Two freshwater fish species reside in streams, rivers and lakes of the Mary River Project area, including Arctic charr (*Salvelinus alpinus*) and ninespine stickleback (*Pungitius pungitius*). Arctic charr have generally been observed in greatest abundance in each of these waterbody types, with ninespine stickleback occurring more rarely and captured in lower abundance (Baffinland 2014). Arctic charr populations near the mine are represented only by resident (i.e., landlocked) individuals, with sea-run (i.e., anadromous) individuals restricted to areas well downstream of the Mary River system due to natural physical barriers (Baffinland 2012). Arctic charr has been the only species captured within the Mary River (Baffinland 2012, 2014). No overwintering habitat is available for Arctic charr in the Mary River due to complete freezing in the winter, and therefore young-of-the-year YOY), juvenile and, to a lesser extent, adult Arctic charr inhabit lotic environments such as the Mary River only through the open-water period (i.e., June – September), migrating from/to regional lakes at which overwintering and spawning have taken place. Movement data collected from mine area lakes and streams has suggested that Arctic charr larger than approximately 250 mm do not move large distances, preferring to spend the majority of their life within a particular lake, although some movement has been documented between lakes via larger rivers during summer (Baffinland 2012). Juveniles overwinter in lakes and either migrate to the nearshore zones of lakes or into the smaller tributaries during spring, and migrate back into overwintering lakes during summer or fall.

Within Mary River, fish are restricted to the lower 15 km by a natural physical barrier (20 m high cascade) located approximately 400 m upstream of the Mary River Tributary-F confluence (Figure 2.1). Reconnaissance fishing conducted at Mary River suggested moderate Arctic charr density represented almost entirely by non-YOY juveniles during late August. The non-YOY Arctic charr population of Mary River included individuals ranging from 46 mm (aged 1^+) to 204 mm (aged 7^+) in fork length, with similar length-at-age distribution observed at candidate reference watercourses (Baffinland 2014). Sampling conducted at the nearshore of area lakes in August 2015 indicated Arctic charr YOY with individual fork lengths ≤ 52 mm (Minnow 2016).

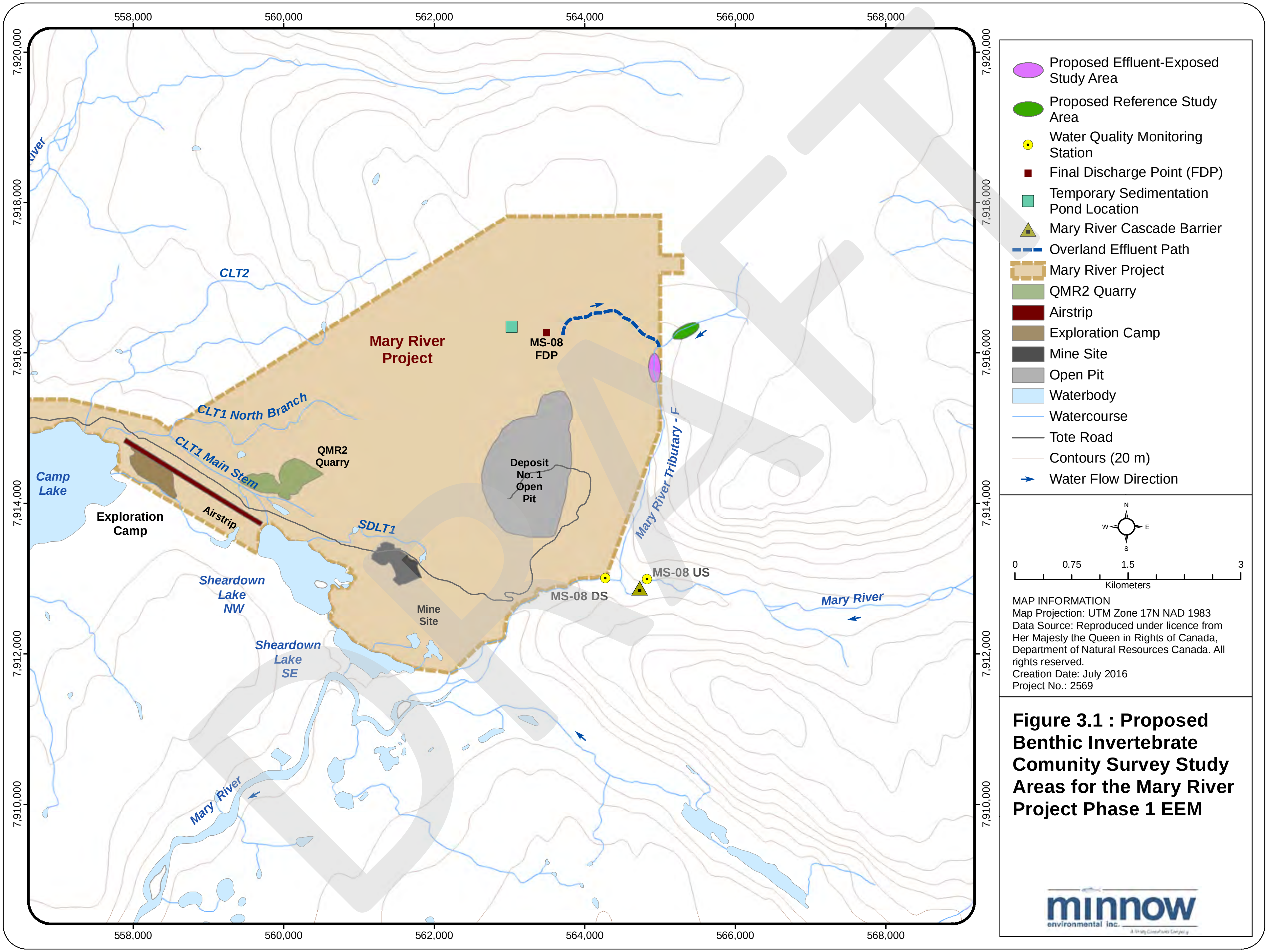
3.0 STUDY DESIGN

The Mary River Project Phase 1 EEM biological study will include benthic invertebrate community and fish population surveys, together with supporting habitat assessment and water quality measures to assist with data interpretation. In accordance with MMER requirements, this study design provides a description of, and the scientific rationale for, sampling areas, sample sizes, species selection (fish population survey only), and methods for field sample collection, laboratory analysis and data analysis that will be used for the benthic invertebrate and fish population surveys, as well as a schedule for study completion. Because effluent mercury concentrations have not exceeded 0.10 μg/L since the initiation of effluent discharge (see Section 2.2.2), a fish tissue assessment is not required for the Mary River Project Phase 1 EEM (Environment Canada 2012). Other EEM components routinely implemented by Baffinland, including effluent quality monitoring (i.e., effluent characterization, effluent sublethal toxicity testing) and receiving environment water quality monitoring, will be incorporated into the Mary River Project Phase 1 EEM Interpretive Report, and therefore methods for these components are briefly discussed in this study design. This Phase 1 EEM Study Design supersedes a draft EEM Study Design (Baffinland 2014) that was developed in anticipation of the mine becoming subject to the MMER so as to incorporate EEM as part of a broader aquatic effects monitoring program for the Mary River Project (i.e., Baffinland 2014). This Phase 1 EEM Study Design builds upon the site characterization information provided in the original draft document (Baffinland 2014), as well as methods and results of previous Mary River Project feasibility and aquatic studies which incorporated sampling designs comparable to those used for the federal EEM program (NSC 2012; Minnow 2016).

3.1 Benthic Invertebrate Community Survey

3.1.1 Approach and Study Area Overview

The Mary River Project Phase 1 EEM benthic invertebrate community survey will employ a control-impact design with quantitative sampling conducted at Mary River Tributary-F downstream (effluent-exposed area) and upstream (reference area) of the confluence with the MS-08 overland discharge pathway (Figure 3.1). During periods of discharge, mine effluent was estimated to represent approximately 1% of flow at the proposed Mary River Tributary-F effluent-exposed area during the July to August open-water period in 2015 (Section 2.2.4). No past or present mining activity has occurred within Mary River Tributary-F upstream of the MS-08 overland discharge pathway confluence, and thus the upstream portion of the system will serve as a suitable reference area. Five stations, separated from one another by a distance of approximately three bankfull widths, will be sampled at each benthic invertebrate community



MAP INFORMATION
Map Projection: UTM Zone 17N NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.
Creation Date: July 2016
Project No.: 2569

Figure 3.1 : Proposed Benthic Invertebrate Comunity Survey Study Areas for the Mary River Project Phase 1 EEM

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study area to provide adequate statistical power to detect differences of ± two standard deviations at an α and β of 0.10, which is consistent with EEM guidance (Environment Canada 2012).

3.1.2 Sample Collection and Laboratory Analysis

Erosional riffle-run habitat with cobble-gravel substrate will be targeted for benthic invertebrate community (benthic) sample collection at the effluent-exposed and reference study areas. A concerted effort will be made to ensure that water velocity, depth and substrate characteristics are comparable between study areas and among stations during sampling to minimize natural influences on benthic invertebrate community variability. Benthic samples will be collected using a 0.1 m^2 Hess Sampler equipped with 500-µm mesh. At each station, one sample representing a composite of three sub-samples (i.e., 0.3 m^2 total area) will be collected to ensure adequate representation of the benthic invertebrate community. Each sub-sample will be collected by carefully placing the sampler on undisturbed substrate and subsequently scrubbing all coarse material within the sampler area (to a depth of approximately 10 cm) while allowing the current to carry all dislodged organisms into the sampler net. After all substrate within the sampler has been completely washed, the sampler will be moved to the next sub-sample location and the procedure repeated. Following collection of the third sub-sample using the above procedure, all material and organisms retained in the collection net will be carefully transferred into pre-labeled wide-mouth plastic jars. As a precautionary measure, internal sample labels will also be used to ensure correct sample identification. All benthic invertebrate samples will be preserved to a level of 10% buffered formalin in ambient water following collection.

At each benthic invertebrate station, supporting information including substrate features (type and approximate diameter), water velocity (m/s), sampling depth (cm), *in-situ* water quality at the sediment-water interface, general habitat notes (e.g., extent of riparian cover, surrounding land use, potential confounding influences, etc.), and global positioning system (GPS) coordinates (recorded in latitude and longitude decimal degrees and based on the North America Datum of 1983 [NAD 83]) will be recorded (see Section 3.4).

Benthic invertebrate community samples will be submitted to and processed by a qualified laboratory using standard sorting methods. Briefly, sample material greater than 500 µm in diameter will be examined under a stereomicroscope at a magnification of at least ten times. All benthic organisms will be removed from the sample debris and placed into vials containing 70% ethanol. A senior taxonomist will later enumerate and identify the benthic organisms to the lowest practical level (typically genus or species) using up-to-date taxonomic keys. During taxonomic identification, representative specimens of each taxon will be placed into separately labeled vials and preserved with a 75% ethanol/3% glycerol solution to create a site-specific voucher collection for potential future reference. Benthic invertebrate community sample processing QA/QC measures will be conducted on a minimum of 10% of samples. These measures will be used to verify that sub-sampling accuracy and precision is within 20% and that greater than 90% of the total organisms were recovered from the benthic invertebrate community samples (Environment Canada 2012).

3.1.3 Data Analysis

Benthic invertebrate communities will be evaluated using EEM primary metrics of mean taxonomic richness (as identified to family level), mean invertebrate density (average number of organisms per m^2), Simpson's Evenness Index and the Bray-Curtis Index of Dissimilarity as required under the MMER (Table 3.1; Environment Canada 2012). Additional comparisons may also be conducted using lowest practical level (LPL) taxonomic richness and percent composition of dominant and indicator taxa (calculated as the abundance of each respective taxonomic group relative to the total number of organisms in the sample; Table 3.1). All required and selected benthic invertebrate community endpoints will be summarized by separately reporting mean, median, minimum, maximum, standard deviation, standard error and sample size for both study areas.

Statistical comparisons of benthic endpoints will be conducted between the effluent-exposed area and the reference area using Analysis-of-Variance (ANOVA). All data will be assessed for normality and homogeneity of variance, with data transformed as required to satisfy the assumptions of ANOVA. If data significantly violate the assumption of normality following transformation, non-parametric statistics will be applied to verify the ANOVA statistical results. An effect on the benthic invertebrate community will be defined as a statistically significant difference between the effluent-exposed area and the reference area at an alpha level of 0.10 (Environment Canada 2012). The magnitude and statistical power of all significant differences will also be reported for each benthic metric where a significant difference is detected in accordance with Environment Canada (2012) requirements. If a significant difference is not detected between study areas for a benthic invertebrate community metric, the minimum effect size that would be detectable will be calculated using the mean square error generated from the ANOVA as an estimate of variability, with alpha and beta equal to 0.10. The minimum detectable effect size will be based on the minimum number of reference area standard deviations, which will be calculated using equations provided by Environment Canada (2012). All statistical analyses will be described in detail in the Interpretive Report, including any transformations or alterations performed on the data.

Table 3.1: Required and supporting endpoints examined for EEM benthic invertebrate community surveys.

Response	Endpoint	Critical Effect Size
Effects on Benthic Invertebrates[a]	Organism density (number of invertebrates·m^2)	± 2 SD_{REF}
	Taxonomic richness (number of taxa)	± 2 SD_{REF}
	Simpson's Evenness	± 2 SD_{REF}
	Bray-Curtis Index of dissimilarity	± 2 SD_{REF}
Supporting Response Variables[b]	Density of dominant groups (number of invertebrates·m^2)	-
	Proportion of dominant groups	-
	Density of metal-sensitive groups (number of invertebrates·m^2)	-
	Proportion of metal-sensitive groups	-
	Simpson's Diversity	-
	Shannon-Wiener Diversity	-
	Proportion of Functional Feeding Groups	-

[a] Endpoints to be used for determining "effects" as designated by statistically significant differences between effluent-exposed and reference areas (Environment Canada 2012).

[b] These analyses are for informational purposes and significant differences between exposure and reference areas are not necessarily used to designate an effect (Environment Canada 2012).

3.2 Fish Population Survey

3.2.1 Approach and Study Area Overview

The Mary River Project Phase 1 EEM fish population survey will use a control-impact, non-lethal design targeting Arctic charr (*Salvelinus alpinus*). Although Environment Canada (2012) recommends the monitoring of two sexually mature, sedentary, fish species using a lethal sampling design for EEM fish population surveys, such an approach is not possible for the Mary River Project EEM because:

- Arctic charr is the only fish species that has been captured in the Mary River system upstream of Mary Lake during previous fish community sampling (Baffinland 2014). Therefore, a second fish species is not available.
- Mary River and tributaries to Mary River located upstream of Mary Lake freeze entirely during the winter, and thus do not provide overwintering habitat for Arctic charr adults and other life stages. The fish community of this portion of the Mary River system therefore consists mainly of juvenile Arctic charr that have migrated from lakes used for overwintering, including young-of-the-year (YOY) that have emerged from lake spawning beds during the late winter. For instance, the maximum size and age of Arctic charr captured in Mary River and regional streams during previous fish community sampling (275 mm fork length, 191 g weight, and 7 years old, n = 653; NSC 2015) generally corresponds to juvenile Arctic charr size/age classes for the Mary River Project area. During lake fish population monitoring in 2015, Arctic charr confirmed as adults averaged 342 mm in fork length and 12.2 years in age (Minnow 2016). Hoop net sampling conducted at tributaries of Mary River Project area lakes indicated that only 1.6% and 0.5% of Arctic charr had a fork length greater than 200 and 250 mm, respectively (n = 4,799), suggesting that very few were adults. Because adult Arctic charr numbers are likely to be very low at lotic waterbodies near the mine, it is unlikely that a suitable number of adults can be captured at the Mary River Project EEM study areas to meet the EEM minimum sample size requirements for a lethal fish population survey design.
- Arctic charr resident adults spawn only every second to third year at latitudes similar to those of the Mary River Project (Jonsson et al. 1988; Scott and Crossman 1998; Gullested and Klemetsen 1997; Klemetsen et al. 2003). As a result, the implementation of a lethal sampling program at Mary River Project using Arctic charr would necessitate the sacrificing of at least 2 – 3 times the number of fish required to meet the EEM minimum sample sizes under a standard sampling program. Approximately 39% of

Arctic charr in ‘adult’ size range that were sampled from Mary River Project lakes in mid-August 2015 contained sufficiently developed gonads from which to visually determine sex (37 of 96 individuals; Minnow 2016). Of these, the ratio of males to females was 1:36 (i.e., 3% males, 97% females). Assuming a similar sex ratio, implementation of an adult Arctic charr lethal sampling program would result in the sacrifice of unacceptably high numbers of fish.

Mary River Tributary-F, downstream of the MS-08 overland discharge pathway confluence, will preferentially be sampled as the effluent-exposed area for the EEM fish population survey (Figure 3.2). During periods of discharge, mine effluent was estimated to represent approximately 1% of flow at the proposed Mary River Tributary-F effluent-exposed area during the July to August open-water period in 2015 (Section 2.2.4). Because of uncertainty of mine effluent exposure for fish residing in upper Mary River Tributary-F, an unnamed tributary to Angajurjualuk Lake (referred to as CLT-REF4) which shares similar watershed size to Mary River Tributary-F at the effluent pathway confluence will serve as a comparable reference area for the Mary River Tributary-F effluent-exposed area (Figure 3.2). Notably, although not formally documented, fish sampling has suggested that fish may be entirely absent from Mary River Tributary-F, presumably as a result of the combination of complete freezing overwinter, a relatively high stream gradient (i.e., on average, approximately 5%), and the presence of natural in-stream barriers (e.g., step-drops due to boulders/bedrock substratum). The latter two factors likely act to limit fish ascension from Mary River during the open-water season. Because an EEM fish population survey is not required in cases in which mine effluent constitutes less than 1% of flow 250 m downstream of a final discharge point (Government of Canada 2016), in the event that Arctic charr are confirmed absent at Mary River Tributary-F during EEM sampling, no fish population survey will be conducted. During discharge, mine effluent was estimated to represent approximately 0.02% - 0.035% of flow at the immediate effluent-exposed area of Mary River under average and maximum effluent discharge, respectively, in 2015 assuming average stream flow rates for months in which effluent was discharged (see Section 2.2.4). The estimated proportion of effluent at Mary River is well below the fish population survey trigger concentration of 1% effluent, and therefore the implementation of an EEM fish population survey to determine potential effects of mine effluent on the Mary River Arctic charr population would not likely be ecologically meaningful.

The fish population survey conducted at Mary River Tributary-F will include a semi-quantitative fish community assessment to assess potential differences in fish species diversity and/or relative abundance between the effluent-exposed and reference areas, and a non-lethal assessment of EEM fish health endpoints between these same study areas (Table 3.2).

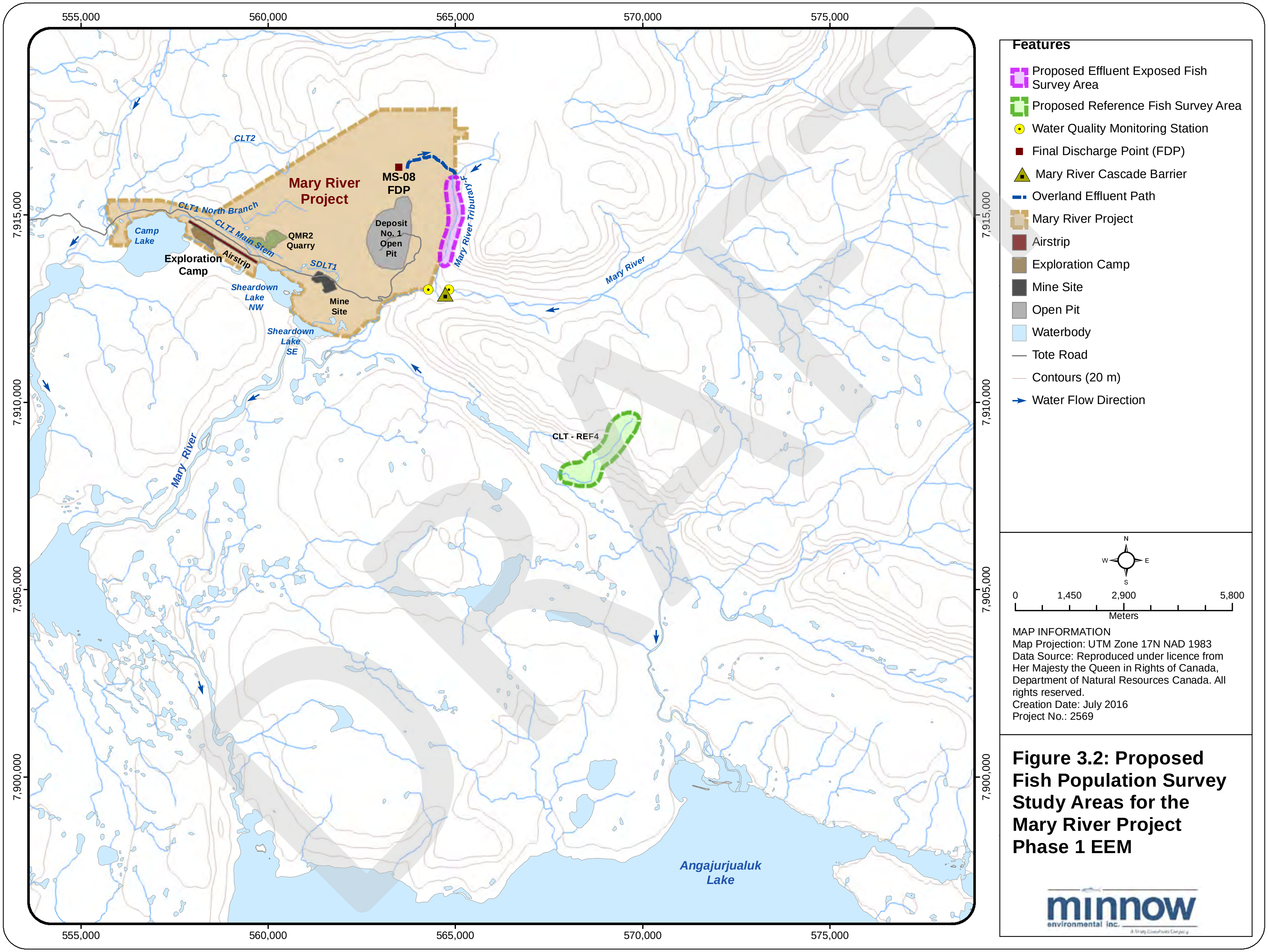

Figure 3.2: Proposed Fish Population Survey Study Areas for the Mary River Project Phase 1 EEM

minnow environmental inc.

3.2.2 Sample Collection and Target Numbers

Arctic charr will be collected using a backpack electrofishing unit (e.g., Smith-Root Model LR-24) by an electrofishing team consisting of a unit operator and one netter. For each electrofishing pass, all captured fish will be placed into buckets containing aerated water. At the conclusion of each pass, total electrofishing effort (i.e., electrofishing seconds) will be recorded to allow calculation of time standardized catch. All captured fish will be identified to species and enumerated, following which any non-target species will be released alive at the capture location. All Arctic charr will be transferred to buckets containing freshly aerated water and retained for processing (described below). Fish sampling will be conducted until 100 juvenile/adult Arctic charr older than young-of-the-year (i.e., non-YOY) have been collected. Age analysis of juvenile Arctic charr captured at lakes near the mine in 2015 suggested a maximum YOY fork length of 52 mm during mid-August (Minnow 2016), and therefore this length will be used to distinguish non-YOY from YOY for the purposes of EEM. The YOY fish will also be processed (i.e., retained and measured), but only to a maximum of the first 100 in the event that YOY are the dominant age class (i.e., >80 – 90% of population). However, fish collection will continue at each study area until a minimum of 100 non-YOY Arctic charr have been captured in accordance with EEM recommendations (Environment Canada 2012). Recorded supporting information collected during the fish population survey will include duration of sampling (electrofishing seconds), area/distance sampled, GPS latitude-longitude coordinates and habitat descriptions (e.g., substrate properties, mean water velocity and depth).

3.2.3 Field and Laboratory Processing

Following completion of each electrofishing pass, captured Arctic charr will be processed in the field. Measurements collected from each fish will include all those recommended for the EEM program (Environment Canada 2012) as described below. Initially, the external condition of each individual will be assessed visually for the presence of any deformities, erosions, lesions and tumors (DELT) or evidence of external or internal parasites. All observations will be recorded on field sheets, and supporting photographs will be taken as appropriate. Length (fork and total) of each fish will then be measured to the nearest millimetre using a standard measuring board, and fresh body weight will be measured to the nearest milligram using an analytical balance with ±1% precision. Approximately 10% of individuals will be sacrificed for collection of otoliths for aging. With the exception of those fish sacrificed for aging tissue collections, fish will be placed into a recovery bucket following processing. These fish will subsequently be returned to the water body in which they were collected at a location sufficiently distant from the point of capture to ensure that no re-capture will occur later in the survey (in the event that target sample sizes were not attained).

Upon completion of the field study, otoliths will be shipped to a qualified laboratory for age determination. Otoliths will be prepared using a “crack-and-burn” method, which involves cracking the otoliths in half and then lightly burning the otolith to make the annuli visible. The otolith samples will then be mounted on a glass slide using a mounting medium and aged (annuli counted) under a compound microscope using transmitted light. For each otolith, the age and edge condition will be recorded along with a confidence rating for the age determination.

