MARY RIVER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

VOLUME 10
Appendix 10D-7D
Fish Habitat Compensation Options

SECTION 1.0 - FISH HABITAT COMPENSATION OPTIONS

1.1 INTRODUCTION

Development of the Mary River Project will result in the unavoidable and harmful alteration, disruption or destruction of fish habitat (HADD) as defined by DFO. Notwithstanding the implementation of mitigation measures to minimize Project impacts, HADD will result from various Project-related developments including a railway and roads (stream crossings and lake encroachments) in the freshwater environment. To offset potential HADD associated with Project developments Baffinland has prepared this Fish Habitat Compensation Options document that presents fish habitat compensation options to address the need to ensure a no net loss (NNL) of habitat pursuant to the DFO policy for the management of fish habitat.

1.2 RATIONALE FOR SELECTION OF COMPENSATION APPROACHES

The selection process for approaches to compensation was based on the DFO NNL guiding principle and its hierarchy of preferred compensation options. Based on this hierarchy Baffinland's efforts to identify compensation options were focused on watersheds located within the aquatics local study areas (LSAs), particularly those that would be directly or indirectly affected by the Project.

1.3 FISH HABITAT COMPENSATION APPROACHES

The freshwater and marine HADD associated with the Project will be subject to compensation requirements. No net loss habitat compensation projects typically focus on creating or enhancing habitat in anthropogenically degraded environments. Identifying compensation opportunities in remote and essentially pristine environments can present significant challenges, and potential projects often are impractical or do not provide an unambiguous net environmental benefit. Nevertheless, several potential compensation approaches that would be consistent with hierarchy of preferred options have been identified (Approaches 1 and 2, below).

1.3.1 Approach 1 – Enhancement of Local Fish Habitat Close to the Rail Corridor

This NNL approach involves creating spawning habitat and establishing an Arctic Char population in a watershed that currently has no Arctic Char. This approach is attractive in that it ranks high when utilizing the "The DFO Hierarchy of Compensation Options" by creating or increasing the productive capacity of like-for-like habitat in the same ecological unit.

In the course of conducting the 2008 summer field studies along the railway alignment it became evident that a relatively large sub-basin in the Cockburn River watershed was apparently devoid of Arctic Char. Sites along the mainstem and 46 tributary streams within this sub-basin were surveyed along the railway corridor without capturing any Arctic Char, despite the presence of abundant suitable Arctic Char habitat. Although 32 of the surveyed streams were ephemeral or intermittent streams with little or no habitat potential, at least 10 streams were classified as perennial streams with suitable Arctic Char rearing habitat. The mainstem is in fact the second largest stream within the Cockburn Lake watershed. It should be noted that several Ninespine Stickleback were captured in the mainstem and one of the larger tributaries.

Searches to locate a downstream barrier revealed a number of major waterfalls between km 86 and the mainstem outlet at the north end of Cockburn Lake. The watershed above the barriers is essentially devoid of lakes that could offer overwintering refuge, and it was initially assumed that this isolated watershed was limited by a lack of overwintering habitat for Arctic Char. Subsequent surveys showed that a lake (Km 81 Lake), actually a widening in the mainstem channel at approximately km 79.4 to km 82.0, has a central basin with a maximum depth of approximately 20 m, making it unlikely that overwintering habitat is the limiting factor. Consequently, it was assumed that the likely limiting factor is a lack of suitable spawning habitat, since all areas with suitable spawning substrates are too shallow to avoid winter ice contact (i.e., < 2 m).

To confirm the absence of Arctic Char in the sub-basin a backpack electrofishing survey was conducted at Km 81 Lake in August of 2010. Intensive electrofishing (7400 sec of effort) along most of the accessible lake shoreline, including all nearshore areas with cobble/boulder substrate, failed to produce any Arctic Char, although over 1000 ninespine stickleback were captured. The conclusion is that the sub-basin does support Ninespine Stickleback but Arctic Char are absent.

The sub-basin described offers a potential opportunity to 'create' a significant amount of high quality Arctic Char habitat by eliminating the conditions that currently preclude Arctic Char survival, and then introducing Arctic Char to that habitat. Given the amount and quality of stream habitat that already exists, it is reasonable to anticipate that a viable and self-sustaining Arctic Char population could be established.

Several potential scenarios for establishing an Arctic Char population in the sub-basin have been identified. Identifying the most appropriate approach is dependent on collection of additional biological and habitat information and definitive assessment of limiting conditions, but the current potential approaches are:

1. Approach 1a (Arctic Char stocking program only) – This approach would be viable only if it is determined that there are no fundamental impediments to Arctic Char survival and propagation in the system.
2. Approach 1b (create spawning habitat, plus Arctic Char stocking program) – This approach would be viable if it is determined that habitat suitability is limited by lack of spawning habitat (i.e., suitable substrates at appropriate depth). If no suitable substrates are found at the required depths (i.e., > 3 m) then these could be added by creation of an artificial spawning reef(s).
3. Approach 1c (construct an outlet control structure to elevate lake, plus Arctic Char stocking program) – This approach assumes that areas with suitable spawning substrate are currently available and that appropriate depths over these areas can be achieved by constructing a low head outlet control weir. The weir design would include a fishway (e.g., rock ramp) configured to facilitate bi-directional fish movement at high and low flows.
4. Approach 1d – This approach would involve a combination of Option 1b and Option 1c, based on a determination that both spawning depth and substrate are limiting.

Arctic Char stocking would be considered if it can be assumed with reasonable confidence that a single introduction, possibly carried out over several years, would be adequate to establish a viable self-sustaining population. Appropriate stocking rates would be determined prior to initiation of a stocking program, and

several stock sources would likely be utilized to ensure genetic diversity. Sources for stocked fish could include, but would not be limited to:

- capture programs conducted at several sites within the region, preferably within the mine site or railway LSAs; and,
- juvenile Arctic Char captured in fish salvage operations during construction of railway or access road stream crossings in the open water season.