3.2.4 Data Analysis

Data analysis methods will follow those recommended for EEM fish surveys (Environment Canada 2012). All catch data will be tabulated, and catch-per-unit-effort (CPUE) will be calculated for, and compared between, each study area. For the Arctic charr non-lethal population survey fish measurement data, summary statistics including mean, median, minimum, maximum, standard deviation, standard error and sample size will be calculated by study area (effluent-exposed and reference) and, if possible, YOY and non-YOY (juvenile/adult) life history stages. The proportion of YOY and individual length and weight measurements will be used to calculate endpoints associated with survival, growth, reproduction and energy storage for each study area (Table 3.2; Environment Canada 2012). All data will be log-transformed and assessed for normality and equality of variance in order to determine the suitability of parametric statistical procedures. If data significantly violate the assumption of normality following transformation, non-parametric statistics will be applied to confirm the parametric test results. Length data will be used to develop size-frequency distributions as described by Bonar (2002) and Gray et al. (2002), with age data used to verify age-classes. Statistically significant differences between size frequency distributions will be assessed using a two-sample Kolmogorov-Smirnov goodness of fit test (per Gray et al. 2002). Based on the analysis of the size-frequency distributions and confirmatory aging, YOY (age-0) fish will be distinguished from other age classes separately for each study area and then subjected to separate evaluation of endpoints. Relative proportions of YOY will also be compared to evaluate potential differences in reproductive success between the effluent-exposed area and the reference area. For each of the calculated endpoints, and separately for non-YOY and YOY data sets, statistical differences between effluent-exposed and reference study areas will be made using ANOVA, Mann-Whitney U-tests or Analysis-of-Covariance (ANCOVA) as appropriate and following technical guidance (Table 3.2; Environment Canada 2012). An effect on the fish population will be evaluated for each of the

Table 3.2: Required and supporting endpoints for EEM non-lethal fish population survey at the Mary River Project.

Response			Endpoint	Statistical Test[c,d,e]	Critical Effect Size
Non-Lethal Comparisons	Effects on Fish[a]	Survival	Length-frequency distribution	K-S Test	-
		Growth	Length of non-YOY (i.e., age-1^+)	ANOVA	25%
			Weight of non-YOY (i.e., age-1^+)	ANOVA	25%
		Reproduction	Relative abundance of YOY (% composition)	None	-
		Energy Storage	Condition (body weight against length)	ANCOVA	10%
	Supporting Response Variables[b]	Survival	Age-frequency distribution (if possible)	K-S Test	-
		Growth	Size of YOY (age 0^+ fish)	ANOVA	-
			Size-at-age (body weight against age, if possible)	ANCOVA	-
		Reproduction	YOY survival	ANCOVA	-

[a] Endpoints to be used for determining "effects" as designated by statistically significant differences between exposure and reference areas (Environment Canada 2012).

[b] These analyses are for informational purposes and significant differences between exposure and reference areas are not necessarily used to designate an effect (Environment Canada 2012).

[c] ANOVA (Analysis of Variance) used except for non-parametric data, where Mann Whitney U-test may be used to verify the results by ANOVA.

[d] ANCOVA (Analysis of Covariance). For the ANCOVA analyses, the first term in parentheses is the endpoint (dependent variable Y) that is analyzed for an effluent effect. The second term in parentheses is the covariate, X (age, weight, or length).

[e] K-S Test (Kolmogorov-Smirnov test).

calculated EEM endpoints, defined as a statistically significant difference between the effluent-exposed area and either reference area at an alpha level of 0.10 (Environment Canada 2012).

For endpoints showing significant area differences, the magnitude of difference between reference and exposure areas will be calculated as described by Environment Canada (2012) using mean (ANOVA), adjusted mean (ANCOVA with no significant interaction) or predicted values (ANCOVA with significant interaction). The anti-log of the mean, adjusted mean, or predicted value will be used in the equations for endpoints that are log_{10}-transformed. In addition, the magnitude of difference for ANCOVA with a significant interaction will be calculated for each of the minimum and maximum values of the covariate. If there is no significant difference indicated between areas, the minimum detectable effect size will be calculated as a percent difference from the reference mean for ANOVA or adjusted reference mean for ANCOVA at alpha = beta = 0.10 using the square root of the mean square error (generated during either the ANOVA or ANCOVA procedures) as a measure of variability in the sample population based on formula provided by Environment Canada (2012). Finally, if outliers or leverage values are observed in a data set(s) upon examination of scatter plots and residuals, then the values will be removed and ANOVA or ANCOVA tests were repeated for the reduced data, with both sets of results then provided.

The magnitude of difference for any significantly differing endpoints between the effluent-exposed and reference areas will be evaluated relative to Critical Effect Size (CES) commonly used in environmental monitoring programs to define any ecologically meaningful ‘effects’ (Environment Canada 2012). The CES is analogous to the magnitude of difference in population endpoints that could be expected to occur naturally among areas that have not been influenced by any anthropogenic inputs (e.g., between reference areas; see Munkittrick et al. 2009). For the fish population survey, the CES for endpoints of size will be ±25%, and the CES for condition (i.e., weight-at-length) will be 10%, consistent with those recommended for EEM (Table 3.2; Environment Canada 2012)

3.3 Fish Usability (Tissue) Analysis

As indicated previously, no assessment of fish tissues is required for the Mary River Project Phase 1 EEM because effluent mercury concentrations have been consistently below the 0.10 µg/L limit stipulated by Environment Canada (2012) since the initiation of MMER monitoring (see Table 2.2; Appendix Table A.1).

3.4 Supporting Environmental Variables

Additional environmental information used to support the benthic invertebrate community and fish population surveys during the EEM biological field program will include habitat characterization and water quality monitoring. The supporting data will be collected from all effluent-exposed and reference areas at the same time as benthic and fish population sampling.

3.4.1 Habitat Characterization

Detailed habitat characterization will be undertaken at each study area with the objective of identifying important biological features and to better understand biophysical dynamics of the study watercourses. At each benthic station and fish population survey study area, channel dimensions (wetted and bankfull width, depth) and water velocity will be measured from at least two transects using a meter stick/tape measure and portable water velocity meter (e.g., Flo-Mate Model 2000, Marsh-McBirney Ltd., Frederick, MD), respectively. Substrate size will be assessed using measurements of the intermediate axis from up to twenty randomly selected substrate samples at each transect. Features associated with stream morphology, channel bed (substrate type, relative size, etc.), bank stability, aquatic and/or riparian vegetation and in-stream cover will be described and/or estimated as the relative proportion that each contributes to total watercourse surface area at the study area, as applicable. Photographs will be taken at each study area to further support the habitat descriptions.

3.4.2 Water Quality Assessment during the Biological Field Study

The Mary River Project Phase 1 EEM study will include supporting water quality evaluation of *in-situ* (field) measures and water sample collection for laboratory analysis. *In-situ* water temperature, dissolved oxygen, pH and specific conductance (i.e., temperature-standardized measurement of conductivity) measurements will be collected near the water-sediment interface at each benthic station and fish population survey study area using portable field meters that have been calibrated and/or checked against standard solutions on the day of measurement. Additional supporting observations regarding water colour and clarity will be recorded at each biological monitoring station/study area. *In-situ* water quality data collected at benthic stations and fish population survey study areas will be compared statistically between the effluent-exposed and reference study areas using appropriate tests and following any applicable data transformation to satisfy statistical test assumptions. Dissolved oxygen and pH data will also be compared to applicable Canadian Water Quality Guidelines for the protection of aquatic life (CWQG; CCME 1999, 2016).

Water samples for chemical analysis will be collected at each study area during the biological monitoring survey. A single water sample will be collected from approximately mid-column at each study area, and will be collected directly into sample bottles with any required preservatives subsequently added to the samples. All water chemistry samples will be placed in coolers and, upon return from the field, into a refrigerator for storage prior to shipment to an accredited laboratory for analysis of EEM analytes (i.e., alkalinity, hardness, total suspended solids [TSS], ^{226}radium, nutrients [ammonia, nitrate], and total metals), and potentially other analytes assessed to satisfy territorial monitoring requirements (e.g., total dissolved solids [TDS], chloride, sulphate, total Kjeldahl nitrogen [TKN], total phosphorus, dissolved and total organic carbon and dissolved metals), using standard analytical procedures. Quality assurance and quality control (QA/QC) for water sampling will include the collection and analysis of field duplicates (on 10% of samples), as well as assessment of laboratory duplicates and blank analyses. Water chemistry data from the effluent-exposed areas will be assessed for any spatial changes with progression from the mine and will also be compared to reference area data. Water chemistry data will also be compared to applicable CWQG (CCME 1999, 2016).

3.5 Effluent and Water Quality Monitoring

Effluent and water quality monitoring consists of effluent characterization, sublethal toxicity testing and receiving environment water quality monitoring. Baffinland personnel have initiated, and will continue to conduct, effluent characterization four times per calendar year or, in instances in which effluent is released for only a short portion of the year, at a minimum frequency of not less than 30 days apart, at the final effluent discharge point in accordance with the MMER. The effluent characterization samples will continue to be shipped to an accredited laboratory for analysis of the suite of EEM parameters stipulated by the MMER (Government of Canada 2016) using appropriate method detection limits and quality assurance protocols. The Mary River Project effluent characterization data are reported to Environment Canada annually by Baffinland, and these data will also be summarized for discussion in the Phase 1 EEM Interpretive Report.

Baffinland has initiated, and will continue to conduct, twice-annual sub-lethal toxicity testing using final effluent samples to fulfil EEM requirements under the MMER. The sub-lethal toxicity tests are conducted using fathead minnow (7-day survival and growth test; Environment Canada 2011), the invertebrate *Ceriodaphnia dubia* (7-day survival and reproduction test; Environment Canada 2007a), the alga *Pseudokirchneriella subcapitata* (3-day growth inhibition test; Environment Canada 2007b) and the aquatic plant *Lemna minor* (7-day growth inhibition test; Environment Canada 2007c). All sub-lethal toxicity tests will be performed by a qualified laboratory. The Mary River Project effluent sub-lethal toxicity results must be reported to Environment Canada annually by Baffinland, and these results will also be summarized for discussion in the Phase 1 EEM Interpretive Report.

Baffinland has initiated, and will continue to conduct, water quality monitoring at Mary River effluent-exposed and reference areas four times per calendar year or, in instances in which effluent is released for only a short portion of the year, at a minimum frequency of not less than 30 days apart, as part of their EEM requirements. During the implementation of the Phase 1 EEM field study, water chemistry samples will be collected from areas of biological sampling as described in Section 3.4.2. All water quality sampling methods, analytical variables, quality assurance/quality control sampling and analysis, sample storage and shipping methods will be conducted in accordance with Environment Canada (2012) technical guidance. Mary River Project routine water quality monitoring data must be reported to Environment Canada annually by Baffinland. These data, together with *in-situ* water quality data and water chemistry data collected during the EEM biological study, will be summarized for discussion in the Phase 1 EEM Interpretive Report.

3.6 Schedule and Reporting

The Mary River Project Phase 1 EEM biological surveys will be conducted in August 2017. This seasonal timing is optimal for the benthic survey as it will ensure that benthic invertebrate communities are relatively stable and that organisms are relatively well developed (e.g., Craig and McCart 1975), allowing identification to suitable taxonomic levels. In addition, Arctic charr will likely have ascended and resided within Mary River and/or associated watercourses for as long as two months prior to field sampling. With the submission of water and benthic samples for analysis at respective laboratories shortly after completion of the fieldwork, all laboratory results should be available in late 2017. This will provide adequate time for data analysis and completion of a final interpretive report for submission to Environment Canada by January 10th, 2018 (i.e., 30 months following the Mary River Project becoming subject to the MMER) in electronic and hard copy formats.

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APPENDIX A

SUPPORTING INFORMATION

Table A.1: Effluent quality monitoring data for Mary River Project Station MS-08, 2015.

	Variable	Units	MMER Grab Limit [a]	9-Jul-15	20-Jul-15	30-Jul-15	6-Aug-15	11-Aug-15
Routine Monitoring [b]	pH	pH units	-	7.13	7.51	7.90	7.44	7.77
	TSS	mg/L	30.0	27	4	2	12	2
	Arsenic (As)	mg/L	1.00	0.0002	<0.00010	<0.0010	<0.00010	<0.00010
	Copper (Cu)	mg/L	0.60	0.0020	0.0005	<0.0010	0.0014	0.0011
	Lead (Pb)	mg/L	0.40	0.00082	0.00044	<0.00050	0.00023	0.00015
	Nickel (Ni)	mg/L	1.00	0.010	0.012	0.013	0.025	0.021
	Zinc (Zn)	mg/L	1.00	0.0051	<0.0030	<0.0030	0.0035	0.0031
	Radium-226	Bq/L	1.11	-	<0.0100	<0.0100	<0.0100	0.0160
Effluent Characterization [c]	Conductivity	μS/cm	-	-	948	-	1,320	-
	Hardness	mg/L (as $CaCO_3$)	-	223	495	678	667	780
	Alkalinity	mg/L (as $CaCO_3$)	-	18	32	45	-	44
	Ammonia (NH_4^+)	mg/L	-	0.36	0.44	0.38	-	0.47
	Nitrate (NO_3)	mg/L	-	1.9	4.0	5.5	-	4.9
	Aluminum (Al)	mg/L	-	0.804	0.065	0.067	0.115	0.118
	Cadmium (Cd)	mg/L	-	0.00005	0.00007	<0.000090	0.00018	0.00014
	Iron (Fe)	mg/L	-	1.120	0.164	0.138	0.479	0.178
	Mercury (Hg)	mg/L	0.000010	<0.000010	<0.000010	<0.000010		<0.000010
	Molybdenum (Mo)	mg/L	-	0.0001	0.0001	<0.00050	0.0002	<0.00050
	Selenium (Se)	mg/L	-	0.0007	0.0014	0.0021	0.0025	0.0027
Other Parameters	Turbidity	NTU	-	22	-	3.9	-	4.4
	Total Dissolved Solids	mg/L	-	290	-	934	-	1,030
	Dissolved Organic Carbon	mg/L	-	1.2	-	<1.0	-	<1.0
	Total Organic Carbon	mg/L	-	1.0	-	<1.0	-	<1.0
	Total Kjeldahl Nitrogen	mg/L	-	0.80	-	0.39	-	0.68
	Total Phosphorus	mg/L	-	0.006	-	<0.030	-	<0.030
	Fluoride (F)	mg/L	-	0.031	-	0.044	-	0.049
	Chloride (Cl)	mg/L	-	12.80	-	25.70	-	26.40
	Sulfate (SO4)	mg/L	-	207	-	585	-	668
	Antimony (Sb)-Total	mg/L	-	<0.00010	<0.00010	-	<0.00010	-
	Barium (Ba)-Total	mg/L	-	0.0196	0.0315	-	0.0301	-
	Beryllium (Be)-Total	mg/L	-	<0.00010	<0.00050	-	<0.00050	-
	Bismuth (Bi)-Total	mg/L	-	<0.000050	<0.00050	-	<0.00050	-
	Boron (B)-Total	mg/L	-	0.011	0.014	-	0.021	-
	Calcium (Ca)-Total	mg/L	-	30.9	64.1	83.2	73.3	84.1
	Chromium (Cr)-Total	mg/L	-	0.0023	<0.00050	-	<0.00050	-
	Cobalt (Co)-Total	mg/L	-	0.013	0.016	-	0.029	-
	Lithium (Li)-Total	mg/L	-	0.004	0.005	-	0.008	-
	Magnesium (Mg)-Total	mg/L	-	41	81	111	118	135
	Manganese (Mn)-Total	mg/L	-	3.1	4.2	4.6	7.2	7.5
	Potassium (K)-Total	mg/L	-	1.2	1.6	1.9	1.8	1.8
	Silicon (Si)-Total	mg/L	-	2.2	1.2	-	1.3	-
	Silver (Ag)-Total	mg/L	-	<0.000050	<0.000010	-	<0.000010	-
	Sodium (Na)-Total	mg/L	-	1.2	2.0	2.5	2.2	2.6
	Strontium (Sr)-Total	mg/L	-	0.016	0.032	-	0.035	-
	Thallium (Tl)-Total	mg/L	-	0.00004	<0.00010	<0.00030	<0.00010	0.00004
	Titanium (Ti)-Total	mg/L	-	0.051	<0.010	-	<0.010	-
	Uranium (U)-Total	mg/L	-	0.0001	0.0003	<0.0010	0.0005	0.0007
	Vanadium (V)-Total	mg/L	-	0.0017	<0.0010	-	<0.0010	-

(grey box) Indicates grab sample concentration above applicable limit for deleterious substances *or* grab sample mercury concentration that exceeded fish usability assessment trigger value.

[a] Limits indicated refer to maximum authorized grab sample concentrations as per Schedule 4 of the MMER (Government of Canada 2016) except the limit for mercury, which has been included as a fish usability assessment trigger limit based on a grab sample concentration of 0.0001 mg/L.

[b] Deleterious substances and pH as defined under Schedule 4 of the MMER (Government of Canada 2016).

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MMER (Government of Canada 2016).

Table A.2: Average monthly discharge data (m^3/s) collected from Mary River Project hydrological gauging stations, 2006 - 2014.

Year	Montth	Hydrological Station					
		H1 Phillips Creek Tributary (250 km^2)	H2 Tom River (210 km^2)	H4 Camp Lake Tributary2 (8.3 km^2)	H5 Camp Lake Tributary1 (5.3 km^2)	H6 Mary River (250 km^2)	H11 Sheardown Lake Trib1 (3.6 km^2)
2006	June	-	5.05	-	-	-	-
	July	14.65	19.20	0.83	0.38	26.64	-
	August	5.46	5.37	0.29	0.15	15.03	-
	September	7.42	3.07	0.29	0.17	24.01	-
2007	June	10.94	4.42	0.25	0.31		-
	July	6.93	7.78	0.21	0.10	11.68	-
	August	3.77	4.04	0.13	0.10	6.54	-
	September	1.62	1.14	0.07	0.05	4.22	-
2008	June	12.20	-	1.56	0.42	26.06	-
	July	10.31	-	0.38	0.22	16.96	-
	August	7.44	-	0.25	0.22	8.21	-
	September	5.33	-	0.17	0.12	7.06	-
2010	June	-	33.25	-	0.78	39.55	-
	July	-	14.34	-	0.19	18.76	-
	August	-	2.34	-	0.08	3.69	-
	September	-	5.42	-	0.14	7.13	-
2011	June	13.70	-	0.44	0.30	27.41	0.07
	July	3.11	-	0.07	0.05	5.29	0.02
	August	1.25	-	0.03	0.02	2.32	0.02
	September	1.56	-	0.03	0.02	1.89	0.02
2012	June	24.24	35.76	0.88	0.81	32.23	0.12
	July	7.49	13.42	0.39	0.22	11.63	0.07
	August	2.36	4.82	0.16	0.10	5.47	0.06
	September	3.90	-	0.28	0.17	8.00	0.08
2013	June	10.80	18.04	-	0.32	19.75	0.14
	July	9.74	17.95	0.09	0.25	20.98	0.12
	August	-	2.88	0.07	0.08	4.63	0.05
	September	-	-	0.05	0.06	3.07	0.06
2014	June	7.03	6.35	-	0.28	-	0.12
	July	13.42	21.28	-	0.42	31.09	0.09
	August	7.18	9.08	-	0.20	9.83	0.09
	September	2.14	1.90	-	0.05	1.88	0.04
Average	June	13.15	17.15	0.78	0.46	29.00	0.11
	July	9.38	15.66	0.33	0.23	17.88	0.08
	August	4.57	4.76	0.16	0.12	6.96	0.06
	September	3.66	2.88	0.15	0.10	7.16	0.05

Table A.3: Summary of Mary River habitat features evaluated as part of the Mary River Project annual aquatic effects benthic invertebrate community survey, August 2015.

Habitat Characteristic		Mary River Upstream of Cascade Barrier		Mary River Downstream of Cascade Barrier	
		GO-09	GO-03	EO-01	EO-20
Mean Width (m)	Wetted	55.0	39.0	16.0	21.0
	Bankfull	72.5	52.0	84.0	30.0
Mean Depth (cm)	Average	25	34	70	27
Mean Velocity (m/s)	Average	0.47	0.39	1.00	0.70
Stream Morphology	% Pool	0	0	0	0
	% Rapid	20	0	30	20
	% Riffle	40	60	40	40
	% Run	40	40	30	40
Substrate (% areal coverage)		30% boulder 60% cobble 5% pebble 5% gravel	30% boulder 60% cobble 5% pebble 5% gravel	40% boulder 50% cobble 5% pebble 5% gravel	15% boulder 70% cobble 5% pebble 5% gravel 5% sand
Aquatic Vegetation (% areal coverage)	Periphyton Coverage	10%	40%	20%	20%
	Periphyton Description	0.5 to 1 mm thick of attached algae/periphyton on rocks	0.5 to 1 mm thick of attached algae/periphyton on rocks	0.5 to 1 mm thick of attached algae/periphyton on rocks	0.5 to 1 mm thick of attached algae/periphyton on rocks
Functional Instream Cover (% areal coverage)		20% boulder	30% boulder	30% boulder	5% boulder

Table A.4: Water chemistry at Mary River water quality monitoring stations during annual aquatic effects monitoring, 2015.

	Parameters	Units	Water Quality Guideline (WQG)[a]	Spring Sampling Event										
				G0-09-A Upstream Ref. 29-Jun-2015	G0-09 Upstream Ref. 29-Jun-2015	G0-09-B Upstream Ref 29-Jun-2015	G0-03 Upstream Ref. 29-Jun-2015	G0-01 Upstream Ref. 29-Jun-2015	E0-03 Near-Field 29-Jun-2015	E0-20 Near-Field 29-Jun-2015	E0-21 Near-Field 29-Jun-2015	C0-10 Far-Field 29-Jun-2015	C0-05 Far-Field 29-Jun-2015	C0-01 Far-Field 29-Jun-2015
Conventionals	Conductivity (lab)	umho/cm	-	21.4	25.6	23.9	24.2	38.5	25.1	23.6	23.8	25.5	36.5	33.9
	pH (lab)	pH	6.5 - 9.0	6.86	6.94	7.06	7.13	7.23	7.28	6.93	6.95	7.05	7.18	7.29
	Hardness (as $CaCO_3$)	mg/L	-	<10	13	11	12	20	12	12	12	13	18	17
	Total Suspended Solids (TSS)	mg/L	-	46.4	13.6	12.8	12	16.4	9.2	<2.0	6.4	<2.0	3.2	4.8
	Total Dissolved Solids (TDS)	mg/L	-	<20	<20	<20	<20	<20	<20	20	<20	20	23.5	<20
	Turbidity	NTU	-	16.6	8.08	8.75	5.42	2.39	4.46	4.4	5.65	4.33	4.305	4.58
	Alkalinity (as $CaCO_3$)	mg/L	-	<10	11	<10	<10	16	12	<10	10	12	16.5	14
Nutrients and Organics	Total Ammonia	mg/L	variable[c]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Nitrate	mg/L	13	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
	Nitrite	mg/L	0.06	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Total Kjeldahl Nitrogen (TKN)	mg/L	-	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.21
	Dissolved Organic Carbon	mg/L	-	<1.0	1.3	1.1	1.2	<1.0	<1.0	1	<1.0	1	1.1	1.1
	Total Organic Carbon	mg/L	-	1.1	1.5	1.1	1.3	<1.0	1	2.5	1.2	1.8	1.2	1.2
	Total Phosphorus	mg/L	0.020[α]	0.0862	0.0214	0.021	0.016	0.0066	0.0145	0.0092	0.0101	0.0072	0.0076	0.0073
	Phenols	mg/L	0.001[α]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Anions	Bromide (Br)	mg/L	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Chloride (Cl)	mg/L	120	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.63	0.59
	Sulphate (SO_4)	mg/L	218[β]	0.33	<0.30	0.31	<0.30	0.61	0.31	0.33	0.31	0.41	0.565	0.52
Total Metals	Aluminum (Al)	mg/L	0.100	0.374	0.159	0.213	0.174	0.0963	0.137	0.114	0.144	0.11	0.1095	0.115
	Antimony (Sb)	mg/L	0.020[α]	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)	mg/L	0.005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L	-	0.00553	0.00296	0.00368	0.00323	0.00244	0.00272	0.00252	0.00285	0.00278	0.00309	0.00298
	Beryllium (Be)	mg/L	0.011[α]	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Bismuth (Bi)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)	mg/L	0.00012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Calcium (Ca)	mg/L	-	2.63	2.94	2.65	2.64	4.12	2.67	2.53	2.61	2.68	3.71	3.53
	Chromium (Cr)	mg/L	0.0089	0.00083	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Cobalt (Co)	mg/L	0.0009[α]	0.00031	0.00011	0.00016	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)	mg/L	0.002	0.00119	0.00061	0.00078	0.00065	<0.00050	0.00053	<0.00050	0.00052	<0.00050	0.00054	0.00055
	Iron (Fe)	mg/L	0.30	0.512	0.155	0.256	0.189	0.105	0.133	0.099	0.134	0.089	0.097	0.107
	Lead (Pb)	mg/L	0.001	0.000602	0.000278	0.000303	0.00021	0.000144	0.00019	0.000144	0.000175	0.000126	0.0001435	0.000157
	Lithium (Li)	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)	mg/L	-	1.58	1.56	1.48	1.49	2.43	1.49	1.45	1.5	1.54	2.19	2.01
	Manganese (Mn)	mg/L	0.935[β]	0.0137	0.0055	0.00683	0.00507	0.00308	0.00347	0.00261	0.00355	0.00215	0.00258	0.00287
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Molybdenum (Mo)	mg/L	0.073	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000084	0.000076
	Nickel (Ni)	mg/L	0.025	0.00068	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Potassium (K)	mg/L	-	0.44	0.34	0.39	0.35	0.29	0.33	0.32	0.33	0.34	0.41	0.39
	Selenium (Se)	mg/L	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silicon (Si)	mg/L	-	0.79	0.55	0.63	0.55	0.38	0.48	0.47	0.52	0.49	0.5	0.52
	Silver (Ag)	mg/L	0.00025	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)	mg/L	-	0.334	0.217	0.328	0.271	0.18	0.273	0.296	0.286	0.322	0.4225	0.39
	Strontium (Sr)	mg/L	-	0.00265	0.00208	0.00243	0.00219	0.00222	0.0021	0.00207	0.00216	0.00217	0.002835	0.00277
	Thallium (Tl)	mg/L	0.0008	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	0.028	<0.010	0.016	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)	mg/L	0.015	0.000356	0.000135	0.00021	0.000158	0.00008	0.000132	0.000117	0.000125	0.000117	0.0001895	0.000169
	Vanadium (V)	mg/L	0.006[α]	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)	mg/L	0.030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

[a] Canadian Water Quality Guideline for the protection of aquatic life (CCME 1987, 1999) except those indicated by α (Ontario Provincial Water Quality Objective [PWQO]; OMOE 1994) and β (British Columbia Water Quality Guideline [BCWQG]; BCMOE 2013).

(shaded) Indicates parameter concentration above applicable Water Quality Guideline.

Table A.4: Water chemistry at Mary River water quality monitoring stations during annual aquatic effects monitoring, 2015.

	Parameters	Units	Water Quality Guideline (WQG)[a]	Summer Sampling Event												
				G0-09-A Upstream Ref. 19-Jul-2015	G0-09 Upstream Ref. 19-Jul-2015	G0-09-B Upstream Ref 19-Jul-2015	G0-03 Upstream Ref. 19-Jul-2015	G0-01 Upstream Ref. 19-Jul-2015	F0-01 Tributary-F 19-Jul-2015	E0-10 Near-Field 19-Jul-2015	E0-03 Near-Field 19-Jul-2015	E0-20 Near-Field 19-Jul-2015	E0-21 Near-Field 19-Jul-2015	C0-10 Far-Field 19-Jul-2015	C0-05 Far-Field 19-Jul-2015	C0-01 Far-Field 19-Jul-2015
Conventionals	Conductivity (lab)	umho/cm	-	104	72.3	72.2	72.1	83.3	184	77.9	81.3	85.2	81.1	84.6	84.1	83.1
	pH (lab)	pH	6.5 - 9.0	7.97	7.905	7.94	7.92	7.94	8	7.78	7.94	7.94	7.93	7.92	7.93	7.95
	Hardness (as $CaCO_3$)	mg/L	-	49	33.5	33	34	40	90	37	39	40	39	40	40	39
	Total Suspended Solids (TSS)	mg/L	-	<2.0	2.2	2.8	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2	<2.0	<2.0	<2.0
	Total Dissolved Solids (TDS)	mg/L	-	51	59	43	41	40	93	48	46	47	45	54	51	51
	Turbidity	NTU	-	2.05	10.05	9.67	8.31	7.06	0.51	7.26	6.54	5.7	6.17	5.26	4.79	4.09
	Alkalinity (as $CaCO_3$)	mg/L	-	52	35.5	35	35	41	83	36	41	41	39	39	43	42
Nutrients and Organics	Total Ammonia	mg/L	variable[c]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Nitrate	mg/L	13	<0.020	<0.020	<0.020	<0.020	<0.020	0.149	<0.020	<0.020	0.032	<0.020	0.025	0.022	0.020
	Nitrite	mg/L	0.06	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Total Kjeldahl Nitrogen (TKN)	mg/L	-	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.20000	<0.15	0.31000	<0.15	<0.15
	Dissolved Organic Carbon	mg/L	-	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2
	Total Organic Carbon	mg/L	-	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	1.5	<1.0	<1.0
	Total Phosphorus	mg/L	0.020[α]	0.0056	0.00895	0.0134	0.0064	0.0061	<0.0030	0.0061	0.0055	0.0059	0.0092	0.0568	0.005	0.014
	Phenols	mg/L	0.001[α]	<0.0010	<0.0010	<0.0010	<0.0010	0.0015	<0.0010	0.0025	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Anions	Bromide (Br)	mg/L	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Chloride (Cl)	mg/L	120	1.54	1.07	1.09	0.93	1.05	2.58	0.97	1.02	1.06	1.02	1.04	1.07	1.03
	Sulphate (SO_4)	mg/L	218[β]	1.0	0.8	0.9	0.8	1.5	8.9	1.1	1.2	1.3	1.3	1.3	1.3	1.2
Total Metals	Aluminum (Al)	mg/L	0.100	0.0815	0.135	0.119	0.152	0.236	0.0236	0.227	0.198	0.296	0.219	0.212	0.249	0.214
	Antimony (Sb)	mg/L	0.020[α]	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)	mg/L	0.005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L	-	0.0067	0.0060	0.0060	0.0061	0.0069	0.0092	0.0066	0.0068	0.0073	0.0069	0.0069	0.0069	0.0069
	Beryllium (Be)	mg/L	0.011[α]	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Bismuth (Bi)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)	mg/L	0.00012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Calcium (Ca)	mg/L	-	10	7	7	7	8	19	8	8	8	8	8	8	8
	Chromium (Cr)	mg/L	0.0089	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Cobalt (Co)	mg/L	0.0009[α]	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)	mg/L	0.002	0.0008	0.0008	0.0009	0.0008	0.0008	0.0007	0.0008	0.0009	0.0009	0.0008	0.0008	0.0008	0.0010
	Iron (Fe)	mg/L	0.30	0.046	0.114	0.100	0.117	0.149	<0.030	0.151	0.140	0.181	0.124	0.120	0.136	0.113
	Lead (Pb)	mg/L	0.001	0.00006	0.00018	0.00016	0.00017	0.00016	<0.000050	0.00018	0.00018	0.00023	0.00015	0.00013	0.00014	0.00013
	Lithium (Li)	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)	mg/L	-	5.48	3.77	3.77	3.8	4.57	10.3	4.2	4.35	4.53	4.36	4.56	4.54	4.49
	Manganese (Mn)	mg/L	0.935[β]	0.00065	0.00147	0.00132	0.00139	0.00148	0.00030	0.00162	0.00187	0.00284	0.00141	0.00139	0.00175	0.00159
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Molybdenum (Mo)	mg/L	0.073	0.00016	0.00015	0.00015	0.00016	0.00018	0.00031	0.00018	0.00023	0.00026	0.00026	0.00027	0.00027	0.00027
	Nickel (Ni)	mg/L	0.025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0006	<0.00050	<0.00050	<0.00050	<0.00050
	Potassium (K)	mg/L	-	0.86	0.78	0.76	0.75	0.82	0.99	0.80	0.83	0.86	0.83	0.85	0.86	0.84
	Selenium (Se)	mg/L	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silicon (Si)	mg/L	-	0.90	0.74	0.72	0.78	1.00	0.77	1.00	0.94	1.12	0.98	0.98	1.09	1.00
	Silver (Ag)	mg/L	0.00025	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)	mg/L	-	1.610	1.130	1.120	1.040	1.040	1.100	1.040	1.060	1.090	1.070	1.110	1.100	1.080
	Strontium (Sr)	mg/L	-	0.009	0.008	0.008	0.007	0.008	0.012	0.008	0.008	0.008	0.008	0.008	0.008	0.008
	Thallium (Tl)	mg/L	0.0008	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.0100	<0.010	<0.010	<0.010	<0.010
	Uranium (U)	mg/L	0.015	0.0011	0.0010	0.0009	0.0007	0.0008	0.0018	0.0007	0.0008	0.0007	0.0007	0.0007	0.0007	0.0007
	Vanadium (V)	mg/L	0.006[α]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)	mg/L	0.030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

[a] Canadian Water Quality Guideline for the protection of aquatic life (CCME 1987, 1999) except those indicated by α (Ontario Provincial Water Quality Objective [PWQO]; OMOE 1994) and β (British Columbia Water Quality Guideline [BCWQG]; BCMOE 2013).

[shaded box] Indicates parameter concentration above applicable Water Quality Guideline.

Table A.4: Water chemistry at Mary River water quality monitoring stations during annual aquatic effects monitoring, 2015.

	Parameters	Units	Water Quality Guideline (WQG)[a]	Fall Sampling Event											
				G0-09-A Upstream Ref. 13-Aug-2015	G0-09 Upstream Ref. 13-Aug-2015	G0-09-B Upstream Ref 13-Aug-2015	G0-03 Upstream Ref. 13-Aug-2015	G0-01 Upstream Ref. 17-Aug-2015	F0-01 Tributary-F 17-Aug-2015	E0-10 Near-Field 17-Aug-2015	E0-03 Near-Field 16-Aug-2015	E0-20 Near-Field 16-Aug-2015	E0-21 Near-Field 16-Aug-2015	C0-10 Far-Field 16-Aug-2015	C0-05 Far-Field 16-Aug-2015
Conventionals	Conductivity (lab)	umho/cm	-	138	147	140	134	145	216	143	138	138	143	139	133
	pH (lab)	pH	6.5 - 9.0	8.03	8.01	8.01	7.98	8.05	8.2	8.05	8	8.01	7.99	7.99	7.92
	Hardness (as $CaCO_3$)	mg/L	-	62	65	66	64	71	114	70	68.5	68	69	68	65
	Total Suspended Solids (TSS)	mg/L	-	5.6	3.2	4.4	14.4	2	9.2	<2.0	3.2	12	5.2	2	3.6
	Total Dissolved Solids (TDS)	mg/L	-	70	73	73	80	650	106	76	76	70	68	79	77
	Turbidity	NTU	-	16.5	13.8	17.7	45.9	7.53	9.48	7.35	8.345	18.9	11.2	6.68	9.67
	Alkalinity (as $CaCO_3$)	mg/L	-	57	59	59	57	67	109	72	64	64	68	66	59
Nutrients and Organics	Total Ammonia	mg/L	variable[c]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Nitrate	mg/L	13	0.021	<0.020	<0.020	0.021	<0.020	0.092	<0.020	<0.020	<0.020	<0.020	0.023	<0.020
	Nitrite	mg/L	0.06	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Total Kjeldahl Nitrogen (TKN)	mg/L	-	<0.15	<0.15	0.16	<0.15	<0.15	0.16	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
	Dissolved Organic Carbon	mg/L	-	1.3	1.4	1.4	1.4	1.7	1.3	1.7	1.6	1.5	1.8	1.8	1.7
	Total Organic Carbon	mg/L	-	1.1	1.3	1.3	1.3	1.6	1.4	1.8	1.65	1.6	1.7	1.8	1.7
	Total Phosphorus	mg/L	0.020[α]	0.0122	0.0079	0.0115	0.0246	0.0079	0.0147	0.0209	0.0094	0.0195	0.0124	0.0087	0.0303
	Phenols	mg/L	0.001[α]	0.0048	0.004	0.005	0.004	0.0017	0.0018	0.0019	0.00265	0.0034	0.0022	0.0012	0.0028
Anions	Bromide (Br)	mg/L	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Chloride (Cl)	mg/L	120	6.48	5.38	5.21	4.27	4.18	3.96	4.19	4.055	4.02	3.83	3.72	3.66
	Sulphate (SO_4)	mg/L	218[β]	3.77	3.34	3.23	3.2	3.4	5.74	3.37	3.31	3.31	3.29	3.18	3.08
Total Metals	Aluminum (Al)	mg/L	0.100	0.695	0.425	1.01	2.58	0.23	0.154	0.223	0.1675	0.238	0.194	0.161	0.23
	Antimony (Sb)	mg/L	0.020[α]	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)	mg/L	0.005	<0.00010	<0.00010	0.00012	0.00021	<0.00010	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L	-	0.012	0.0111	0.0136	0.022	0.00987	0.0113	0.00999	0.009555	0.0106	0.01	0.00948	0.00918
	Beryllium (Be)	mg/L	0.011[α]	<0.00010	<0.00010	<0.00010	0.0001	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Bismuth (Bi)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)	mg/L	0.00012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Calcium (Ca)	mg/L	-	13.1	14.1	13.9	13.3	14.7	23.6	14.6	14.45	14.4	14.3	14.4	13.7
	Chromium (Cr)	mg/L	0.0089	0.00109	0.00077	0.00168	0.00432	<0.00050	<0.00050	<0.00050	<0.00050	0.00072	0.00051	<0.00050	0.0005
	Cobalt (Co)	mg/L	0.0009[α]	0.00024	0.00017	0.00032	0.00085	<0.00010	0.00014	<0.00010	0.000105	0.00024	0.00014	<0.00010	0.00014
	Copper (Cu)	mg/L	0.002	0.0014	0.0013	0.0019	0.003	0.00102	0.00117	0.00107	0.00117	0.00164	0.00133	0.00143	0.00146
	Iron (Fe)	mg/L	0.30	0.559	0.367	0.75	2.01	0.16	0.146	0.158	0.159	0.304	0.209	0.133	0.244
	Lead (Pb)	mg/L	0.001	0.00044	0.00033	0.00052	0.00141	0.00019	0.00032	0.000179	0.0002155	0.000489	0.000299	0.000166	0.00028
	Lithium (Li)	mg/L	-	0.0011	<0.0010	0.0012	0.003	<0.0010	0.0012	<0.0010	0.00115	0.0013	0.001	<0.0010	0.0012
	Magnesium (Mg)	mg/L	-	7.53	8.21	8.17	8.44	8.17	13.7	8.17	7.99	8.17	8.24	7.84	7.44
	Manganese (Mn)	mg/L	0.935[β]	0.0066	0.0046	0.0085	0.0221	0.0022	0.0057	0.0020	0.0031	0.0075	0.0045	0.0021	0.0042
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Molybdenum (Mo)	mg/L	0.073	0.00041	0.00034	0.00044	0.00043	0.00034	0.00021	0.00031	0.00038	0.00024	0.00030	0.00041	0.00039
	Nickel (Ni)	mg/L	0.025	0.00083	0.0006	0.00111	0.00279	<0.00050	0.00086	<0.00050	0.00059	0.0011	0.00087	0.00057	0.00085
	Potassium (K)	mg/L	-	1.4	1.27	1.5	2.12	1.09	1.12	1.11	1.01	1.04	1.02	1.02	0.97
	Selenium (Se)	mg/L	0.001	<0.000050	<0.000050	<0.000050	<0.000050	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silicon (Si)	mg/L	-	1.72	1.29	2.47	5.78	1.14	1.22	1.18	1.12	1.19	1.19	1.2	1.26
	Silver (Ag)	mg/L	0.00025	<0.000050	<0.000050	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)	mg/L	-	3.38	3.24	3.24	2.87	2.39	1.48	2.43	2.53	2.62	2.44	2.25	2.21
	Strontium (Sr)	mg/L	-	0.0166	0.0158	0.0166	0.0164	0.0141	0.0151	0.0142	0.015	0.0146	0.0141	0.0137	0.013
	Thallium (Tl)	mg/L	0.0008	0.000014	0.000011	0.000017	0.000043	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	0.0326	0.022	0.0449	0.133	<0.010	<0.010	<0.010	<0.010	0.015	0.011	<0.010	0.013
	Uranium (U)	mg/L	0.015	0.00437	0.00408	0.00388	0.00339	0.00301	0.00254	0.00304	0.00294	0.0029	0.00271	0.00253	0.00233
	Vanadium (V)	mg/L	0.006[α]	0.00126	0.00091	0.00158	0.00393	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)	mg/L	0.030	<0.0030	<0.0030	<0.0030	0.0049	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

[a] Canadian Water Quality Guideline for the protection of aquatic life (CCME 1987, 1999) except those indicated by α (Ontario Provincial Water Quality Objective [PWQO]; OMOE 1994) and β (British Columbia Water Quality Guideline [BCWQG]; BCMOE 2013).

(grey box) Indicates parameter concentration above applicable Water Quality Guideline.

Table A.5: Benthic invertebrate community summary statistics for Mary River as part of the Mary River Project annual aquatic effects study, August 2015 (n = 5 per study area).

Metric	Area	Mean	Standard Deviation	Standard Error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
Density (no. organisms / m^2)	GO-09 Reference	472	255	114	155	789	205	758
	GO-03 Reference	169	122	55	17	321	61	357
	EO-01	116	97	43	-4	235	23	278
	EO-20	278	146	65	97	459	131	502
Richness (Number of Taxa)	GO-09 Reference	11	3	1	7	15	8	16
	GO-03 Reference	9	4	2	5	14	4	13
	EO-01	8	3	1	4	11	4	10
	EO-20	12	2	1	9	14	8	14
Simpson's Evenness	GO-09 Reference	0.878	0.049	0.022	0.817	0.939	0.818	0.953
	GO-03 Reference	0.921	0.045	0.020	0.865	0.977	0.855	0.964
	EO-01	0.873	0.095	0.043	0.755	0.992	0.753	0.988
	EO-20	0.726	0.140	0.063	0.552	0.900	0.526	0.920
Bray-Curtis Index	GO-09 Reference	0.340	0.143	0.064	0.162	0.517	0.215	0.547
	GO-03 Reference	0.530	0.139	0.062	0.358	0.702	0.359	0.659
	EO-01	0.639	0.207	0.093	0.381	0.897	0.315	0.894
	EO-20	0.478	0.054	0.024	0.411	0.545	0.422	0.560
Oligochaeta (% of community)	GO-09 Reference	0.8%	1.0%	0.5%	-0.5%	2.0%	0.0%	1.9%
	GO-03 Reference	0.7%	1.6%	0.7%	-1.2%	2.6%	0.0%	3.5%
	EO-01	1.8%	3.2%	1.4%	-2.2%	5.8%	0.0%	7.4%
	EO-20	0.7%	0.7%	0.3%	-0.2%	1.6%	0.0%	1.6%
Hydracarina (% of community)	GO-09 Reference	4.1%	3.0%	1.3%	0.4%	7.9%	1.5%	7.9%
	GO-03 Reference	7.0%	2.5%	1.1%	4.0%	10.1%	3.1%	9.6%
	EO-01	2.1%	3.0%	1.4%	-1.6%	5.9%	0.0%	6.5%
	EO-20	3.8%	1.4%	0.6%	2.1%	5.5%	2.8%	6.2%
Chironomidae (% of community)	GO-09 Reference	88.1%	2.8%	1.2%	84.7%	91.6%	84.4%	91.4%
	GO-03 Reference	72.2%	8.8%	3.9%	61.3%	83.1%	61.7%	82.9%
	EO-01	82.6%	6.0%	2.7%	75.2%	90.0%	73.6%	89.0%
	EO-20	87.4%	5.1%	2.3%	81.1%	93.8%	79.2%	93.0%
Tipulidae (% of community)	GO-09 Reference	4.6%	2.9%	1.3%	1.0%	8.1%	0.9%	8.8%
	GO-03 Reference	19.0%	6.2%	2.8%	11.4%	26.6%	11.0%	25.3%
	EO-01	7.9%	5.5%	2.5%	1.1%	14.7%	3.6%	17.4%
	EO-20	4.6%	2.4%	1.1%	1.7%	7.6%	1.2%	7.9%
Shredders (% of community)	GO-09 Reference	16.0%	11.2%	5.0%	2.0%	29.9%	0.9%	32.0%
	GO-03 Reference	29.8%	8.7%	3.9%	19.0%	40.5%	23.0%	44.3%
	EO-01	20.1%	18.3%	8.2%	-2.6%	42.9%	5.5%	52.2%
	EO-20	13.0%	3.9%	1.7%	8.2%	17.8%	7.9%	18.4%
Collector-Gatherers (% of community)	GO-09 Reference	78.0%	12.1%	5.4%	63.0%	93.0%	61.3%	93.8%
	GO-03 Reference	60.7%	9.5%	4.2%	49.0%	72.5%	48.7%	70.5%
	EO-01	71.4%	16.9%	7.6%	50.4%	92.4%	47.8%	89.0%
	EO-20	77.1%	6.5%	2.9%	69.1%	85.2%	70.0%	85.5%
Clingers (% of community)	GO-09 Reference	17.3%	10.5%	4.7%	4.2%	30.3%	5.3%	33.5%
	GO-03 Reference	18.9%	11.4%	5.1%	4.8%	33.0%	6.6%	33.3%
	EO-01	15.8%	11.4%	5.1%	1.6%	29.9%	5.5%	34.8%
	EO-20	13.1%	3.6%	1.6%	8.5%	17.6%	8.4%	18.4%
Sprawlers (% of community)	GO-09 Reference	76.8%	10.9%	4.9%	63.3%	90.3%	61.3%	91.4%
	GO-03 Reference	60.0%	10.7%	4.8%	46.8%	73.3%	45.2%	70.5%
	EO-01	67.3%	17.8%	8.0%	45.2%	89.4%	47.8%	89.0%
	EO-20	75.5%	6.7%	3.0%	67.1%	83.8%	66.8%	84.2%
Burrowers (% of community)	GO-09 Reference	5.9%	2.8%	1.2%	2.5%	9.3%	3.3%	8.9%
	GO-03 Reference	21.1%	8.6%	3.8%	10.4%	31.8%	11.0%	32.2%
	EO-01	16.9%	13.9%	6.2%	-0.3%	34.1%	5.5%	40.0%
	EO-20	11.0%	5.5%	2.5%	4.2%	17.9%	2.4%	16.8%

Table A.6: Statistical comparison of benthic invertebrate communtiy endpoints among Mary River benthic invertebrate community study areas as part of the Mary River Project annual effects monitoring program, August 2015.

Metric	Overall 5-group Comparison			Pair-wise, post-hoc comparisons[a]					
	Significant Difference Among Areas?	p-value	Staistical Test[b]	(I) Area	(J) Area	Significant Difference Between 2 Areas?	p-value	Magnitude of Difference	Statistical Test
Density (individuals/m^2)	YES	0.02961	ANOVA[c]	GO-09 Reference 1	GO-03 Reference 2	NO	0.4388	-	Tamhane's[d]
				GO-09 Reference 1	EO-01	NO	0.2794	-	
				GO-09 Reference 1	EO-20	NO	0.8771	-	
				GO-03 Reference 2	EO-01	NO	0.9980	-	
				GO-03 Reference 2	EO-20	NO	0.9345	-	
				EO-01	EO-20	NO	0.5501	-	
Richness (number of taxa)	YES	0.06431	ANOVA[c]	GO-09 Reference 1	GO-03 Reference 2	NO	0.8077	-	Tukey's[c]
				GO-09 Reference 1	EO-01	NO	0.3160	-	
				GO-09 Reference 1	EO-20	NO	1.0000	-	
				GO-03 Reference 2	EO-01	NO	0.9027	-	
				GO-03 Reference 2	EO-20	NO	0.7497	-	
				EO-01	EO-20	NO	0.2676	-	
Bray-Curtis Index	YES	0.00177	ANOVA[c]	GO-09 Reference 1	GO-03 Reference 2	NO	0.2400	-	Tukey's[c]
				GO-09 Reference 1	EO-01	YES	0.0222	2.1	
				GO-09 Reference 1	EO-20	NO	0.5371	-	
				GO-03 Reference 2	EO-01	NO	0.7332	-	
				GO-03 Reference 2	EO-20	NO	0.9758	-	
				EO-01	EO-20	NO	0.3915	-	
Oligochaeta (% of community)	YES	0.00064	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	NO	0.9981	-	Tukey's[e]
				GO-09 Reference 1	EO-01	NO	0.3785	-	
				GO-09 Reference 1	EO-20	NO	0.9492	-	
				GO-03 Reference 2	EO-01	NO	0.5489	-	
				GO-03 Reference 2	EO-20	NO	0.9929	-	
				EO-01	EO-20	NO	0.7935	-	
Hydracarina (% of community)	YES	0.07488	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	NO	0.6995	-	Tamhane's[e]
				GO-09 Reference 1	EO-01	NO	0.9885	-	
				GO-09 Reference 1	EO-20	NO	1.0000	-	
				GO-03 Reference 2	EO-01	NO	0.4682	-	
				GO-03 Reference 2	EO-20	NO	0.3491	-	
				EO-01	EO-20	NO	0.9402	-	

[a] Post-hoc analysis of 1-way ANOVA among all areas protected for multiple comparisons.

[b] Statistical tests include Analysis of Variance (ANOVA) and Kruskal Wallis H-test (KW H-test).

[c] Data normally distributed. Untransformed data used for comparison(s).

[d] Data non-normally distributed. Kruskal-Wallis H-test confirmed ANOVA test results.

[e] Logit transformed data were normally distributed. Parametric statistics applied.

[f] Logit transformed data were non-normally distributed for at least one study area. Post hoc statistics for pair-wise comparisons were confirmed using MW U-tests.

[grey box] Highlighted values indicate significant difference between study areas based on ANOVA p-value less than 0.10 that were also outside of a Critical Effect Size of ±2 SD, suggesting an ecologically meaningful difference.

BOLD Bold text values indicate significant difference between study areas based on ANOVA p-value less than 0.10, but a Critical Effect Size within ±2 SD, suggesting the difference is not ecologically meaningful.

Table A.6: Statistical comparison of benthic invertebrate communtiy endpoints among Mary River benthic invertebrate community study areas as part of the Mary River Project annual effects monitoring program, August 2015.

Metric	Overall 5-group Comparison			Pair-wise, post-hoc comparisons[a]					
	Significant Difference Among Areas?	p-value	Staistical Test[b]	(I) Area	(J) Area	Significant Difference Between 2 Areas?	p-value	Magnitude of Difference	Statistical Test
Chironomidae (% of community)	YES	0.00655	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	YES	0.0132	-5.7	Tukey's[e]
				GO-09 Reference 1	EO-01	NO	0.7582	-	
				GO-09 Reference 1	EO-20	NO	1.0000	-	
				GO-03 Reference 2	EO-01	NO	0.1483	-	
				GO-03 Reference 2	EO-20	***YES***	***0.0142***	***1.7***	
				EO-01	EO-20	NO	0.7759	-	
Tipulidae (% of community)	YES	0.01526	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	YES	0.0618	5.1	Tamhane's[e]
				GO-09 Reference 1	EO-01	NO	0.8604	-	
				GO-09 Reference 1	EO-20	NO	1.0000	-	
				GO-03 Reference 2	EO-01	NO	0.2155	-	
				GO-03 Reference 2	EO-20	YES	0.0310	-2.3	
				EO-01	EO-20	NO	0.8861	-	
Shredder (% of community)	NO	0.31194	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	NO	0.2950	-	Tukey's[e]
				GO-09 Reference 1	EO-01	NO	0.9054	-	
				GO-09 Reference 1	EO-20	NO	0.9987	-	
				GO-03 Reference 2	EO-01	NO	0.7800	-	
				GO-03 Reference 2	EO-20	NO	0.4317	-	
				EO-01	EO-20	NO	0.9741	-	
Collector-Gatherer (% of community)	NO	0.15695	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	NO	0.2848	-	Tukey's[e]
				GO-09 Reference 1	EO-01	NO	0.9585	-	
				GO-09 Reference 1	EO-20	NO	0.9966	-	
				GO-03 Reference 2	EO-01	NO	0.6602	-	
				GO-03 Reference 2	EO-20	NO	0.4614	-	
				EO-01	EO-20	NO	0.9971	-	
Burrower (% of community)	YES	0.01056	ANOVA[e]	GO-09 Reference 1	GO-03 Reference 2	YES	0.0228	5.5	Tukey's[f]
				GO-09 Reference 1	EO-01	NO	0.1400	-	
				GO-09 Reference 1	EO-20	NO	0.6586	-	
				GO-03 Reference 2	EO-01	NO	0.8920	-	
				GO-03 Reference 2	EO-20	NO	0.2994	-	
				EO-01	EO-20	NO	0.8040	-	

[a] Post-hoc analysis of 1-way ANOVA among all areas protected for multiple comparisons.

[b] Statistical tests include Analysis of Variance (ANOVA) and Kruskal Wallis H-test (KW H-test).

[c] Data normally distributed. Untransformed data used for comparison(s).

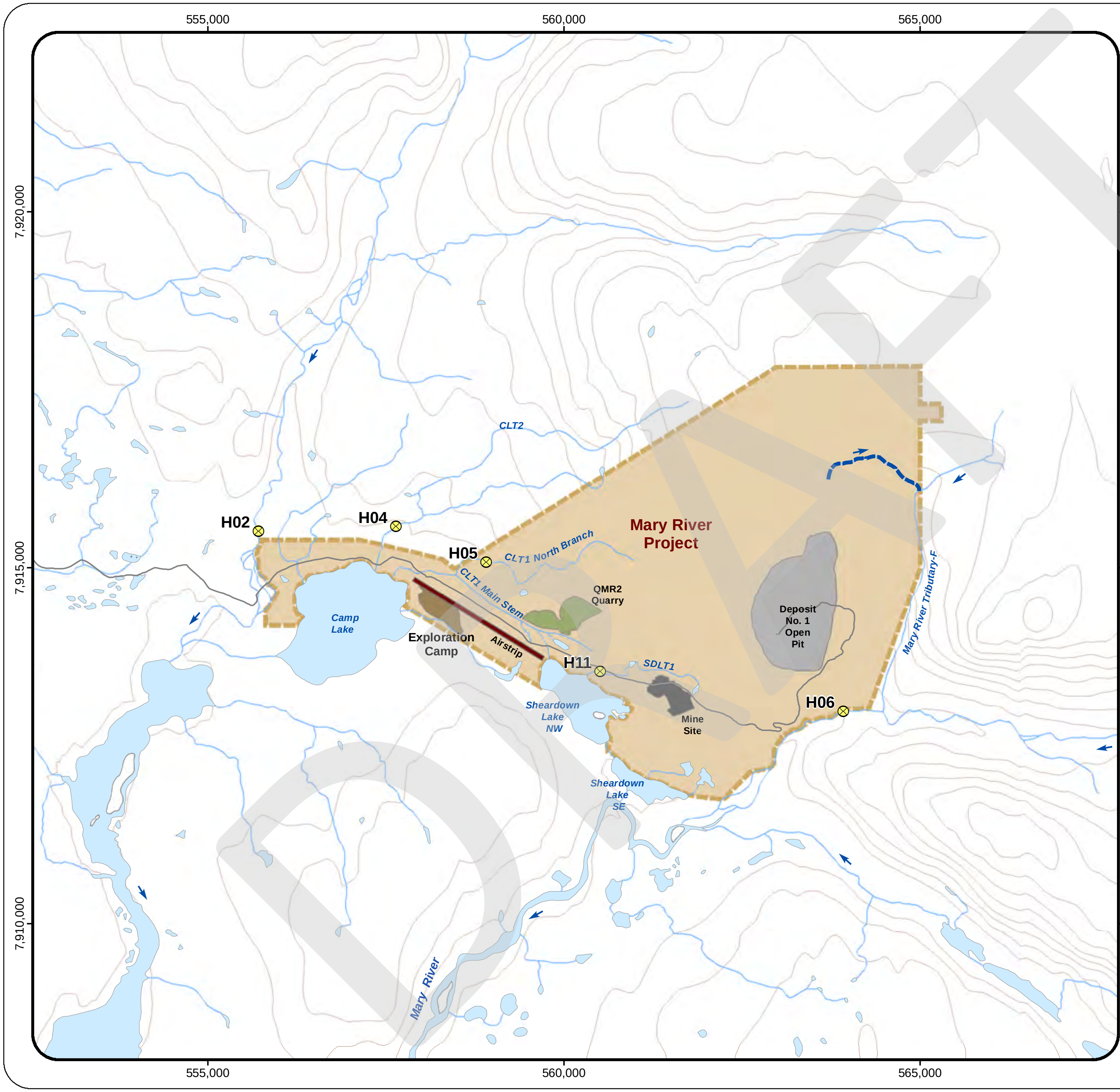
[d] Data non-normally distributed. Kruskal-Wallis H-test confirmed ANOVA test results.

[e] Logit transformed data were normally distributed. Parametric statistics applied.

[f] Logit transformed data were non-normally distributed for at least one study area. Post hoc statistics for pair-wise comparisons were confirmed using MW U-tests.

(grey box) Highlighted values indicate significant difference between study areas based on ANOVA p-value less than 0.10 that were also outside of a Critical Effect Size of ±2 SD, suggesting an ecologically meaningful difference.

BOLD Bold text values indicate significant difference between study areas based on ANOVA p-value less than 0.10, but a Critical Effect Size within ±2 SD, suggesting the difference is not ecologically meaningful.



Features

- Hydrometric Monitoring Station
- Overland Effluent Path
- Mary River Project
- Airstrip
- Exploration Camp
- Mine Site
- Open Pit
- Waterbody
- Tote Road
- Contours (20 m)
- Water Flow Direction

N E S W

0 875 1,750 3,500
Meters

MAP INFORMATION
Map Projection: UTM Zone 17N NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.
Creation Date: July 2016
Project No.: 2569

Figure A.1: Hydrological Station Locations at the Mary River Project

minnow environmental inc.

Appendix 4

Baffinland Response to ECCC Comments on EEM Phase 1 Study Design

Baffinland

August 10th, 2017

Mr. Erik Allen
Environmental Effects Monitoring Coordinator
Prairie and Northern Region
Environmental Protection Operations Directorate
9250 – 49th Street NW
Edmonton, Alberta T6B 1K5

Dear Mr. Allen,

Re: <u>Response to ECCC Action Items and Comments on the Mary River Project 1st Environmental Effects Monitoring Study Design</u>

Environment and Climate Change Canada (ECCC) reviewed the Mary River Project First Environmental Effects Monitoring (EEM) Study Design report submitted by Baffinland Iron Mines Corporation (Baffinland) and provided specific action items and comments applicable to the study as outlined in their letter dated February 28th, 2017. Baffinland has prepared this detailed response to address the fifteen action items and eight 'other items' provided by ECCC stemming from their review of the study design. As follow-up to this response, it is suggested that resolution to any potential outstanding issues can be achieved either through a teleconference arranged between ECCC and Baffinland prior to implementation of the field study (August 2017), or during the ECCC site visit to the Mary River Project from August 15th – 17th, 2017.

Sincerely,
Baffinland Iron Mines Corporation

Laura Taylor
Environmental Superintendent

Cc: William Bowden, Environmental Superintendent, Baffinland
Paul LePage, Minnow Environmental Inc.

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Baffinland Iron Mines Corporation: Response to ECCC Comments on the Mary River Project 1^{st} Environmental Effects Monitoring Study Design

PART A - Action Items

Action Item 1: "*p. 1, Section 1.1. The NWB currently has on file a copy of Baffinland Iron Mines Corporation's (BIMC) Aquatic Effect Monitoring Plan (AEMP) (Rev 2), which includes a Draft EEM Cycle Study Design as a subset of the AEMP. As the NWB is currently in the process of considering BIMC's AEMP for Approval, confirmation is required from BIMC on the extent to which changes included in the current EEM Study Design, which superseded the Draft EEM study design, may impact the NWB's ability to potentially approve the current version of the AEMP.*"

Response: The (2014) EEM study design presented as part of the Rev 2 AEMP had assumed a total of four Final Discharge Points (FDP) operating under full capacity of the Mary River Project as described in the Baffinland (2012) Final Environmental Impact Assessment. Currently, only two FDP are intermittently active (MS-08 East Pond, MS-06 Ore Stockpile Runoff). In addition, to date, annual effluent discharge rates from each of these FDP have been much lower than the discharge rates estimated in the Rev 2 AEMP EEM study design (i.e., 2,217 m^3 in 2015 versus 3,133,000 m^3/year estimated in the Rev 2 EEM study design for Station MS-08; 86 m^3 in 2016 versus 110,000 m^3/year estimated in the Rev 2 EEM study design for Station MS-06).

The current (2016) EEM study design better reflects conditions of existing mine operations, focusing on those watercourses that currently receive mine effluent under the more limited effluent flow rates. Specifically, biological sampling will focus on Mary River Tributary-F under the current (2016) EEM study design. Under the (2014) Rev 2 AEMP EEM Study Design, sampling areas were concentrated on Mary River and Camp Lake Tributary 1. However, intensive sampling, similar to that conducted for the EEM program, is currently conducted at both Mary River and Camp Lake Tributary 1 under Baffinland's Core Receiving Environment Monitoring Program (CREMP), which has been conducted annually following the commencement of mine operations. For instance, three and two mine-exposed biological monitoring areas have been established/ sampled on Mary River and Camp Lake Tributary 1, respectively, in addition to comparable reference areas. These same areas were proposed for sampling under the former (2014) Rev 2 AEMP EEM Study Design. The benthic invertebrate community survey and fish population survey approaches were very similar between the former (2014) Rev 2 AEMP EEM study design and the current (2016) EEM study design.

Therefore, through the additional focus on the watercourse most likely to be influenced by mine effluent (i.e., Mary River Tributary-F), the current (2016) EEM study design enhances the overall spatial coverage of environmental monitoring at the Mary River Project relative to the former (2014) Rev 2 AEMP EEM study design. Moreover, because the current CREMP included biological sampling at those areas proposed for monitoring under the former (2014) Rev 2 AEMP EEM study design, the changes between the 2014 and 2016 EEM study designs will not detract from the overall objectives of the AEMP (e.g., to evaluate short- and long-term effects of the Mary River Project on aquatic ecosystems) and will actually enhance the overall program (i.e., through the addition of Mary River Tributary-F as a sampling area).

Action Item 2: "*p. 7. The study design includes a description of how effluent mixes in the exposure area, based on extrapolated stream discharge volumes for Tributary-F. It would appear that daily effluent discharge was compared to a stream flow estimate based on annual average flows from nearby streams, however the methods were unclear. Please provide further details on how the stream discharge and effluent concentrations were estimated.*

a. Were extrapolated values based on the average flows from similarly-sized watersheds listed in Table A2? Were the watersheds similar to Tributary-F in elevation, gradient, and aspect?

b. Was the extrapolated discharge for Tributary F based on 2015 data only?

c. Were monthly and annual variations in streamflow considered in the estimates of effluent concentration?

***d. Where along Tributary-F do the estimates of effluent concentration apply (e.g., at the confluence with the effluent stream, or downstream at the confluence with Mary River)?*"**

Response: Streamflow of Tributary-F was estimated using average per unit watershed area flow data ($m^3/day/km^2$) from six nearby watercourses for the months of July and August collected in 2015. These average flow data were multiplied by the watershed area of Tributary F (in this case, 6.8 km^2 at the confluence with the effluent discharge) to determine the percent effluent following complete mixing using the average and maximum effluent discharge rate (148 and 293 m^3/day, respectively) over the period of effluent discharge in July/August 2015. The formula used to determine the percentage of effluent at the Tributary F/ effluent discharge confluence was as follows:

- effluent discharge (m^3/day) / [stream flow (m^3/day for the 6.8 km^2 area) + effluent discharge (m^3/day)]

This value was calculated separately for July and August, and then averaged to arrive at an extrapolated average effluent concentration during the period of mine effluent discharge. The same method was used to determine the percentage of effluent at the Mary River confluence with Tributary F (watershed area of 232.6 km^2).

a. Extrapolated values were taken from the six watershed sizes indicated in Appendix Table A.2, which ranged from 3.6 – 250 km^2. As indicated above, the average discharge per unit area (m^3/day/km^2) for these six watercourses was used to extrapolate the percentage of effluent at Tributary F and Mary River. In general, watercourses with smaller watershed sizes (i.e., under 10 km^2) more closely mirrored the elevation, gradient and aspect of Tributary F than watercourses with larger watersheds at the Baffinland hydrological monitoring stations.

b. Stream discharge data from 2015 became available for incorporation into the Study Design document in the later stages of preparation. Unfortunately, changes applicable to some of the text in the effluent dilution (Section 2.2.4) and fish population survey (Section 3.2.1) portions of the report were not consistently updated/adjusted to reflect the addition of the 2015 data. Text from the first paragraph of Section 2.2.4 should have read as follows (in bold):

Estimates of effluent dilution in the mine receiving environment were conducted using the 2015 final effluent discharge data together with watershed discharge rates pro-rated using data from six Mary River Project mine site stream gauging stations over the 2015 open-water period. Based on estimated annual average flow by watershed and average daily effluent discharge (i.e., 148 m^3/day during periods of discharge; see Section 2.2.2), the MS-08 effluent was estimated to constitute an average of 1.3% and 0.03% of flow during periods of effluent discharge in 2015 (i.e., July and August) at the effluent stream confluence with Mary River Tributary-F and Mary River, respectively (Figure 2.3). Assuming the maximum daily effluent volume discharged in 2015 (i.e., 293 m^3 on July 12, 2015), the MS-08 effluent was estimated to constitute approximately 2.5% and 0.065% of flow at the effluent stream confluence with Mary River Tributary-F and Mary River, respectively, during the July-August period of discharge in 2015, assuming average regional monthly flow conditions on the day of maximum discharge (Figure 2.3).

c. Based on the monthly 2015 streamflow data, average and maximum effluent concentrations were 1.3 ± 0.5% and 2.5 ± 0.9%, respectively, for the months of July/August at the Tributary-F confluence with the effluent channel based on the streamflow data from all six watercourses. Similarly, average and maximum effluent concentrations were 0.033 ± 0.019% and 0.065 ± 0.038%, respectively, for the months of July/August at the Mary River confluence with Tributary-F based on the 2015 streamflow data from the Mary River gauging station.

d. Effluent concentrations on Tributary F that were indicated on p. 7 applied to the confluence with the effluent stream (i.e., the initial mixing zone).

Action Item 3: "*p. 12. The proponent is recommended to verify effluent concentrations with in-stream conductivity measurements during effluent discharge periods in 2017. Please provide details on an approach to assess effluent concentrations based on effluent and stream conductivity in the receiving environment, including sampling locations and calculations (refer to the Metal Mining EEM Guidance Technical Document (TGD), Sections 2.2.1.1 and 2.2.1.2)*"

Response: Effluent concentrations within Tributary F and Mary River will be determined at the time of biological sampling in August 2017 using the approach suggested in the Metal Mining EEM TGD. Together with effluent specific conductance measured at the time of biological sampling, specific conductance measurements at reference and effluent-exposed benthic invertebrate community/fish monitoring stations will be used as the basis for determination of effluent concentrations at Tributary F and Mary River, as applicable. During site reconnaissance conducted by Minnow in 2015, a specific conductance survey conducted to estimate effluent concentrations along Tributary-F was confounded by runoff received from areas subject to drilling and/or hauling activity which resulted in higher aqueous specific conductivity in Tributary-F. Notably, calcium chloride ($CaCl_2$) is used to aid with drilling through permafrost at Baffinland, which was believed to result in elevated specific conductance in runoff feeding into Tributary-F at the time of the 2015 specific conductance survey.

Action Item 4: "*p. 12, Section 2.3.4. It is recommended that the proponent provide details regarding measures implemented and monitoring that may be conducted to determine whether or not the effluent discharged from MS-08 may have any negative impact on the receiving environment, preceding the final discharge point"*

Response: It is unclear as to the recommended location referred to in this Action Item (i.e, "preceding the final discharge point"). If referring to the lower 740 m length of channel that drains into Tributary-F, no monitoring is proposed for this portion of the system, with the exception of *in situ* water quality measurements conducted at the time of biological monitoring in August 2017. Flow in this intermittent section of the channel is likely to be represented entirely by effluent in August, and we believe there is very low likelihood that benthic invertebrate communities become well established in watersheds of this small size, confounding the ability to assess biological influences of the mine effluent on biota. The photograph below illustrates the portion of the channel just upstream of Tributary-F in August 2016 during effluent discharge. In this photo, the channel width is approximately 30 cm and water depths reach a maximum of approximately 5 cm.

Action Item 5: "*Figure 2.4. The legend in Figure 2.4 indicates that 2015 data were used to estimate monthly discharge for the Mary River and Tributary-F. Table A-2 presents monthly discharge data for several stations from 2006 to 2014, but there are no 2015 data. Please provide the missing data."*

Response: As indicated in the response to Action Item 2, stream discharge data from 2015 became available for incorporation into the Study Design document in the later stages of preparation. Appendix Table A.2 has been updated to include the 2015 data and is presented at the end of this response.

Action Item 6: "*p. 18. The study design did not describe methods for the collection of sediment samples for particle size and total organic carbon analyses, which are required if the study is conducted in an area where it is possible to sample sediment (MMER, Sched. 5, s. 16(a)(iii)). The description of the sampling areas (erosional habitat with gravel/cobble substrate) would suggest that sediment sampling will not be possible; please confirm or provide the missing information.*"

Response: Correct. Sediment sampling will not be collected concurrent with benthic invertebrate community samples given the presence of only erosional habitat (boulder with interspersed gravel/cobble) in Tributary-F. The photo below illustrates habitat typical of Tributary-F.

**Action Item 7: "*p. 21. The study design suggests that low effluent concentration in the Mary River would exempt the proponent from the requirement to conduct a fish study, should no fish be collected from Tributary-F. The MMER require a fish population study if the effluent concentration in the exposure area is greater than 1% in the area located within 250 m of the final discharge point (FDP) (Sched. 5, s. 9(b)). Based on the information provided, the fish survey exemption does not apply to the proposed study. The fish survey should be initially conducted in Tributary-F as proposed, and if fish are determined to be absent or in low abundance, field crews should sample progressively downstream into the Mary River, where fish may be more abundant. Please provide information on potential reference sites for the Mary River exposure area. Given concerns over low fish abundance, the proponent is recommend to identify several reference site options for the Tributary-F and Mary River exposure areas."*

Response: From our consultant's perspective, greater clarity on the MMER definition of a "final discharge point (FDP)" is required in cases in which an overland effluent discharge point is concerned. Effluent concentrations in Tributary-F, the first 'permanent' flowing watercourse that the effluent meets during the open-water period (approximately late June to early September), appears to be approximately 1% within 250 m of the confluence with the effluent channel, on average. Extrapolation using maximum effluent flow data suggested that effluent concentrations in Tributary-F may periodically be greater than 1% within 250 m of the confluence with the effluent channel. Despite this, the ecological relevance of conducting a fish survey at Mary River, where effluent concentrations are estimated to be well less than 1% (i.e., average and maximum of 0.02% and 0.035%, respectively, based on data collected from 2006 – 2015, assuming continual effluent discharge), is questionable. Attributing potential differences in fish population endpoints between reference and effluent-exposed areas of Mary River to mine effluent exposure (the intent of the MMER) does not seem scientifically defensible in cases where the maximum effluent concentration is so low. Furthermore, the evaluation of effluent-related effects on Arctic charr populations of Mary River (and other watercourses in the Mary River Project region) is further limited by the fact that liquid water is generally present (and fish possibly present) only from early July through mid-September, and that mine effluent is only discharged intermittently (e.g., 16 days in 2015). Thus, very low effluent concentrations coupled with limited exposure period will preclude definitive assessment of mine effluent-related effects to fish populations of Mary River.

It is suggested that resolution of this Action Item occur through teleconference prior to implementation of the field study (August 2017) or during the ECCC site visit to the Mary River Project from August 15th – 17th, 2017.

Action Item 8: "*p. 21. The report indicates that mine effluent represented 0.02% - 0.035% of flow in the Mary River. On p.7, the effluent percentage of flow in the Mary River was given as 0.03% and 0.065%; please clarify.*"

Response: On page 21, average and maximum concentrations of mine effluent in Mary River were 0.02% - 0.035%, respectively, based on average streamflow at the Baffinland Mary River hydrological station over the period of 2006-2015. On page 7, average and maximum concentrations of mine effluent in Mary River were 0.03% - 0.065%, respectively, based on average streamflow at the Baffinland Mary River hydrological station only in 2015 (July/August period). Please see response to Action Item 2 for additional clarity.

Action Item 9: "*p. 25. The study design indicates that stream velocity and channel dimensions will be measured, will discharge volumes be calculated?*"

Response: No, discharge volumes will not be calculated from the stream water velocity and channel dimension data collected for EEM. These data will be collected to provide general information on habitat characteristics of each study area to assist with the interpretation of biological data. The number of monitoring points along each transect, and the in-stream transect locations, are not intended to be sufficient for accurate discharge volume calculation.

Action Item 10: "*p. 26. Please briefly describe field preservation and shipping protocols for water samples to ensure laboratory sample hold times are met, given the remote location of the study area.*"

Response: Please refer to the attached Standard Operating Procedure (SOP) developed for water sampling at the Mary River Project.

Action Item 11: "*p. 14. Section 3.5.6 It is recommended that the proponent provide details regarding further or continued monitoring and/or analyses that may be conducted to determine the extent to which mining activities may be contributing to the differences, over time, in results observed in the water quality parameters measured at Tributary F and the Mary River Up-stream Reference Station*"

Response: Baffinland will conduct water quality monitoring at established EEM and AEMP (CREMP) stations at frequencies required under each respective approved monitoring plan. The locations and frequencies of sampling appear to be sufficient for monitoring spatial differences between mine-exposed and reference areas, and temporal changes over time, in water quality of Tributary-F and Mary River.

Action Item 12: "*p. 26. Section 3.5. It is recommended that details regarding the exposure and reference areas to be monitored be confirmed in the EEM Study Design in the context of BIMC's recommended discontinuation of monitoring for several stations potentially related to exposure and/or reference areas, based on the correspondence accompanying the AEMP (Rev 2).*"

Response: Because approval for changes suggested in correspondence accompanying the AEMP (Rev 2) has not been received from regulators and other stakeholders, no changes to stations will be implemented within the time period of the first EEM study

Action Item 13: "*The proponent previously notified the authorization officer of the addition of a second FDP (MS-06) for the Mary River Project (letter from J. Millard to S. Forbrich, June 18, 2016). The MS-06 FDP was not described in the current study design. The MMER require a description of the manner in which the effluent mixes within the exposure area for each final discharge point (MMER, Sched. 5, s. 11(a)). Please provide any available information regarding effluent mixing from MS-06, and a description of plume delineation methods to be implemented in 2017 (as requested for MS-08; see comment #3).*"

Response: Discharge of effluent from the MS-06 FDP was limited to a single day (September 12) in 2016, during which 86 m^3 of effluent was released. Because the EEM study design was required to be submitted by July 10, 2016, data pertaining to the MS-06 FDP effluent release were not provided. It is anticipated that effluent release from the MS-06 FDP discharge will occur rarely, and for very brief periods of time. To the extent possible, given potential safety concerns associated with high water velocities, water depths greater than 1 m, and large boulder substrate (safe footing issues), Baffinland will conduct a specific conductance survey as indicated in the response to Action Item 3 above within the Mary River receiver at the time of effluent release to characterize mixing features. Because a hydrological station is established on Mary River, extrapolation of effluent concentrations in Mary River can also be conducted on a daily basis, as required, following download of the data at the end of the open-water season.

As suggested in the response to Action Item 1, the MS-08 FDP is likely to release greater volume of effluent than the MS-06 FDP in any given year (e.g., 2,217 m^3 was released at MS-08 in 2015, and 86 m^3 was released at MS-06 in 2016). Therefore, the MS-08 FDP will served as the focus for biological studies in the current EEM phase.

Action Item 14: "*The MS-06 FDP will discharge to the Mary River through a treated sewage pipeline; will mine effluent and treated sewage be discharged concurrently?"*

Response: Although it is unlikely that the MS-06 FDP will discharge concurrently with the discharge of treated sewage, in the event that unusually high amounts of runoff, there may be periods in which both are discharged concurrently. Please note that it is currently anticipated that discharge from the MS-06 FDP will occur very rarely (a few days per year) on an intermittent basis.

Action Item 15: "*Appendix A, Table A.4. Please indicate the location of stream sampling sites listed in Table A.4. Was there a noticeable difference in water chemistry between upstream and downstream sites on Tributary-F?"*

Response: A map showing the locations of the CREMP lotic sampling sites indicated on Appendix Table A.4 accompanies this response. No difference in water chemistry has been indicated between Mary River stations located upstream and downstream of the Tributary-F confluence.

<u>PART B – Other Items</u>

Comment 16: "*Fig. 2-4. The figure caption should refer to mean monthly stream discharge, not effluent discharge; please confirm."*

Response: Correct. The caption for Figure 2.4 should refer to mean monthly stream discharge, not effluent discharge. Sorry for any confusion.

Comment 17: "*p. 14. The proponent is recommended to conduct annual water quality monitoring in Tributary F near the confluence with the effluent discharge, and a comparable reference stream, in addition to proposed monitoring in the Mary River.*"

Response: Acknowledged. Annual water quality monitoring will be conducted in Tributary-F near the confluence with the effluent discharge, and a comparable reference stream, in addition to proposed monitoring in the Mary River.

Comment 18: "*p. 15. The report states that ninespine stickleback have been captured in low abundance in the Mary River area, but later states that arctic charr are the only species captured in Mary River. Have ninespine stickleback been located in any of the streams identified for the biological monitoring study?*"

Response: To our knowledge, no ninespine stickleback have been captured in the Mary River or in any of the streams identified for the EEM biological study. However, because this species is known to inhabit streams, rivers and lakes, there is some potential for ninespine stickleback presence in streams and rivers of the Mary River Project area. It is anticipated that if present, ninespine stickleback are likely to be present in low abundance in area lotic habitats given low numbers captured in lentic habitat near the mine.

Comment 19: "*p. 22. The proponent is advised to plan for up to 7 days of sampling per area to meet sample size targets for the fish survey.*"

Response: Stream backpack electrofishing is the proposed method of fish capture for the EEM study. Given the relatively small size of Tributary-F, the determination of whether fish are present within this tributary will likely require less than a day by an experienced electrofishing team. It is proposed that, in the event that fish are determined to be absent in Tributary-F through the initial sampling, ECCC will be contacted to determine the best course of action. Continuing to conduct active sampling for a full seven days in the absence of fish is not considered practical or cost efficient. It is suggested that resolution of this item occur through teleconference prior to implementation of the field study (August 2017) or during the ECCC site visit to the Mary River Project from August 15th – 17th, 2017.

Comment 20: "*p. 23. Please be advised that the TGD recommends independent confirmation of fish ageing for 10% of samples.*"

Response: Acknowledged. Independent confirmation of fish ageing will be conducted on 10% of submitted samples.

Comment 21: "*Table 3.2. The table indicates no statistical analysis for the reproduction endpoint. Please note that the non-lethal reproduction endpoint (relative abundance of YOY) can be analyzed by comparing exposure and reference length frequency distributions with the Kolmogorov-Smirnov test, with and without YOY. If the inclusion of YOY changes the outcome of statistical comparison, the proportion of YOY is considered to be different between sampling areas (TGD, Section 3.4.2.2).***"**

Response: Acknowledged.

Comment 22: "*p. 25. Please ensure collection of trip and field blanks for water chemistry QA/QC, as recommended by the TGD (Section 5.8.4).***"**

Response: Acknowledged. Water chemistry trip and field blanks will be collected.

Comment 23: "*An overview document outlining the amendments proposed for the MMER was shared with stakeholders in December 2016. If you have not received this document and would like a copy, please contact Erik Allen. The proposed amendments are expected to be published in Canada Gazette, Part 1 in spring of 2017. Canada Gazette, Part II publication would likely occur 12 to 18 months following Canada Gazette Part 1 publication.***"**

Response: Thank you for letting us know. We had received a copy of the overview document early in 2017.

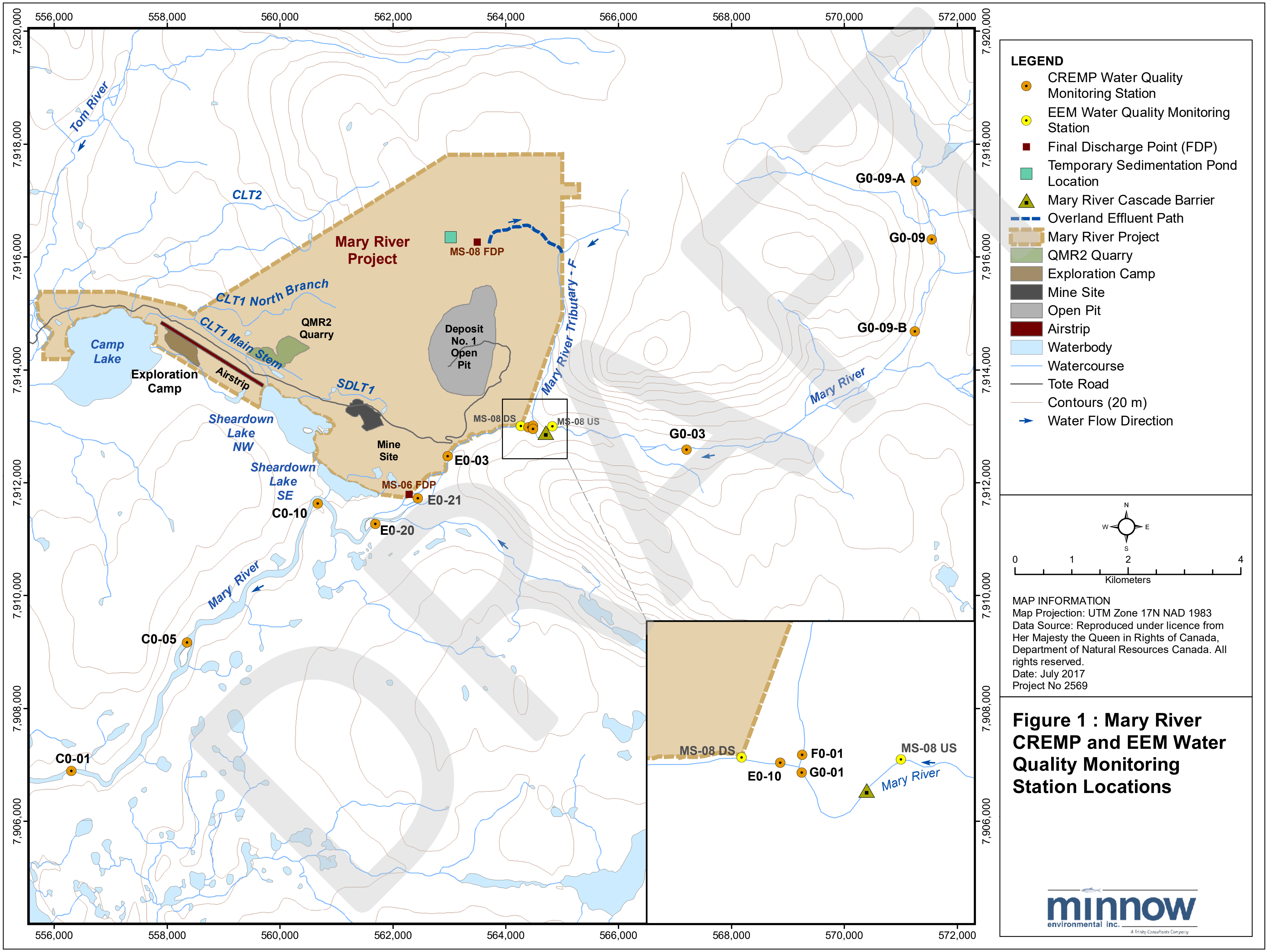

Figure 1 : Mary River CREMP and EEM Water Quality Monitoring Station Locations

Table A.2: Average monthly discharge data (m^3/s) collected from Mary River Project hydrological gauging stations, 2006 - 2015.

Year	Montth	Hydrological Station					
		H1 Phillips Creek Tributary (250 km^2)	H2 Tom River (210 km^2)	H4 Camp Lake Tributary2 (8.3 km^2)	H5 Camp Lake Tributary1 (5.3 km^2)	H6 Mary River (250 km^2)	H11 Sheardown Lake Trib1 (3.6 km^2)
2006	June	-	5.05	-	-	-	-
	July	14.65	19.20	0.83	0.38	26.64	-
	August	5.46	5.37	0.29	0.15	15.03	-
	September	7.42	3.07	0.29	0.17	24.01	-
2007	June	10.94	4.42	0.25	0.31		-
	July	6.93	7.78	0.21	0.10	11.68	-
	August	3.77	4.04	0.13	0.10	6.54	-
	September	1.62	1.14	0.07	0.05	4.22	-
2008	June	12.20	-	1.56	0.42	26.06	-
	July	10.31	-	0.38	0.22	16.96	-
	August	7.44	-	0.25	0.22	8.21	-
	September	5.33	-	0.17	0.12	7.06	-
2010	June	-	33.25	-	0.78	39.55	-
	July	-	14.34	-	0.19	18.76	-
	August	-	2.34	-	0.08	3.69	-
	September	-	5.42	-	0.14	7.13	-
2011	June	13.70	-	0.44	0.30	27.41	0.07
	July	3.11	-	0.07	0.05	5.29	0.02
	August	1.25	-	0.03	0.02	2.32	0.02
	September	1.56	-	0.03	0.02	1.89	0.02
2012	June	24.24	35.76	0.88	0.81	32.23	0.12
	July	7.49	13.42	0.39	0.22	11.63	0.07
	August	2.36	4.82	0.16	0.10	5.47	0.06
	September	3.90	-	0.28	0.17	8.00	0.08
2013	June	10.80	18.04	-	0.32	19.75	0.14
	July	9.74	17.95	0.09	0.25	20.98	0.12
	August	-	2.88	0.07	0.08	4.63	0.05
	September	-	-	0.05	0.06	3.07	0.06
2014	June	7.03	6.35	-	0.28	-	0.12
	July	13.42	21.28	-	0.42	31.09	0.09
	August	7.18	9.08	-	0.20	9.83	0.09
	September	2.14	1.90	-	0.05	1.88	0.04
2015	June	15.70	14.50	0.41	0.13	18.60	0.03
	July	8.80	6.00	0.20	0.06	9.20	0.04
	August	3.50	2.30	0.20	0.08	3.80	0.06
	September	-	0.90	0.03	0.03	1.10	0.03
Average	June	13.52	16.77	0.71	0.42	27.27	0.09
	July	9.31	14.28	0.31	0.21	16.91	0.07
	August	4.42	4.41	0.16	0.12	6.61	0.06
	September	3.66	2.49	0.13	0.09	6.48	0.04

APPENDIX A

WATER AND SEDIMENT QUALITY SAMPLING PROTOCOL

(Pages A-1 to A-24)

ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

WATER AND SEDIMENT QUALITY SAMPLING PROTOCOL
NB102-181/33-2

Rev	Description	Date
0	Issued in Final	March 28, 2014

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Appendix A 2014 Surface Water and Sediment Quality Parameter List
Appendix B Field Record Sheet
Appendix C Example Chain of Custody

ABBREVIATIONS

AEMP	Aquatic Environment Monitoring Program
BIM	Baffinland Iron Mines Corporation
DO	dissolved oxygen
EC	Environment Canada
FEIS	Final Environmental Impact Statement
KP	Knight Piésold Ltd
Mary River Project	the project
NSC	North South Consultants
UTM	universal transverse mercator

1 – INTRODUCTION

Baseline surface water and sediment quality sampling was conducted for the Mary River Project (the Project) in support of the Final Environmental Impact Statement (FEIS) completed by Baffinland Iron Mines Corporation (BIM) in 2012. An Aquatic Environment Monitoring Program (AEMP) Framework has been developed following submission of the FEIS. This field water and sediment sampling protocol supports the AEMP.

This document is intended to provide a detailed description of the baseline surface water and sediment quality field sampling methodologies that have been applied to date and that will be applied to the Project in the future.

The baseline sampling programs are conducted during the open-water season for streams and lakes in the Project area. Stream water quality is monitored during the spring, summer and fall, whereas, lake sampling takes places only during the summer and fall. Sediment sampling is done concurrently with the surface water sampling program during the fall campaign. The sampling methodologies within this protocol include details regarding:

- Equipment and sampling
- Field measurements and observations
- Quality assurance/quality control (QA/QC)
- Sample tracking (Chain of Custody) and shipping

2 – WATER QUALITY

2.1 GENERAL

Stream and lake water quality data were collected for the Mary River Project (the Project) by Knight Piésold Ltd. (KP) every year since 2005, with the exception of 2009 and 2010. Additional sampling was conducted by North/South Consultants Inc. (NSC) in 2007. The analytical suite of parameters included nutrients, total and dissolved metals, and major ions. A detailed list of water quality parameters is provided in Appendix A.

2.2 STREAM SAMPLING METHODOLOGY

2.2.1 Sampling Strategy

Consistent sampling methods have been applied throughout the stream water sampling programs. Stream samples are collected from flowing sections of the streams (unless otherwise noted) and are obtained by either wading into the stream or by collecting the sample from the bank. Samples are collected in an upstream direction, with bottles being placed beneath the surface (when possible) to reduce the amount of surface residue collected. Bottles with no acid preservative are rinsed three times before filling. For bottles where an acid preservative is required, the samples are transferred from a clean bottle into the bottle containing preservative.

2.2.2 Equipment and Sampling

The width of the stream at the sampling location is measured using range finders. If the stream is less than 5 metres (minimum distance for range finders), the width is estimated. Photos are taken upstream, downstream and across the sampling site.

The baseline water quality monitoring program includes as suite of analytical parameters (Appendix A). The laboratory typically provides nine sample bottles for these analyses (Table 2.1).

Table 2.1 Sample Bottle Summary

Sample Bottle Volume/Description	Analytical Parameter
1 L Amber glass	Chlorophyll *a*/Pheophytin
125 mL Plastic X 2	Total and Dissolved Metals
125 mL Plastic X 2 (pre-charged)	Nutrients
1 L Plastic	General/Routine
125 mL Amber glass X 2 (one pre-charged)	TOC, phenols, COD, etc.
250 mL Plastic	Chromium

The metals bottles require nitric acid preservative (blue label) that is provided in single dose vials by the laboratory (one vial per bottle). On occasion, the chromium sample bottle will not be provided pre-charged with preservative. In this case, a chromium preservative (green label) will be provided as required.

Prior to the addition of preservative, samples for dissolved metals and the other required parameters listed on the labels (e.g., dissolved organic carbon) are field filtered using Acrodisc® 32 mm Syringe Filters with 0.45 µm Supor® membrane filter. The syringes and filters are sealed in sterile packaging and should not be rinsed prior to use. The following steps outline the basic filtration technique that will be utilized:

- Attach the filter to the syringe prior to pulling the plunger out of the syringe (Note: pulling the plunger activates the filter media).
- Pull the plunger from the syringe, fill the syringe with sample water and then replace the plunger. Dispense the first 10 mL of water to the ground (not as sample).
- Filter the remaining sample directly into the appropriate container. Repeat the process until the sample bottle is full.
- Repeat the initial two steps if the water is particularly turbid and another filter is necessary prior to the sample bottle being full

2.2.3 Field Measurements and Observations

In-situ water quality measurements will be taken during the sample collection process, provided the multi-parameter probe (e.g., Quanta Hydrolab or YSI 600Q sonde) can be positioned downstream of the sample collection area. The following in-situ parameters are recorded (when available from the multi-parameter sonde):

- Water temperature (°C)
- Dissolved oxygen (mg/L and %)
- pH (pH units)
- Conductivity (µS/cm) and/or specific conductance (µS/cm^n) (both when possible)

Field observations around the sample area include:

- Description of the landscape (e.g., hilly, mountains, marsh, etc.)
- Vegetation
- Stream substrate (e.g., sand, cobble, boulder, bedrock)
- Stream flow description (e.g., strong-turbulent, slow-calm)
- Weather conditions
- Air temperature

All measurements and observations are recorded on the field record sheets included within Appendix B.

2.2.4 QA/QC

The QA/QC protocol aims to ensure the collection of reliable and accurate data. Using standard methods as outlined in this document provides control of sample collection, handling and shipping. While collection of duplicate samples ensures the laboratory results meet defined standards of quality, in addition to the internal laboratory QA/QC protocols required for analytical accreditation. Duplicate samples will be taken for 10 percent of the total number of samples. When possible, one field blank should be taken per sampling event.

2.2.5 Chain of Custody and Sample Shipment

An essential part of the QA/QC protocol is maintaining a record of the collected samples and the corresponding list of analytical parameters reported for those samples. A chain of custody (CoC) form will be completed digitally on the BIM environmental office laptop. An example of a completed CoC form is included as Appendix C. In order to start a new entry, the previous CoC should be opened and saved as a new file name beginning with the current sample date, followed by sample type (e.g., 13_07_24_COC_BWQ.pdf). The CoC is an editable pdf document that can be found using the following folder structure:

Mary River Project (\\10.20.1.253)(M:)
Environment
FINAL File System
14.0 LABORATORY ANALYTICAL RESULTS
2014 - Open last CoC and save as "YY_MM_DD_COC_BWQ.pdf"

The waybills for shipping coolers are provided by BIM in the environment office. One of the seasonal environmental staff or environmental coordinators will provide assistance in completing the required paperwork.

All coolers must have "this side up" arrows attached to either end of the cooler. These stickers are found on a roll in the BIM environment office. The laboratory shipping labels are also in the BIM environment office. Each cooler requires one laboratory shipping label affixed to the lid.

2.3 LAKE SAMPLING METHODOLOGY

2.3.1 Sampling Strategy

Consistent sampling methods have been applied throughout the lake water sampling programs. Wherever possible, water quality samples are collected from two isolated depths (approximately 1 m below surface and approximately 1 m above the bottom) at each of the lake water quality sites. Inflatable zodiac boats are used to access the lake sample locations and are anchored at the stations for the duration of the sampling and in-situ data collection. Some boat drift is inevitable due to wind and wave influence. The general procedures to be undertaken at each lake sampling station are detailed below.

2.3.2 Equipment and Sampling

The total depth of the water at each lake station is determined either using a portable fish finder, a weighted meter tape or the pressure sensor on the multi-parameter probe. The depth is recorded on the field record sheets. Windy conditions during sampling may result in variable depth measurements. The depth range, the estimated wind speed, and the estimated wind direction are always recorded.

The baseline water quality monitoring program includes a suite of analytes (Appendix A). As above (i.e., Table 2.1), the analytical laboratory typically provides nine sample bottles for these analyses.

A 2.2 L acrylic Kemmerer bottle with a graduated line is utilized to obtain water samples at the target depths. The Kemmerer bottle is set in the open position for sampling with the bottom sample valve in the closed position. The sampler is lowered to the desired depth and the messenger weight is released down the line to trigger the closing spring of the sampler. The Kemmerer bottle is retrieved and the retained water is discarded over the side of the boat.

Following this initial rinse, the Kemmerer bottle is deployed to the sample depth to obtain the analytical sample. Upon retrieval of the Kemmerer bottle, a small amount of water is purged out of the bottom sample valve. The remaining sample is discharged into the pre-labelled, laboratory sample containers (or into a field filter) via the sample valve. The remaining water is discarded over the side of the boat. This sampling process is then repeated for the next sample depth.

Bottles with no acid preservative are rinsed three times before filling. For bottles where acid preservative is required, samples are transferred from the Kemmerer bottle into the sample bottle containing preservative. Some samples will also require field filtration before adding preservatives. The filtration process is discussed in Section 2.2.2.

2.3.3 Field Measurements and Observations

Upon collection of the shallow and deep samples, in-situ lake profiling and secchi depths are completed at each sample station.

The profiling is undertaken using a measuring tape that is secured to a multi-parameter probe (e.g., Quanta Hydrolab or YSI 600Q sonde). The probe is lowered in 1 m increments and given time to stabilize prior to recording the in-situ parameters listed in Section 2.2.2.

Secchi depths are determined by attaching the measuring tape to the secchi disk and lowering the disk over the shaded side of the boat. Two depths are recorded: the depth at which the disk disappears while lowering the disk and the depth at which it reappears while raising the disk. The secchi depth is calculated from the average of these two depths and recorded on the field record sheets.

2.3.4 QA/QC

As with the stream samples, duplicate samples are to be taken for 10 percent of the total number of samples. When possible, one field blank per sampling event will be taken.

2.3.5 Chain of Custody and Sample Shipment

Information regarding the COC's and sample shipping methods are discussed in Section 2.2.5.

2.4 METHODOLOGY ADJUSTMENTS OVER TIME

There have not been any changes to the sampling methods for streams and lakes between 2005 and 2013, unless specific circumstances required alternative methods. These exceptions would be very rare, and any changes to methodology would be recorded on field record sheets. Field record sheets used by KP were updated in 2013 and are included in Appendix B. NSC used their own field sheets.

Equipment used for field measurements and lake sample collection have varied over time, based on the equipment available at the time. For lake sampling, the following samplers have been used:

- Beta bottle
- Van Dorn sampler
- Kemmerer bottle

It was decided in 2012 that the Kemmerer bottle would be the only sampler used for future sampling events in order to maintain consistency.

3 – SEDIMENT QUALITY

3.1 GENERAL

Stream sediment quality data were collected for the Project by KP every year since 2005, with the exception of 2009 and 2010. Lake sediment quality data were collected for the Project every year since 2006, with the exception of 2009 and 2010. Parameters analysed included nutrients, metals, major ions and particle size. A detailed list of parameters is provided in Appendix A.

Sediment quality monitoring is typically conducted as part of the benthic invertebrate community surveys for mining projects. These sampling programs typically focus on total organic carbon content, metals and particle size distribution (EC, 2012). The purpose of sediment monitoring at these sites is to identify any habitat differences that may contribute to changes in the invertebrate community. As such, sediment samples will be collected concurrently with benthic invertebrate samples.

3.2 STREAM SEDIMENT SAMPLING METHODOLOGY

3.2.1 Sampling Strategy

Consistent sampling methods have been applied throughout the stream sediment sampling programs. Stream samples are collected from flowing sections of the streams (unless otherwise noted) and are obtained by wading into the stream. The sampling equipment and collection protocol is discussed in the following section.

3.2.2 Equipment and Sampling

Equipment used for stream sediment sampling includes the following:

- Stainless steel bowl
- Stainless steel spatula
- Stainless steel spoon
- 500 mL Polyethylene (PET) bottle with open ends
- Four 250 mL amber glass sample jars
- Zip-top or Whirl-pak sample bag for archived sample

Stream sediment samples are collected as near as possible to the water sample location. Wherever possible, sediment samples are collected from the wetted area of the stream at water depths between 10 cm and 40 cm. Prior to collecting the sediment samples, all of the sampling equipment is rinsed in the stream water to ensure that trace sediments do not transfer between sample stations. Samples are collected by wading downstream to upstream. Where possible, sediment is collected from the surface of the stream bed. Up to 10 sub-samples can be taken where sufficient fine sediments (particles < 2 mm diameter) are present.

The following procedure for sampling stream sediments is followed at each sub-sample location:

- Insert the open-ended PET bottle 5 cm to 10 cm into the bottom substrate
- Slide the stainless steel spatula under the bottom of the PET bottle to trap the sediments inside
- Slowly raise the spatula and PET bottle out of the stream
- Place the contents of the PET bottle into a stainless steel bowl for compositing

The stainless steel bowl and sample is allowed to settle once sufficient sample has been obtained to fill the sample containers. Any excess water that forms on the surface of the sample is either poured-off or siphoned-off using a sterile syringe. Care must be taken during this process not to lose any fines. The sample is homogenized using a stainless steel spoon. The composite sample is then created by removing any large inorganic material (e.g., cobble). The sample is transferred to laboratory provided sample jars. This transfer is completed by adding a spoonful of sample to each of the jars and repeating until all the jars they are all full. This approach provides more consistent results than what would be obtained if each jar was filled in turn. Surplus sample will be put into a labeled Zip-top or Whirl-pak bag. Samples should be kept cool and in the dark until they can be shipped to the laboratory.

The field record sheet will record the number of jars and/or sample bags obtained at each station. A note on the field record sheet should also indicate if insufficient sample is available at a station.

3.2.3 Field Measurements and Observations

Field observations made during sediment sampling include sample characteristics, such as:

- Substratum composition
- Colour
- Odour
- Vegetation presence

3.2.4 QA/QC

As with the water samples, duplicate sediment samples will be taken for 10 percent of the total number of samples.

3.2.5 Chain of Custody and Sample Shipment

The required COC's and sample shipping procedures are discussed in Section 2.2.5.

3.3 LAKE SEDIMENT SAMPLING METHODOLOGY

3.3.1 Sampling Strategy

Lake sediment samples have been collected using various methods as described in section 3.4. The methods defined below describe the collection of the lake sediment samples.

3.3.2 Equipment and Sampling

A sediment gravity core sampler (Figure 3.1) will be utilized to obtain lake sediment samples. The top two centimeters of sediment from the core samples will be retained for laboratory analysis.

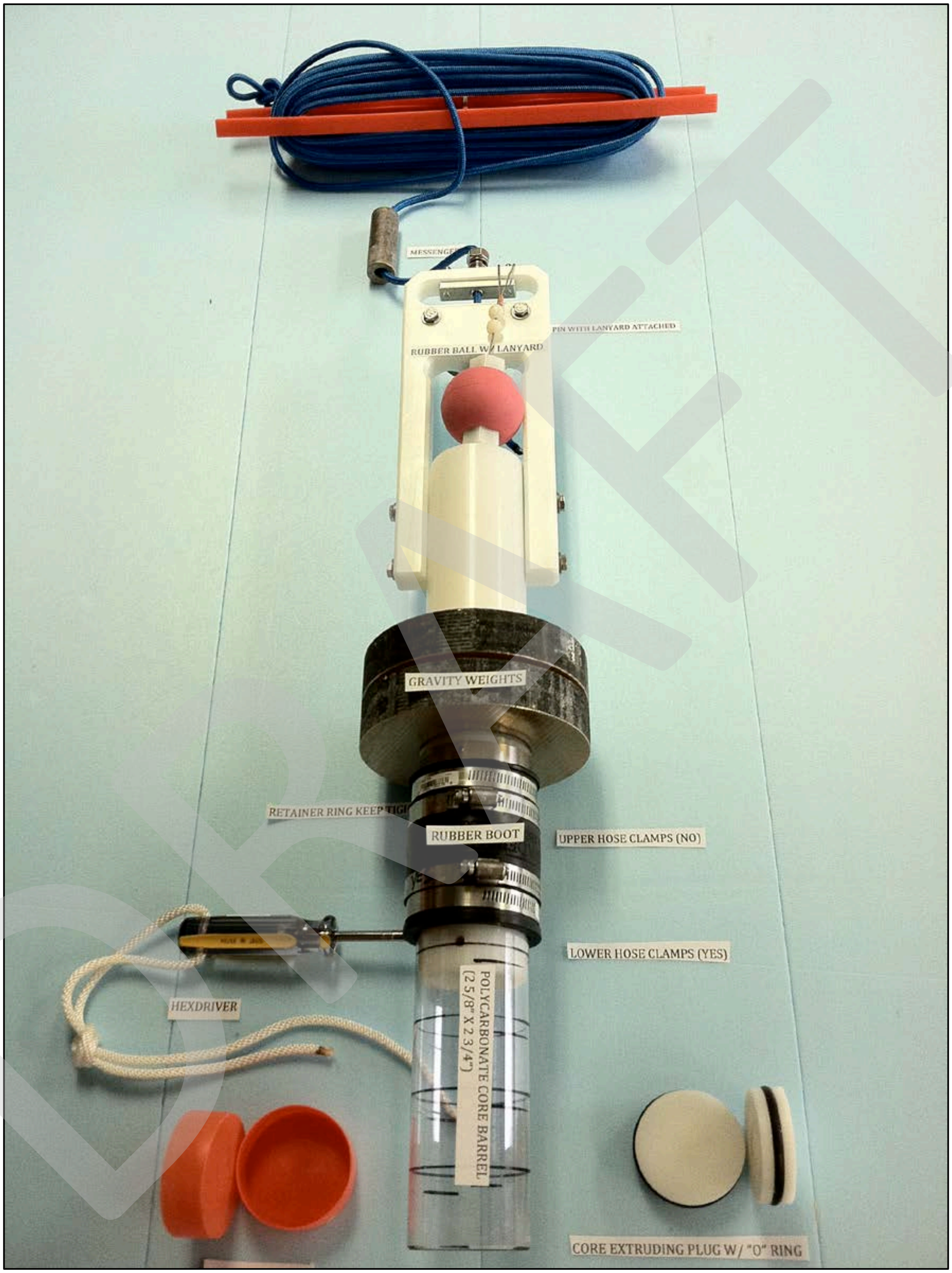

Figure 3.1 Sediment Gravity Core Sampler

3.3.3 Field Measurements and Observations

At each sampling site, the following information will be recorded during the collection of sediment samples.

- Site ID and UTM coordinates and location of any duplicate samples collected
- Sampling date and time
- Ambient weather conditions (e.g., wind speed, direction, wave action, current, air temperature)
- Sediment collection device
- General site description and observations (e.g., depth of water or ice)
- Sample properties (e.g., colour, texture, consistency, odour, presence of biota, estimate of quantity of recovered sediment)
- Deviations from standard operating procedures

Lake sediment samples will be collected using the sediment gravity corer and the following procedure.

- A clear polycarbonate core tube will be loaded into the corer and secured using a set of stainless steel hose clamps
- The corer (Figure 3.1) will be positioned perpendicular to the water surface prior to release. The penetration depth of the core tube is affected by the depth of water, angle of corer deployment and substrate type.
- Once the corer is embedded in the substrate, the stainless steel messenger will be sent down the corer rope to release the ball-type seal. This seal creates a vacuum in the core tube, retaining the sampled sediment.
- The corer will be retrieved vertically and at a constant speed to surface
- Upon retrieval, the bottom of the core tube will be plugged using an extruding plug prior to breaking the air-water interface. This procedure will prevent sample loss.
- Following placement of the core tube plugs, the hose clamps on the corer will be loosened to release the tube
- The visual characteristics of the core sample will be recorded on the field record sheets (e.g., colour, apparent horizons, aquatic vegetation, etc.)
- Overlying water within the tube will be described on field notes (e.g., clarity) prior to decanting. The decanting process should be undertaken carefully to ensure that no sediment sample is lost.

The sample is extruded out of the core tube and processed as follows:

- A suitable extruding apparatus, such as a PVC tube cut longer than core tube and with a slightly smaller outside diameter, will be used to force the extruding plug through the core tube. This process moves the sediment sample to the end. Care will be taken not to extrude the sediment, since the first two centimetres are the sample.
- The top two centimeters of sediment will be scooped out using a clean stainless steel spoon and placed in a clean stainless steel bowl
- A minimum of three core samples will be required per station. Limiting the amount of sampled sediment per tube (i.e., the top two centimeters) typically requires more sampling effort to obtain the required sample size.

- Samples within a station will be close to one another, but far enough apart to ensure that sampling disturbance from one grab does not affect another. Sampling from both sides of the boat and around the bow typically provides suitable spatial distribution within the station.
- After the top two centimeters are retained, the remaining, unused sediments within the core tube will be placed into a bucket and only released once sampling is complete at that particular station
- The core tube will be rinsed at surface and reloaded into the sampler in preparation for the next sample.

3.3.4 Sediment Sample Homogenization

Once sufficient sediments have been collected within the stainless steel bowl, the sample will be homogenized. Prior to homogenization, excess water will be decanted once the water has settled (to prevent loss of fines) and any large inorganic material (e.g., cobble) or debris will be removed. Once this step is complete, the sample will be thoroughly mixed using a newly gloved hand or stainless steel spoon until the sample has a homogeneous appearance. The sample containers will be filled by alternating aliquots between each of the containers. Once the containers are full, each sample will be transferred to an ice-packed cooler. Samples will be kept cool and in the dark until they can be shipped to the analytical laboratory.

3.3.5 QA/QC

All sampling equipment will be thoroughly cleaned between sampling stations and rinsed with ambient water prior to sampling. Duplicate samples will be taken for ten percent of the total number of samples.

3.3.6 Chain of Custody and Sample Shipment

The COC's and sample shipping methods are discussed in Section 2.2.5.

3.4 METHODOLOGY ADJUSTMENTS OVER TIME

Sediment sampling conducted prior to 2012 utilized a Petite Ponar grab sampler (231 cm^2) or an Ekman dredge sampler (523 cm^2). The sediment fraction collected for analysis was limited to the top 5 cm.

During review of the FEIS, BIM agreed to a recommendation from Environment Canada to carry out sediment sampling utilizing core in order to collect only the uppermost one to two centimetres. The rationale for this approach is that most infaunal organisms and the most recently introduced sediment (including contaminants of concern) are found in the upper two centimetres of the lake sediment. Arctic lakes experience low sedimentation rates and, therefore, collection of a thinner sample using a sediment coring instrument provides better resolution of changes in sediment quality.

Collection of thinner (1 cm to 2 cm) sediment samples was implemented by Baffinland starting in 2012. The top 2 cm of sediment from the core samples as described above will be retained for laboratory analysis.

4 – REFERENCES

Environment Canada (EC). 2012. *Environmental Effects Monitoring Technical Guidance Document*. National Environmental Effects Monitoring Office.

APPENDIX A

2014 SURFACE WATER AND SEDIMENT QUALITY PARAMETER LIST

(Pages A-1 to A-3)

Details of Quotation

Baseline - Cr III and VI

ANALYTE	METHOD REFERENCE	MDL	UNITS
Cr(VI)	Cr(VI) water M US EPA	0.05	mg/L
Cr(III)	Cr(VI) water M US EPA	0	mg/L

Baseline - Sediment

ANALYTE	METHOD REFERENCE	MDL	UNITS
Ca	Metals soil FAA - AMSFAAE2 M SM3111B-3050B	100	ug/g
Mg	Metals soil FAA - AMSFAAE2 M SM3111B-3050B	100	ug/g
Na	Metals soil FAA - AMSFAAE2 M SM3111B-3050B	100	ug/g
K	Metals soil FAA - AMSFAAE2 M SM3111B-3050B	100	ug/g
Al	ICP-MS SOIL PE6100 EPA 200.8	5	ug/g
Ba	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Be	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Cd	ICP-MS SOIL PE6100 EPA 200.8	0.5	ug/g
Cr	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Co	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Cu	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Fe	ICP-MS SOIL PE6100 EPA 200.8	5	ug/g
Pb	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Mn	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Mo	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Ni	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Ag	ICP-MS SOIL PE6100 EPA 200.8	0.2	ug/g
Sr	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Tl	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
V	ICP-MS SOIL PE6100 EPA 200.8	2	ug/g
Zn	ICP-MS SOIL PE6100 EPA 200.8	2	ug/g
As	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Sb	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Se	ICP-MS SOIL PE6100 EPA 200.8	1	ug/g
Hg	Hydride - Soil M SM3114C-3500C	0.1	ug/g
Sand (>0.050mm)	Particle Size C Ag Particle	1	%
Silt (>0.002-0.050mm)	Particle Size C Ag Particle	1	%
Clay (<=0.002mm)	Particle Size C Ag Particle	1	%
Moisture	MOISTURE C SM2540B	0.1	%
Total Kjeldahl Nitrogen	TKN soil/solids - AMTKNHX8 C SM4500-Norg-B	0.01	%
TOC	Organic matter Ag Soil	0.01	%
N-NO2	SOIL - Extractable N C 33-3 Methods of So	1	ppm
N-NO3	SOIL - Extractable N C 33-3 Methods of So	1	ppm
NO2 + NO3 as N	NO2/NO3 SKALAR - AMNOXSE1 C SM4500-NO3-F	0.1	mg/L
Boron (hot water extract)	Boron - hot water EXT Boron HWE	0.5	ug/g

Baseline - SW Chem

ANALYTE	METHOD REFERENCE	MDL	UNITS

pH	pH in water : Auto - AMAPCAE1 C SM4500-H+B	1	
Conductivity	Conductivity : Auto - AMAPCAE1 C SM2510B	5	uS/cm
Alkalinity as CaCO3	Alkalinity : Auto - AMAPCAE1 SM 2320B	5	mg/L
TDS (COND - CALC)	solids in water - AMSOLWE1 C SM2540	5	mg/L
Turbidity	Turbidity - AMTURBE1 C SM2130B	0.1	NTU
Phenols	Phenols 4-AAP - AMPHACE1 C SM5530D	0.001	mg/L
N-NH3	NH3 water low - AMNH3LE1 C SM4500-NH3D	0.02	mg/L
SO4	Anions by IC - DX-100 SM 4110C	3	mg/L
Cl	Anions by IC - DX-100 SM 4110C	1	mg/L
Br	Anions by IC - DX-100 SM 4110C	0.05	mg/L
N-NO2	Low NO2 - Technicon C SM4500-NO2-B	0.005	mg/L
N-NO3	NO2/NO3 SKALAR - AMNOXSE1 C SM4500-NO3-F	0.1	mg/L
NO2 + NO3 as N	NO2/NO3 SKALAR - AMNOXSE1 C SM4500-NO3-F	0.1	mg/L
TOC	TOC in water - AMDTOCE1 C SM5310C	0.5	mg/L
DOC	TOC in water - AMDTOCE1 C SM5310C	0.5	mg/L
Total Suspended Solids	solids in water - AMSOLWE1 C SM2540	2	mg/L
Total P	Low Total P C SM4500-PF	0.003	mg/L
Total Kjeldahl Nitrogen	TKN low water - AMTKNLE1 C SM4500-Norg-C	0.1	mg/L

Baseline Chlorophyll-Pheo

ANALYTE	METHOD REFERENCE	MDL	UNITS
Chlorophyll-a	Chlorophyll C SM10200H	0.2	mg/m3
Pheophytin-a	Chlorophyll C SM10200H	0.2	mg/m3

Baseline Dissolved Metals

ANALYTE	METHOD REFERENCE	MDL	UNITS
Ca	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Mg	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	100	ug/L
Na	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
K	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Al	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	3	ug/L
Sb	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
As	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Ba	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Be	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Bi	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
B	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	10	ug/L
Cd	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
Cr	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Co	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Cu	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Fe	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	30	ug/L
Pb	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Li	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	5	ug/L
Mn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Mo	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Ni	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Se	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	1	ug/L

Si	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Ag	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
Sr	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Tl	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Sn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Ti	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	10	ug/L
U	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
V	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	1	ug/L
Zn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	3	ug/L
Hardness as CaCO3	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	500	ug/L
Hg	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L

Baseline Total Metals

ANALYTE	METHOD REFERENCE	MDL	UNITS
Ca	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Mg	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	100	ug/L
Na	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
K	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Al	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	3	ug/L
Sb	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
As	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Ba	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Be	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Bi	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
B	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	10	ug/L
Cd	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
Cr	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Co	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Cu	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Fe	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	30	ug/L
Pb	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Li	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	5	ug/L
Mn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Mo	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.05	ug/L
Ni	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.5	ug/L
Se	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	1	ug/L
Si	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	50	ug/L
Ag	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
Sr	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Tl	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Sn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.1	ug/L
Ti	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	10	ug/L
U	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L
V	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	1	ug/L
Zn	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	3	ug/L
Hardness as CaCO3	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	500	ug/L
Hg	ALS Low Level ICP-MS TOTAL Met ALS-OUTSIDE	0.01	ug/L

APPENDIX B

FIELD RECORD SHEET

(Page B-1)

SURFACE WATER QUALITY SAMPLING FIELD FORM

Knight Piésold CONSULTING

PROJECT NO.: ______________________ *(i.e. NB102-102/10)*

SITE: ______________________ *(i.e. BISSETT CREEK)* **DATE:** ______________________ *(i.e.12MAR2013)*

STATION ID: ______________________ *(i.e. SW12-01)* **STAFF:** ______________________ *(i.e. SMR / DKK)*

SITE CONDITIONS

Air Temperature ____________ ºC **Wind** ____________ *(direction, speed)* **Weather** ____________ *(clear, o'cast, rain, etc.)*

SAMPLE DESCRIPTION/OBSERVATIONS

Sample ID: ______________________ *(i.e. SW12-01)* **UTM mE** ______________________ *(i.e. 558407)*

Sample Date / Time: ______________________ *(i.e.12MAR2013/14:35)* **UTM mN** ______________________ *(i.e. 7914885)*

No. of bottles ______________________ **Zone / Datum** ______________________ *(i.e. 17T / NAD83)*

Quote No. ______________________ **Accuracy** ______________________ *(± m)*

WATER BODY TYPE: ☐ Lake ☐ Pond ☐ Wetland ☐ Stream

FLOW: ☐ Stagnant ☐ Low ☐ Moderate ☐ High

ODOUR: ☐ None ☐ Describe: ______________________ *(i.e. mineral, organic)*

COLOUR: ☐ None ☐ Describe: ______________________ *(i.e. light tea, brown, black)*

TRANSPARENCY: ☐ Clear ☐ Translucent ☐ Opaque

SAMPLES FILTERED: ☐ None ☐ Yes, analytes incl.: ______________________

IN-SITU WQ DATA

Water Temperature: ____________ ºC **pH:** ____________ pH **WQ INSTRUMENT:** *(i.e. Hanna/HI 98129, YSI 600QS)*

Conductivity: ____________ µS/cm **Secchi:** ____________ m ______________________

Dissolved Oxygen: ____________ % ______ : ____________ Calibrated (Date / Time):

Dissolved Oxygen: ____________ mg/L ______ : ____________ ______________________

Calibration Check (Date / Time):

PHOTOS: ☐ Upstream/Downstream ☐ None taken ______________________

QA/QC INFORMATION

Duplicate Collected: ☐ No ☐ Yes, ID: ______________________ *(i.e. SW12-01-DUP)*

Field Blank Collected: ☐ No ☐ Yes, ID: ______________________ *(i.e. SW12-01-FB)*

SITE SKETCH: *(i.e. stream, flow direction, road, culvert, north arrow, beaver dams, sample location, etc.)*

NOTES: *(i.e. additional WQ instrument calibration notes, water body name, photo notes, changes in site since last visit)*

APPENDIX C

EXAMPLE CHAIN OF CUSTODY

(Page C-1)

CHAIN OF CUSTODY RECORD

ACCUTEST LABORATORIES LTD.

☑ 146 Colonnade Rd., Unit 8
Ottawa, ON K2E 7Y1
Ph: (613) 727-5692 Fax: (613) 727-5222

☐ 608 Norris Court
Kingston, ON K7P 2R9
Ph: (613) 634-9307 Fax: (613) 634-9308

LABORATORY USE ONLY
Report #: ____________

Company Name: Baffinland Iron Mines Corporation	Address: Mary River	☐ Fax Results to: ____________
Report Attention: Mr. Jim Millard/Allan Knight/Trevor Myers	City/Prov: via Iqaluit, NU; Postal Code:	☑ E-mail Results to: Millard/Myers/Knight/mrsite.sd
Phone: 647-693-9447; Ext	Project #; * Quotation # Baseline Water Quality	☑ Copy of Results to: salldred@knightpiesold.com
* Waterworks Name:	* Waterworks Number:	*Note that for drinking water samples, all exceedances will be reported where applicable legislation requires.*

Invoice to:
(if different from above)

____
____

SAMPLE ANALYSIS REQUIRED

⇦ Indicate: F=Filtered or P=Preserved

Sample ID	* Date/Time Collected	Sample Matrix i.e. Water, Soil, Paint	* Sample Type (see "Codes" below)	* MOE Reportable? Y = Yes N = No	# of Containers	** Service Required R=Rush S=Standard	Baseline Water Quality - Dissolved Metals Field Filtered							Criteria Required (i.e. Reg.170, Reg.153, CCME, PWQO etc.)	Laboratory Identification
BL0-05-B4	July 24, 2013, 14:35	Water	-	N	9	S	✔								
C0-01	July 24, 2013, 15:20	Water	-	N	9	S	✔								
C0-01-DUP	July 24, 2013, 15:25	Water	-	N	9	S	✔								
C0-10	July 24, 2013, 16:20	Water	-	N	9	S	✔								
C0-10-FB	July 24, 2013, 16:25	Water	-	N	9	S	✔								
E0-20	July 24, 2013, 17:10	Water	-	N	9	S	✔								
E0-21	July 24, 2013, 17:50	Water	-	N	9	S	✔								

Sample Type Codes for Drinking Water Systems: **RW** = Raw Water, **RWFC** = Raw Water For Consumption, **TW** = Treated Water at point of entry to distribution, **DW** = Distribution/Plumbing Water
"MOE Reportable" refers to the requirements under the SDWA for immediate reporting of results, which are indicators of adverse water quality, to the Owner/Operator, MOE, and MOH Medical Officer.

Sampled By: Shannon Alldred	Date/Time: July 24, 2013 19:00	Relinquished By: Allan Knight	Date/Time: July 25, 2013 08:00	Comments: CN AWB 518-64071313	**Cooler Temp (°C) on Receipt**
Work Authorized By (signature):	Date/Time:	Received By Lab:	Date/Time:		

*** Indicates a required field.** If not complete, analysis will proceed only on verification of missing information. A quotation number is required, if one was provided.
**** There may surcharges applied to "Rush" service.** Please check with lab prior to submission of samples for rush analysis to confirm availability and pricing.

Copies: White – Sampler, Yellow – Laboratory, Pink – With Report
Please print and submit, to the laboratory, 2 copies of this form with your samples.

Appendix 5

ECCC Approval Letter for Current EEM Phase 1 Study Design

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Prairie & Northern Region
Environmental Protection Operations Directorate
9250 – 49th Street NW
Edmonton, AB T6B 1K5

August 22, 2017

via email to: wayne.mcphee@baffinland.com

Wayne McPhee
Director Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville,ON L6H 0C3

Dear Mr. McPhee:

Subject: Metal Mining Effluent Regulations – Evaluation of 1st Environmental Effects Monitoring Study Design, Mary River Project, NU

This letter is to advise you that Environment and Climate Change Canada has reviewed your Environmental Effects Monitoring (EEM) biological study design report entitled "Mary River Project Environmental Effects Monitoring Phase 1 Study Design", received July 8, 2016 and an addendum to the report, received August 10, 2017. The review of study design reports takes into account information requirements in the *Metal Mining Effluent Regulations (MMER)* of the *Fisheries Act* and also offers comments on the study based on the EEM Technical Guidance Document and generally accepted standards of good scientific practice.

Review comments and recommendations are attached. No further response is required.

Regulated facilities are now required to submit reports to the Environmental Effects Monitoring Electronic Reporting system (EEMER). It is no longer necessary to submit electronic or paper copies directly to the authorization officer.

Environment and Climate Change Canada looks forward to receiving your interpretive report no later than January 10, 2018. Should you have any questions or concerns regarding the EEM program or wish to discuss the review of the study design, please do not hesitate to contact Erik Allen at (780) 717-4884 or at erik.allen@canada.ca.

Sincerely,

Susanne Forbrich
Regional Director
Regional Authorization Officer

Canada

cc:	William Bowden	Baffinland Iron Mines Corporation
	Laura Taylor	Baffinland Iron Mines Corporation
	Reg Ejeckam	Environment and Climate Change Canada, Winnipeg
	Paula Siwik	Environment and Climate Change Canada, Edmonton
	Erik Allen	Environment and Climate Change Canada, Edmonton
	Curtis Didham	Environment and Climate Change Canada, Iqaluit
	Sean Joseph	Nunavut Water Board, Vancouver
	Sarah Forté	Indigenous and Northern Affairs Canada, Iqaluit

Attachment: Review Comments and Recommendations on "Response to ECCC Comments on the Mary River Project 1st Environmental Effects Monitoring Study Design" (submitted August 10, 2017)

Review Comments and Recommendations on "Response to ECCC Comments on the Mary River Project 1st Environmental Effects Monitoring Study Design" (submitted August 10, 2017)

7. Regarding the fish survey, it was agreed during a meeting with the proponent and their consultant (Aug. 16/17) that fish sampling will be attempted in the Mary River near the confluence with Tributary-F, if no fish are located in the tributary. A downstream reach of the Mary River will be sampled as a reference area to the upstream Mary River exposure area, if needed. If fish sampling in Mary River is determined to be impractical, the facility is recommended to provide supporting information in the interpretative report.

19. With respect to the level of effort for the fish survey, the response suggests that less than a day would be needed to determine if fish are present in Tributary-F. During a meeting with the proponent and consultant (Aug. 16/17), ECCC noted that 7 days is the recommended level of effort to achieve target sample sizes, but that it could take less time to determine the presence or absence of fish. The sampling crew is recommended to apply an adequate level of effort to achieve the objective of the fish survey. Supporting information should be provided in the report to justify the level of effort.

Appendix 6

2017 Freshwater Workshop – AEMP Workshop Slide Decks

Aquatic Effects Monitoring Plan (AEMP)

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Aquatic Effects Monitoring Plan (AEMP)

- Requirement under Baffinland`s Type A Water Licence No. 2AM-MRY1325 issued by the Nunavut Water Board (NWB).
- Structured to serve as an overarching plan that conceptually provides the opportunity to integrate the results of individual but related aquatic monitoring programs.
- Includes 2 long-term and 3 targeted component studies:
  - Core Receiving Environment Monitoring Program (long-term)
  - Environmental Effects Monitoring (long-term);
  - Lake Sedimentation Monitoring (targeted);
  - Dustfall Monitoring (targeted); and,
  - Stream Diversion Monitoring (targeted).

Aquatic Effects Monitoring Plan (AEMP)

- Living document expected to be updated periodically throughout the life of the mine to account for the close-out of shorter-term monitoring programs, changes in study designs that are driven by the findings of monitoring or changes to the Project.

Core Receiving Environment Monitoring Program (CREMP)

- Overview of CREMP Study Design
- Key Results of 2015 and 2016 Studies

Core Receiving Environment Monitoring Program : Objectives

- To assess potential mine-related influences on water quality, sediment quality and biota at aquatic environments located near the Mary River Project mine site.
- Biotic components include phytoplankton, benthic invertebrates and fish (Arctic charr).

- In 2015, approach was transitioned from a baseline ***characterization***-based design to an ***effects***-based design.

CREMP Water Quality Assessment

- Surface water quality monitoring conducted by Baffinland environment department personnel.
- Sampling conducted at a total of 57 stations, including:
  - 20 Mine-exposed stream (lotic) stations;
  - 26 Mine-exposed lake (lentic) stations;
  - 8 Reference stream (lotic) stations; and,
  - 3 Reference lake (lentic) stations.

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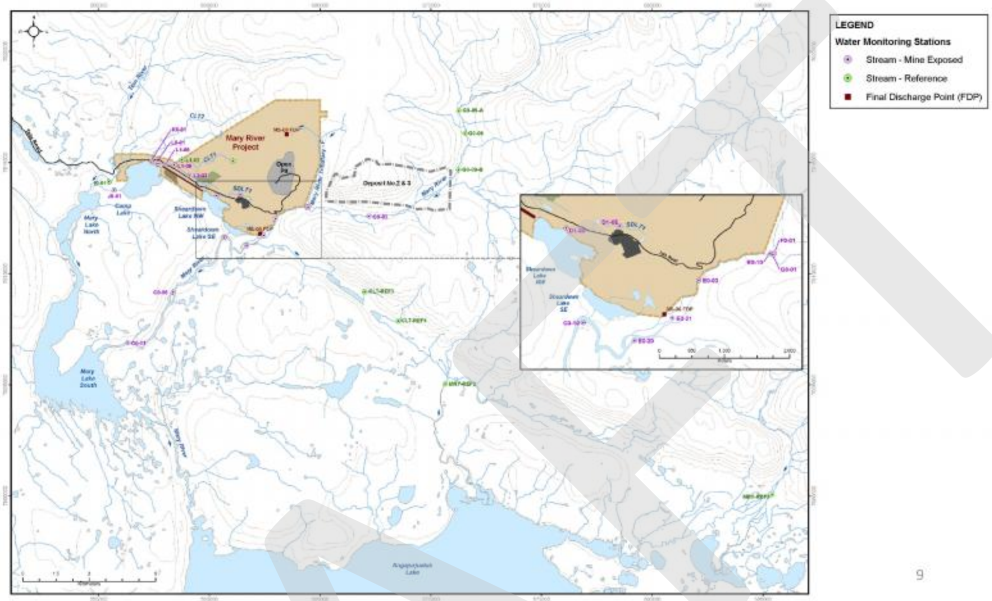
CREMP Water Quality Assessment: Stream Stations



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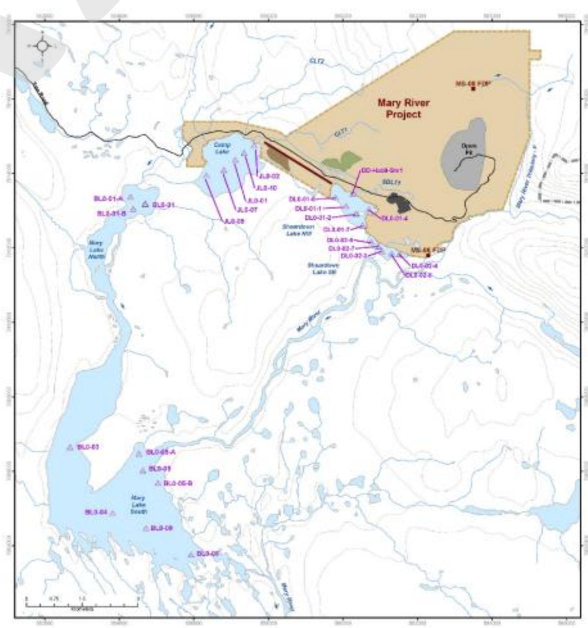
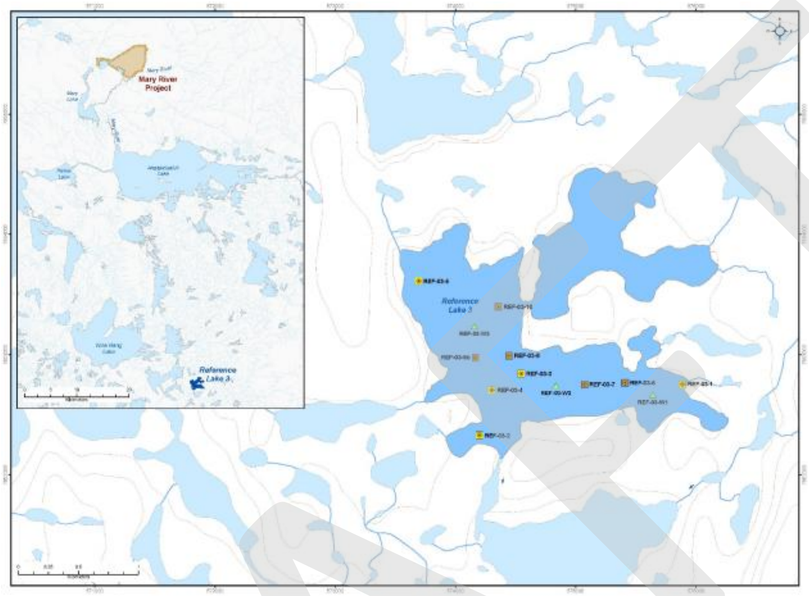
CREMP Water Quality Assessment:

Mine-Exposed Lake Stations



CREMP Water Quality Assessment: Reference Lake Stations



CREMP Water Quality Assessment

- **Three water sampling periods each year, corresponding to spring, summer and fall for lotic stations, and winter (under-ice), summer and fall for lentic stations.**
- **Water sampling included:**
  - ***in situ* (field) measures of temperature, dissolved oxygen, pH, specific conductance and turbidity collected at the bottom (streams) or as a profile (lakes);**
  - **chemistry samples for hardness, TSS, TDS, anions (e.g., chloride, sulphate), nutrients (e.g., carbon- and nitrogen-based parameters), total and dissolved metals and phenols collected at surface (streams) or at surface and bottom (lakes).**

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CREMP Water Quality Assessment

- Water quality data analysis included:
  - Mine-exposed area versus respective reference area comparisons;
  - Spatial and seasonal analysis for individual waterbodies;
  - Comparisons to applicable water quality guidelines / objectives (e.g., CWQG, Ontario PWQO, BC WQG);
  - Comparisons to AEMP site-specific benchmarks; and,
  - Comparisons to baseline water quality data (collected prior to commercial mine start-up, from 2007-2014).

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CREMP Sediment Quality Assessment

- Sediment quality monitoring data collection led by Minnow personnel, with the field sampling completed in fall (August).
- Lake sediment stations sampled in 2015 and 2017 included those indicated in the AEMP Revision 1 design:
  - 10 stations in each of Camp, Mary and Reference Lake 3, and eight and five stations in Sheardown Lake NW and SE, respectively (total of 43).
- Although not included in AEMP design, a total of 20 additional sediment samples collected at mine lakes to support benthic study in 2015 and 2017.
- Sediment stations variably situated at littoral and profundal depths.

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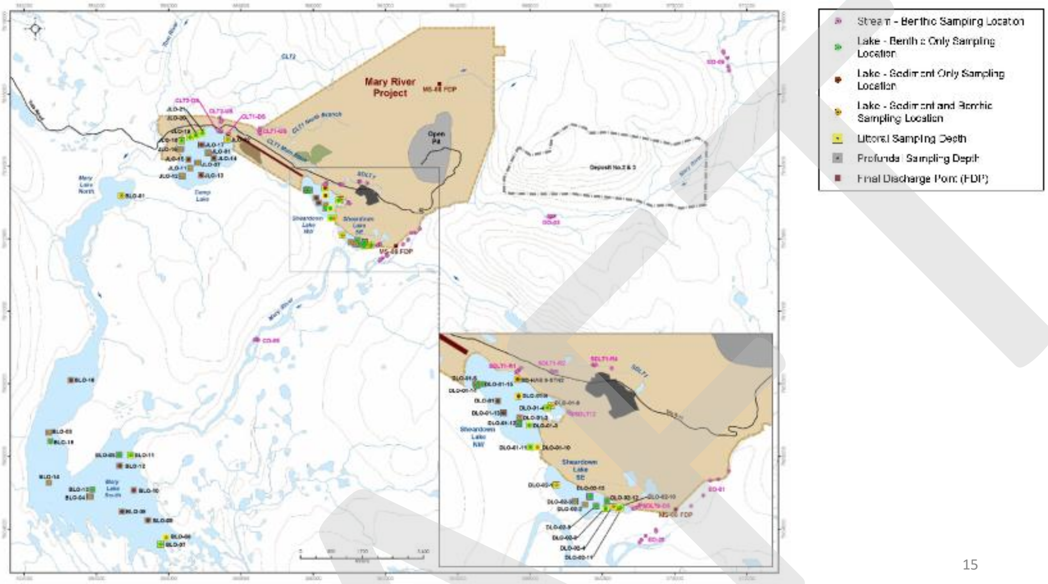
CREMP Sediment Quality Assessment



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CREMP Sediment Quality Assessment

- **In 2016, the design for the sediment quality assessment was modified to better reflect an effects-based approach.**
- **Sediment sampled at five littoral (shallow) and three profundal (deep) stations at each lake except Sheardown Lake SE (no profundal stations) and Reference Lake 3 (five profundal stations sampled), for a total of 39 stations.**

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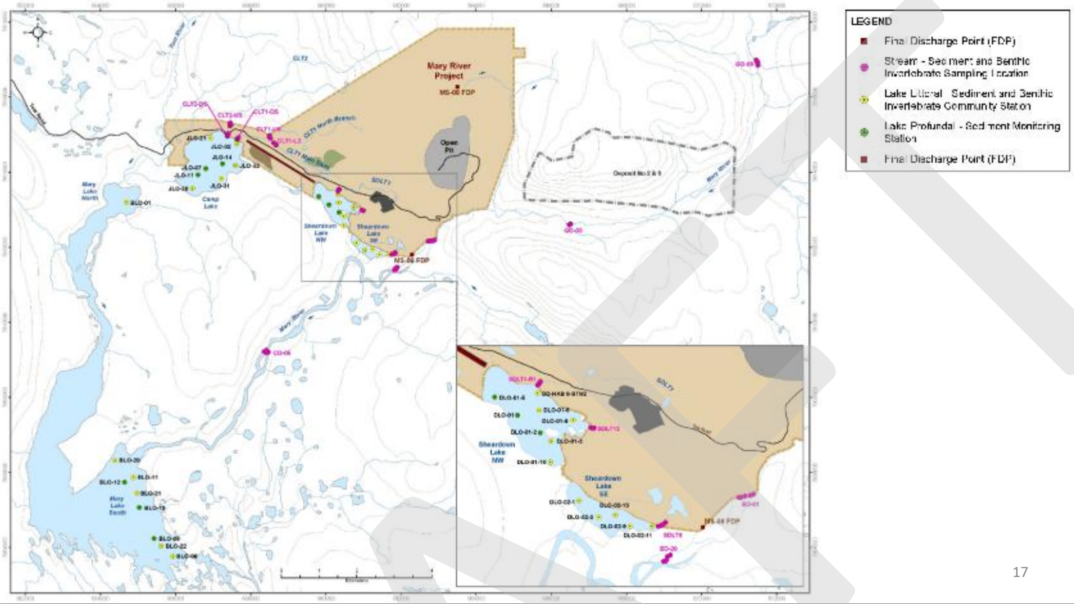
CREMP Sediment Quality Assessment



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CREMP Sediment Quality Assessment

- **Lake sediment samples collected using a gravity coring unit to retrieve samples for sediment TOC, particle size, and total metals analysis.**

- **In 2015 and 2017, 'additional' sediment samples for TOC and particle size analysis collected using a petite-Ponar.**

- **No stream sediment sampling conducted in 2015 and 2016, but sediment samples from erosional habitat (i.e., sand to fine gravel) collected in 2017 at all benthic stations (73 in total) for TOC and total metals analysis.**

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CREMP Sediment Quality Assessment

- Sediment quality data analysis included:
  - Mine-exposed area versus respective reference area comparisons;
  - Spatial analysis for individual waterbodies;
  - Comparisons to applicable sediment quality guidelines (e.g., CSQG, Ontario PSQG);
  - Comparisons to AEMP site-specific benchmarks; and,
  - Comparisons to baseline sediment quality data (collected prior to commercial mine start-up, from 2007-2014).

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CREMP Phytoplankton Assessment

- Phytoplankton monitoring conducted by Baffinland environment department personnel at same stations and sampling frequency as for water quality (chemistry) sampling (total of 57 stations).
- Chlorophyll a used as a surrogate for phytoplankton productivity.
- Chlorophyll a data analysis included:
  - Mine-exposed area versus respective reference area comparisons;
  - Spatial and seasonal analysis for individual waterbodies;
  - Comparisons to AEMP site-specific benchmarks; and,
  - Comparisons to baseline water quality data (collected prior to commercial mine start-up, from 2007-2014).

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CREMP Benthic Invertebrate Community Assessment

- Benthic invertebrate community sample collection led by Minnow personnel. Conducted in fall (August).
- Lake benthic stations sampled in 2015 and 2017 included those indicated in the AEMP Revision 1 design:
    - 10 stations in each of Camp, Sheardown NW, Sheardown SE, Mary and the reference lake (total of 50).
- Variable sampling depths in each lake, reflecting the characterization-based approach conducted for baseline purposes.
- Sampling conducted using a petite-Ponar and field sieving using 500 um mesh.

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CREMP Benthic Invertebrate Community Assessment

- In 2016, the design for the lake benthic invertebrate community assessment was modified to reflect an effects-based approach.
- Five littoral (shallow) stations at each lake except Reference Lake 3 (five profundal stations also sampled), for a total of 30 stations.

- Stream benthic stations sampled in 2015, 2016 and 2017 generally included those indicated in the AEMP Revision 1 design.
- Five stations typically sampled at each stream benthic area, targeting erosional habitat with suitable substrate and water velocity.
- Sampling conducted using a Surber sampler outfitted with 500 um mesh net.

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CREMP Benthic Invertebrate Community Assessment

- Benthic invertebrate community data analysis included:
  - Mine-exposed area versus respective reference area comparisons;
  - Spatial analysis for individual waterbodies; and,
  - Comparisons to baseline data (collected prior to commercial mine start-up, from 2007-2014).
- Data analysis endpoints include those used for standard EEM (i.e., density, richness, Evenness, Bray-Curtis Index) as well as proportion of dominant groups, Functional Feeding groups, and Habitat Preference Groups. Applied Critical Effect Sizes (CES) to define 'ecologically meaningful' statistical differences.

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CREMP Fish Population Assessment

- Fish sampling component led by Minnow personnel. Sampling conducted in fall (August).
- Fish sampling focused entirely on lakes. Applied non-lethal design targeting Arctic charr (*Salvelinus alpinus*).
- A total of 100 nearshore (electrofishing) samples and 100 littoral/ profundal (gill netting) Arctic charr targeted from each lake.
- Low numbers of Arctic charr were captured in littoral/profundal habitat of Reference Lake 3 in 2015, 2016, and 2017, precluding statistical analysis between mine-exposed and reference areas for fish of this size category.

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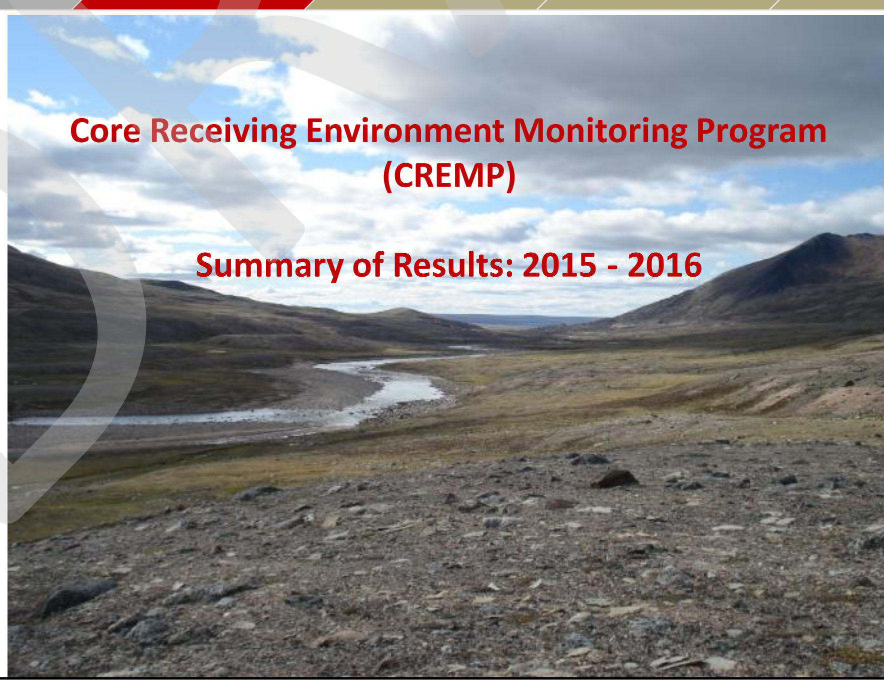
CREMP Fish Population Assessment

- **Fish population data analysis included:**
  - **Comparison of total catch and catch-per-unit-effort (CPUE) between mine-exposed and reference areas;**
  - **Mine-exposed area versus reference area endpoint comparisons for nearshore-captured fish;**
  - **Comparisons to baseline data (collected prior to commercial mine start-up, from 2007-2014).**

- **Endpoints for health analysis include those used for standard EEM (i.e., length distribution, condition). Opportunistic sampling also provided information on growth and reproductive status. Applied standard CES.**

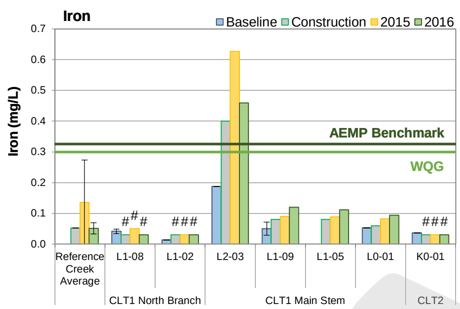
Introduction | AEMP | EEM Phase 1 | Additional Topics | Conclusion

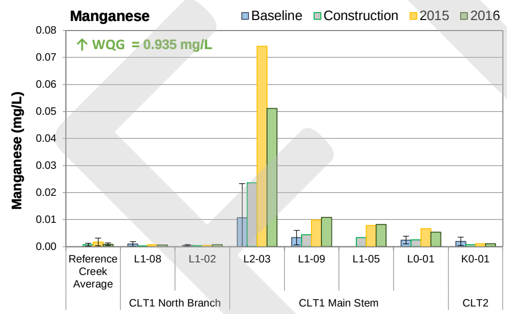


Introduction | AEMP | EEM Phase 1 | Additional Topics | Conclusion

Camp Lake System: Camp Lake Tributary 1 (CLT1)

- **CLT1 waters showed elevated hardness, conductivity, nitrate, sulphate and metals including iron, manganese, molybdenum and uranium versus reference and baseline conditions.**





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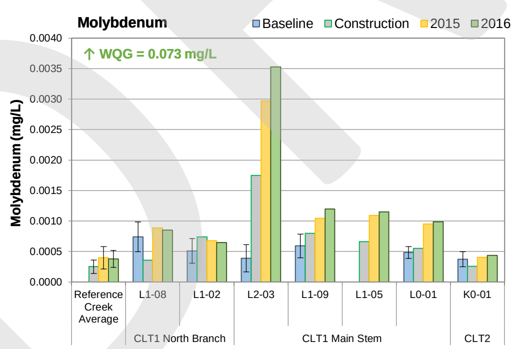
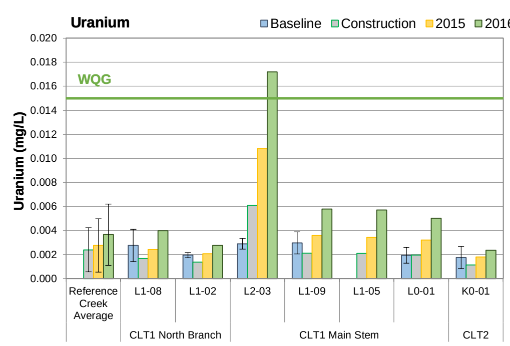
Camp Lake System: Camp Lake Tributary 1 (CLT1)





- **However, only iron and uranium concentrations were elevated above applicable Water Quality Guidelines (WQG) and/or AEMP benchmarks, *but only at the CLT1 upper main stem*.**

→ **Blasting activity at QMR2 main suspected source.**

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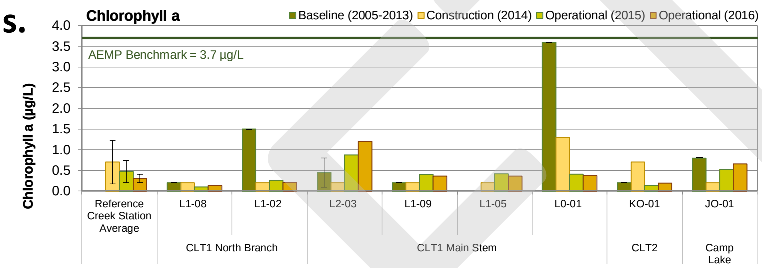
Camp Lake System: Camp Lake Tributary 1 (CLT1)

- **Elevated chlorophyll a concentrations and significantly greater benthic invertebrate density, richness and proportion of metal-sensitive taxa *only* at upper CLT1 compared to reference and/or baseline conditions.**



- **Suggested nutrient enrichment (e.g., nitrate) and commensurate non-bioavailability of iron, uranium and other metals at upper CLT1.**
- **Overall, no adverse effects to biota at CLT1.**

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Camp Lake System: Camp Lake Tributary 2 (CLT2)

- **Slightly elevated conductivity, sulphate and zinc concentrations at CLT2 compared to the reference creek in 2016, but not compared to baseline conditions (natural regional variability)**
- **Chlorophyll a concentrations similar to reference and baseline conditions.**
- **No significant differences in benthic invertebrate richness and community composition, although density lower at CLT2 than reference conditions in 2016. However, differences compared to baseline conditions only included higher Evenness in 2016.**

- **Indicated no adverse mine-related influences to biota of CLT2.**

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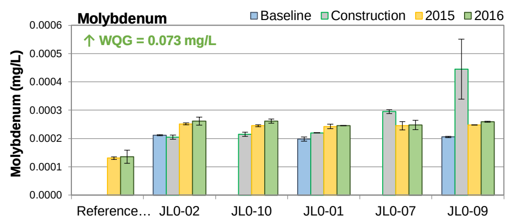
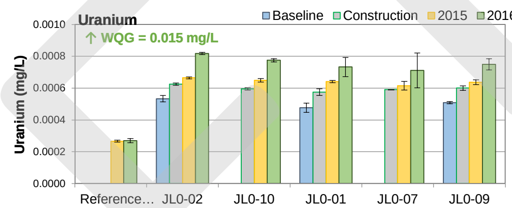
Camp Lake System: Camp Lake (JLO)

- **Camp Lake water quality showed elevated manganese compared to reference conditions, and elevated conductivity, chloride and metals including molybdenum, sodium, strontium and uranium versus baseline conditions.**

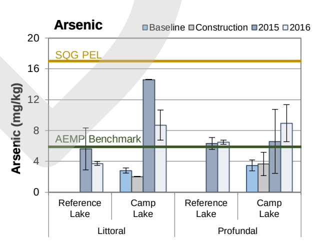


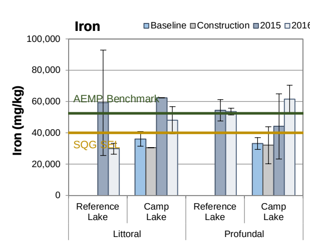


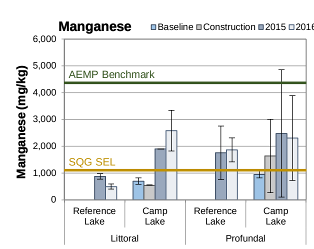
- **However, concentrations of all parameters below applicable WQG and AEMP benchmarks.**

Camp Lake System: Camp Lake (JLO)

- **Camp Lake sediment arsenic, manganese and molybdenum elevated compared to reference and/or baseline conditions, but only at littoral stations. Metal concentrations in profundal sediment comparable to reference and baseline conditions.**







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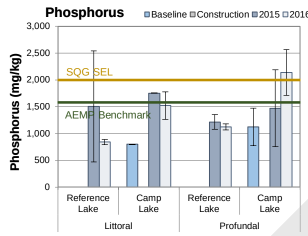
Camp Lake System: Camp Lake (JLO)



- **Phosphorus was only metal elevated above Sediment Quality Guidelines (SQG) at Camp Lake that was not also elevated at the reference lake.**
- **Low potential for adverse effects due to metals in sediment.**

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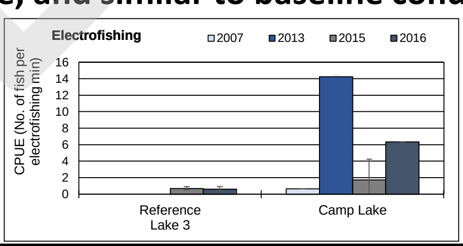
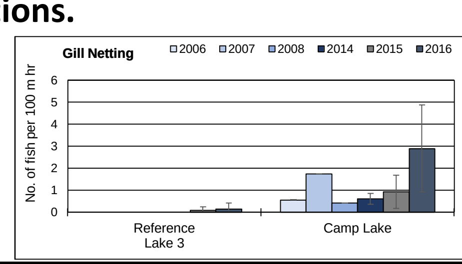
Camp Lake System: Camp Lake (JLO)

- **Camp Lake chlorophyll a concentrations were significantly higher than at the reference lake in 2016, but no significant within-lake differences were indicated from 2014 – 2016.**
- **Benthic invertebrate primary endpoints at Camp Lake in 2016 were similar to the reference lake, and to Camp Lake baseline conditions.**
- **Arctic charr abundance at Camp Lake higher than at the reference lake, and similar to baseline conditions.**





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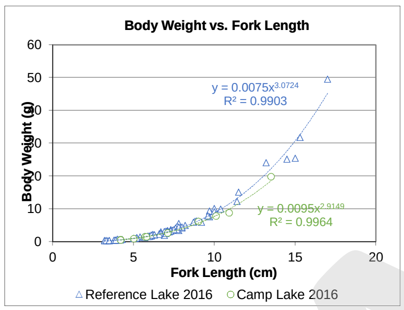
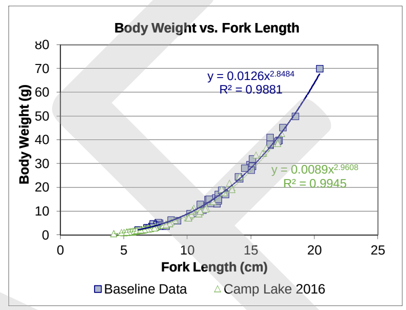
Camp Lake System: Camp Lake (JLO)

- **Arctic charr condition in 2015 and 2016 did not show an ecologically meaningful difference compared to fish sampled at the reference lake (nearshore population) or during baseline (nearshore and littoral/profundal population).**





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Camp Lake System: Overall Conclusions

- **Some mine-related influences on water quality of CLT1, and water and sediment quality of Camp Lake, but parameter concentrations generally below respective guidelines and/or AEMP benchmarks.**
- **No adverse, mine-related effects apparent to biota (phytoplankton, benthic invertebrate and Arctic charr) of the Camp Lake Tributaries or Camp Lake based on comparisons to reference and/or baseline conditions.**
- **Possible mine-related enrichment of upper CLT1 and Camp Lake reflected primarily in the phytoplankton data, suggesting that any influence is subtle.**

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Sheardown Lake System: Tributaries

- **Water quality of Sheardown Lake Tributary 1 (SDLT1) showed elevated concentrations of several metals compared to reference conditions, but only nitrate and sulphate elevated compared to baseline conditions.**
- **However, parameter concentrations generally were not elevated compared to WQG and/or AEMP benchmarks.**

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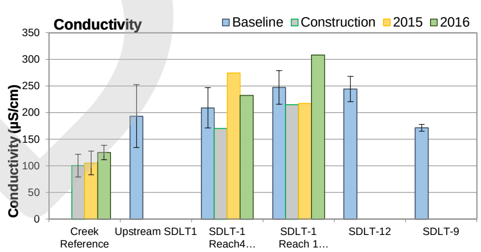
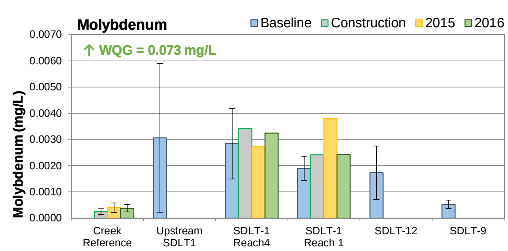
Sheardown Lake System: Tributaries

- **Water quality of Sheardown Lake Tributary 1 (SDLT1) showed elevated concentrations of several metals compared to reference conditions, but only nitrate and sulphate elevated compared to baseline conditions.**





- **However, parameter concentrations generally were not elevated compared to WQG and/or AEMP benchmarks.**

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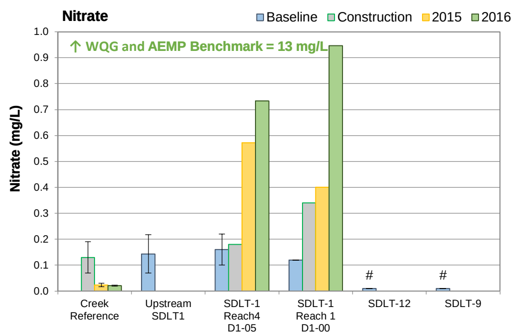
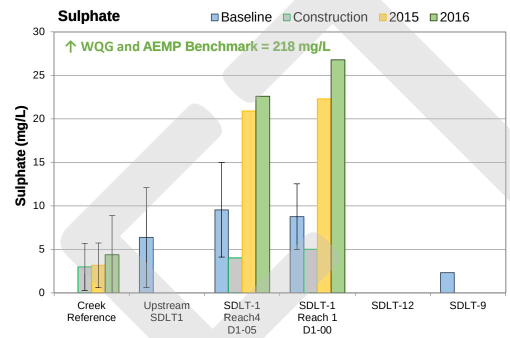
Sheardown Lake System: Tributaries





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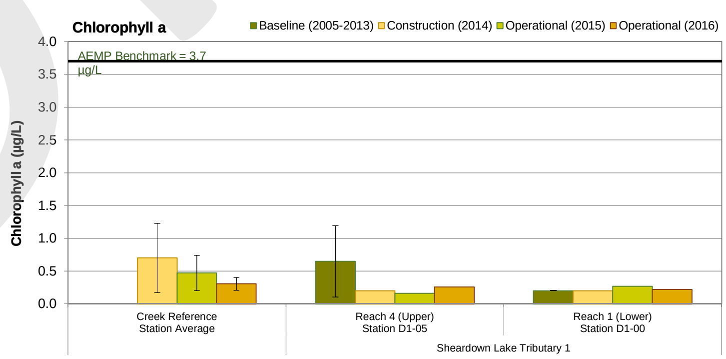
Sheardown Lake System: Tributaries

- **Fall chlorophyll a concentrations at SDLT1 in 2015 and 2016 were comparable to baseline conditions.**



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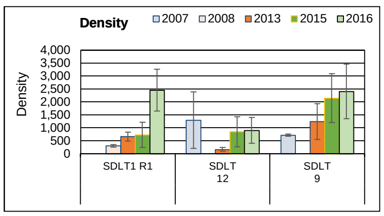
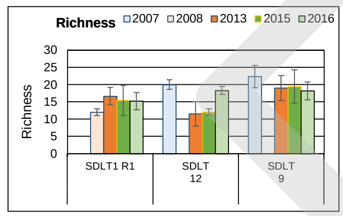
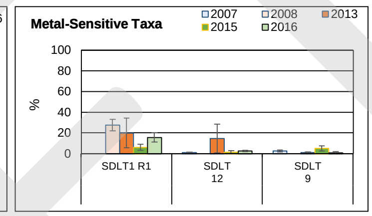
Sheardown Lake System: Tributaries

- **Subtle differences in benthic invertebrate density and composition suggested slight nutrient enrichment at SDLT1 compared to reference conditions, but no substantive changes in key endpoints were indicated at any of the Sheardown Lake tributaries compared to baseline conditions.**







- **Overall, suggested no adverse effects to biota of the Sheardown Lake tributaries.**

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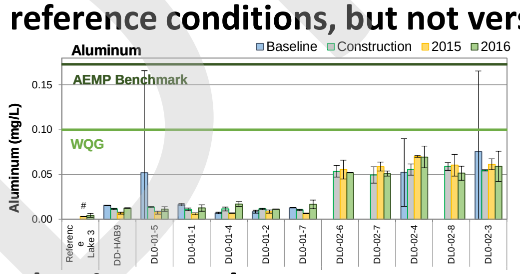
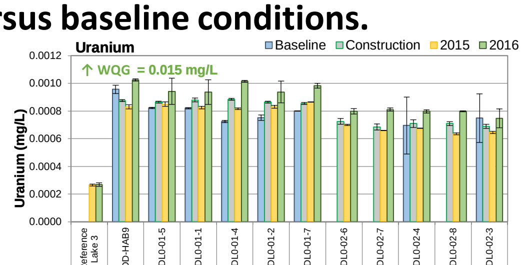
Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

- **Water quality of the Sheardown Lakes in 2015-2016 showed elevated aluminum, manganese, molybdenum and uranium compared to reference conditions, but not versus baseline conditions.**





- **Aluminum and manganese concentrations show significant positive correlation with turbidity, suggesting association with suspended particles (Mary River influence) and that not biologically available.**
- **All parameters below applicable WQG and AEMP benchmarks.**

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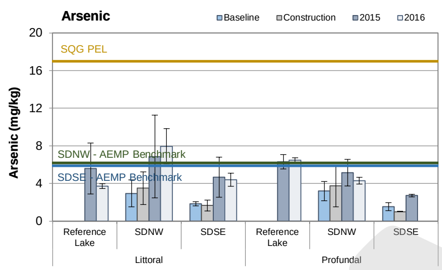
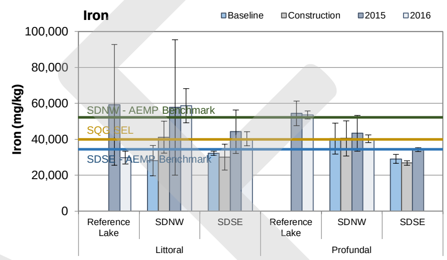
Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

- **Sediment arsenic, manganese and molybdenum concentrations were elevated at the Sheardown Lake basins compared to reference and/or baseline conditions, but only at littoral stations. Metal concentrations in profundal sediment were comparable to reference and baseline conditions. Similar to findings at Camp Lake.**





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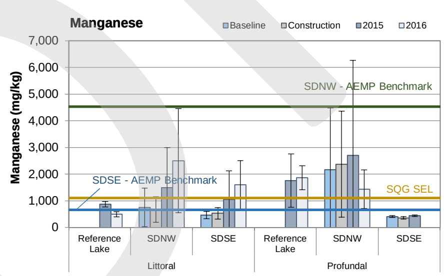
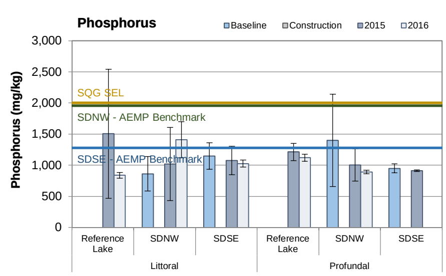
Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

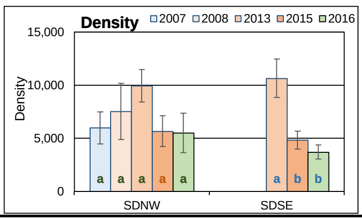


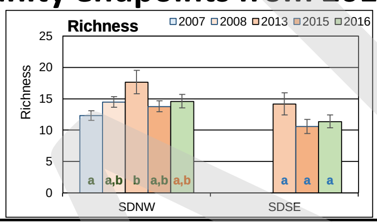


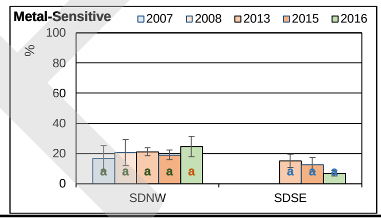
- **No metals were elevated above Sediment Quality Guidelines (SQG) at Sheardown Lake that were not also elevated at the reference lake.**
- **Low potential for adverse effects due to metals in sediment.**

Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

- **Sheardown Lake chlorophyll a concentrations were significantly higher than at the reference lake in 2016, but no significant within-lake differences were indicated from 2014 – 2016.**
- **Benthic invertebrate primary endpoints at littoral and profundal depths showed no significant adverse (negative) differences between Sheardown Lake and the reference lake in 2015 or 2016.**
- **No consistent types and/or direction of differences in benthic invertebrate community endpoints from 2015-2016 to baseline.**

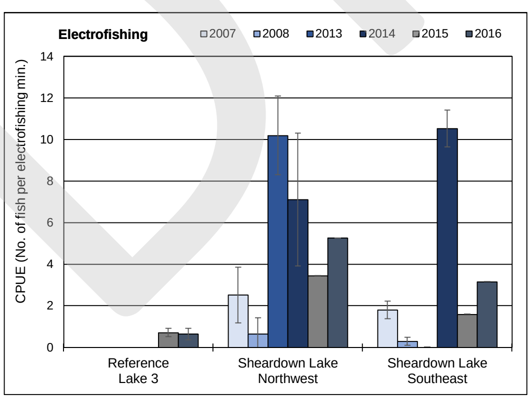


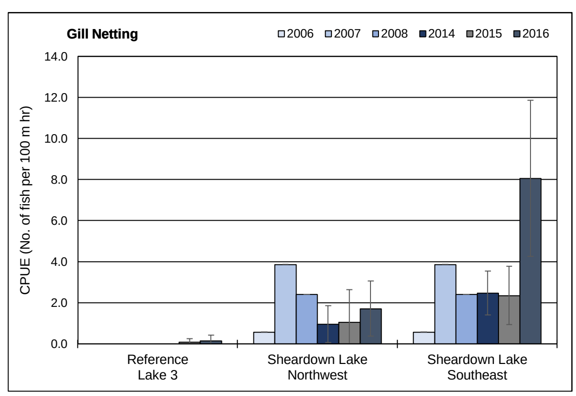




Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

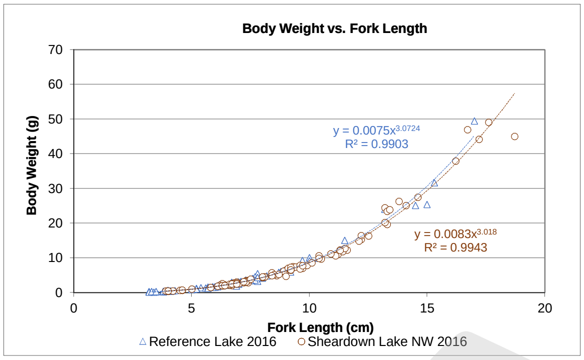
- **Arctic charr abundance at Sheardown Lake was consistently higher than at the reference lake, and similar to baseline conditions.**

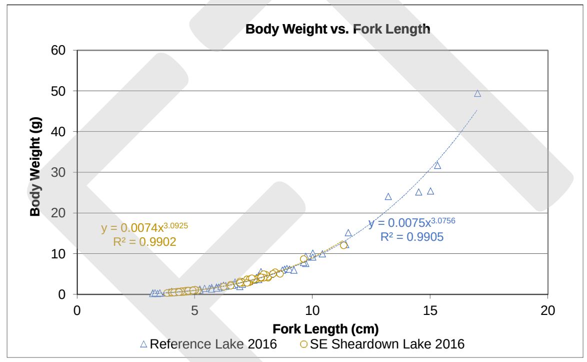




Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

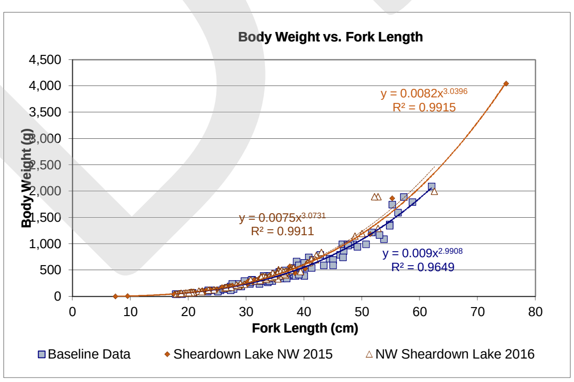
- **Arctic charr at SDL nearshore areas showed no ecologically meaningful difference in condition compared to the reference lake.**

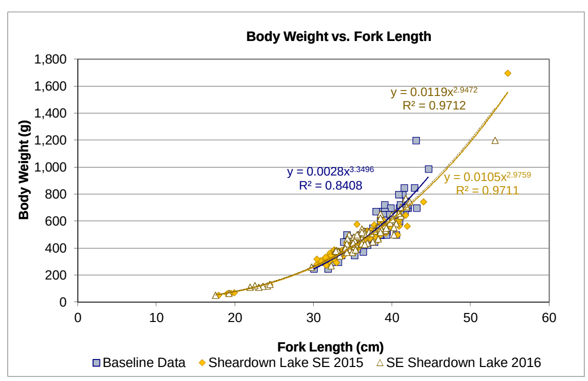




Sheardown Lake System: Northwest (SDNW) and Southeast (SDSE) Basins

- **Although SDL Arctic charr captured at nearshore areas showed consistently lower condition compared to baseline, no differences shown for the littoral/profundal population.**





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Sheardown Lake System: Overall Conclusions

- Some mine-related influences on water quality of SDLT1, and water and sediment quality of Camp Lake, but parameter concentrations below respective guidelines and/or AEMP benchmarks.
- No adverse, mine-related effects apparent to phytoplankton or benthic invertebrates of the SDL Tributaries or Camp Lake based on comparisons to reference and/or baseline conditions.
- Inconsistent response in SDL Arctic charr condition – no meaningful differences between SDL and reference area nearshore fish, but lower condition relative to baseline whereas no difference for littoral/profundal fish condition relative to baseline: possible artifact of sampling program(?)

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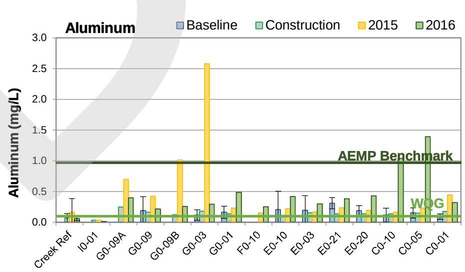
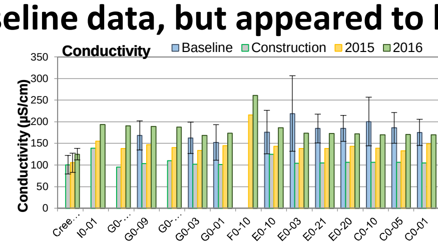
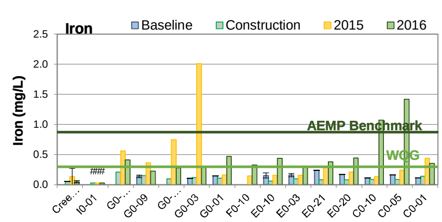
Mary Lake System: Mary River

- Water quality of Mary River mine-exposed areas showed elevated concentrations of several metals (Al, Cr, Cu, Fe, Pb, Mn, Ni) compared to reference and/or baseline data, but appeared to be due to naturally high turbidity.







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Mary Lake System: Mary River

- **Four lines of evidence suggested elevated metals were not related to mine operations, including:**
  - **Dissolved metal concentrations did not show similar patterns;**
  - **Significant positive correlations between total metals and turbidity;**
  - **High ratios of total to dissolved metals; and,**
  - **Highest turbidity often shown at the upstream reference area.**

- **Turbidity-related total Al, Cu, Fe, Pb and P concentrations were often elevated compared to WQG and/or AEMP benchmarks at Mary River.**

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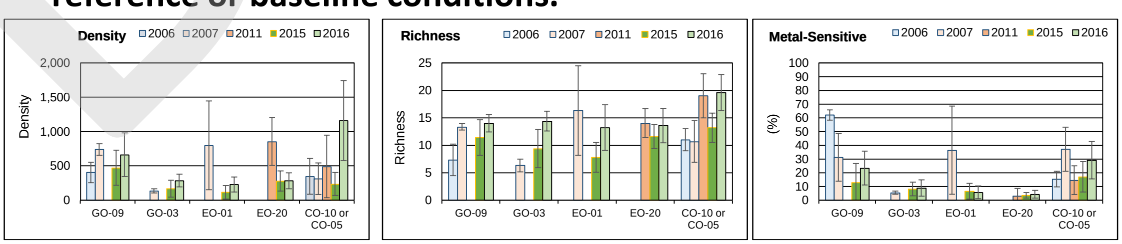
Mary Lake System: Mary River

- **Chlorophyll a concentrations did not differ significantly between Mary River and the reference area, but were lower than during baseline (potentially reflected higher turbidity in 2015-2016).**
- **Benthic invertebrate density, richness and metal-sensitive taxa proportion generally did not ecologically/adversely differ from reference or baseline conditions.**



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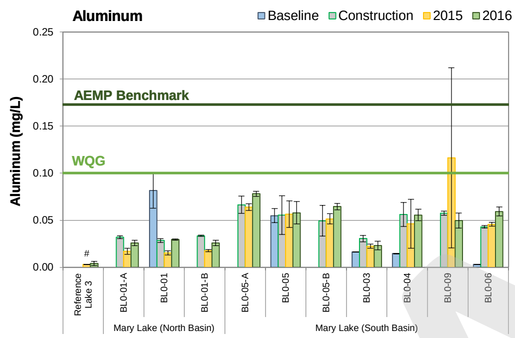
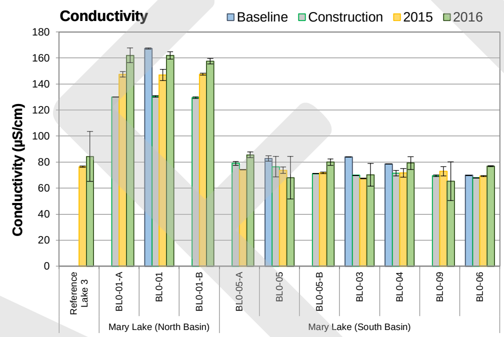
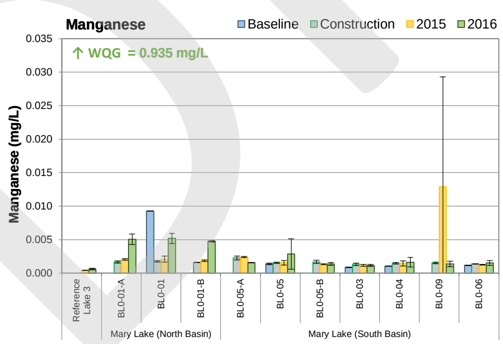
Mary Lake System: Mary Lake

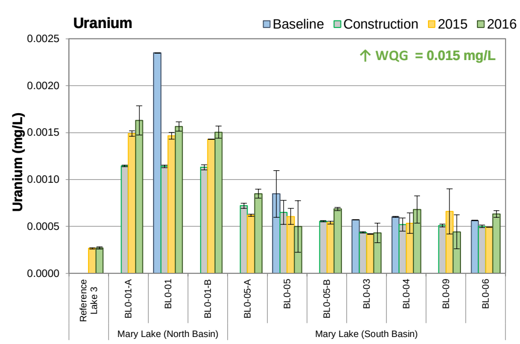
- **Water quality of the Mary Lake in 2015-2016 showed elevated total aluminum, manganese and uranium compared to reference conditions, but not versus baseline conditions – as at Sheardown Lakes and Mary River, reflected turbidity.**





Mary Lake System: Mary Lake





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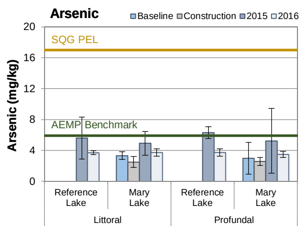
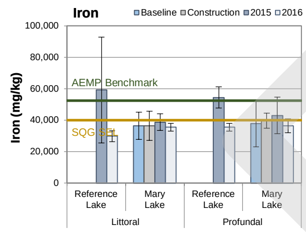
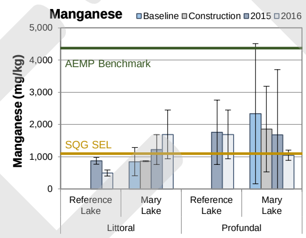
Mary Lake System: Mary Lake

- Sediment metal concentrations at Mary Lake littoral and profundal stations, and with exception of slightly elevated manganese at littoral stations, were comparable to baseline.







- No metals were generally elevated above SQG/AEMP benchmarks at Mary Lake that were not also elevated at the reference lake.
- Low potential for adverse effects due to metals in sediment.

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Mary Lake System: Mary Lake

- Mary Lake chlorophyll a concentrations were significantly higher than (N-basin) or similar to (S-basin) the reference lake in 2016, but no significant within-lake differences were indicated from 2014 – 2016.
- Benthic invertebrate community of littoral habitat showed significantly lower richness and composition differences compared to the reference lake (natural differences in TOC/particle size), but no significant differences to baseline.