It is understood that implementation of Approach 1c could involve several potential negative effects on the existing environment and would be considered only if these potential effects can with reasonable confidence be avoided or mitigated. Potential negative effects include:

1. Mobilization of organic mercury or increased rates of erosion and sedimentation resulting from the flooding of shoreline areas – Detailed shoreline surveys to classify and quantify vegetation and surficial geology would be required to assess the risk of increased mercury mobilization or erosion and sedimentation. Potential mercury increase can be estimated through modelling and this would be an important consideration in the decision process. A fundamental principal for selection and design of Approach 1c would be to minimize both the extent of flooding and the risk of adverse effects. For a conceptual design based on a proposed lake elevation increase of 1 m, the area flooded would be 23 ha (Table 1).
2. Long-term maintenance requirements for a weir, including after project closure – The conceptual design presented in Figure 1 includes a low profile weir with a wide base (20:1 slope on the upstream and downstream sides), intended to be inherently stable. The weir would incorporate an impermeable core or sub-surface treatment (e.g., impermeable membrane) to prevent water intrusion through the structure, and appropriately sized rock and boulder rip rap cover to ensure long term stability and integrity. Achieving low or zero maintenance characteristics would be a high priority.
3. Loss of fish over the weir – Fish passage would be an important design consideration and preference would be given to a 'nature like' fishway design capable of facilitating bi-directional fish passage under a wide range of flow conditions. The weir design illustrated in Figure 1 includes a rock ramp fishway that emulates the existing outflow channel and incorporates a central low flow channel. The goal would be to provide unimpeded upstream and downstream fish passage even under low flow conditions.
4. Upstream impacts due to habitat alteration – An outlet control weir would marginally elevate the level of an existing lake and would not fundamentally alter existing aquatic habitats. The existing maximum depth would be increased by 1 m and the current mean depth of 2.7 m would be decreased to 2.3 m, reflecting an overall increase in littoral habitat. The 2010 survey found that the lower reaches of several streams entering the lake are utilized by Ninespine Stickleback. Although some of this habitat would be altered by flooding, it would be offset by an increased area of shallow littoral lake habitat.
5. HADD resulting from weir construction – Figure 1 shows the location of a weir at the outlet of Km 81 Lake. At this location the weir would be constructed on a natural shallow riffle, which is not

considered high quality ninespine stickleback habitat but is likely used by that species to some extent. The weir configuration illustrated in Figure 1 would provide very similar habitat (i.e., along the rock ramp) as well as additional cobble/boulder littoral habitat along the upstream weir face.

Successful implementation of any of the above options would be contingent on establishment of a viable and self-sustaining Arctic Char population.

Table 1 summarizes the potential gains associated with Approach 1c, according to depth zones. The 0 - 2 m zone is subject to winter ice contact and would be limited to summer rearing and feeding. The 2 – 5 m zone is likely the most critical depth range for Arctic Char spawning. In the existing lake (surface elevation at 186 m ASL) this zone is limited to 4.3 ha, 75% of which is located on the steeply sloping edges of the central basin. At a surface elevation of 187 m ASL the area of this zone would increase to 12.2 ha, with 75% of it on flat or gently sloping lakebed. The total potential habitat gain associated with Approach 1c is estimated to be 65 ha of stream habitat and 56 ha of lake habitat (i.e., 33 ha of existing habitat plus 23 ha if the lake level is raised by 1 m), or a total of 121 ha.

Table 1 Potential habitat gains associated with compensation Approach 1c.

Water Depth	Lake Area (ha)		Lake Area Gained	
	at 186 m ASL	at 187 m ASL	ha	%
Surface Area	33.3	56.3	22.9	69%
0 - 2 m	24.3	38.7	14.4	59%
2 - 5 m	4.3	12.2	8.0	187%
5 - 10 m	2.1	2.2	0.1	5%
> 10 m	2.7	3.1	0.4	15%

1.3.2 Approach 2 – Small Regional Projects

Several opportunities for smaller regional projects that would have NNL benefits have been identified. In general terms, projects to remove passage barriers in fish streams, stocking of non fish-bearing lakes or enhancing existing habitat, within or outside the regional study area, could add fish habitat, possibly in locations closer to communities. Identifying locations suitable for barrier removal, fish stocking or other enhancement opportunities will require more effort and will likely not result in full compensation for all identified HADD resulting from the Project. However, in combination with other approaches mentioned below (Approaches 3a and 3b), Approach 2 may provide viable compensation measures. Based on studies conducted to date, several potential fish habitat enhancement projects have been identified, including:

1. Removal of fish barriers at streams along the railway or access road corridors – Three sites have been identified where removal of fish barriers could increase the amount of high quality habitat available to juvenile Arctic Char. These include CV-3-1, CV-17-1, and CV-11-1. Removal of barriers at these streams would result in an estimated gain of 900 m of stream length and an area of 0.6 ha.

2. Removal of fish barriers to improve fish passage at other locations – Location CV-27-2 was surveyed in 2007 as a potential railway crossing but the site was subsequently abandoned due to railway re-alignment. The site is located at the terminus of a 500 m section of stream that connects a 46 ha upstream lake to a small downstream lake. Continuing downstream, the stream connects several more small shallow lakes and eventually ends at Angajurjualuk Lake, approximately 8 km downstream. It is believed, but not confirmed, that the upstream lake supports an Arctic Char population, but the habitat status of the small downstream lake is not known. For the last 100 m of this section the stream flows through a dense boulder field that creates a partial barrier under most flow conditions, and likely a total barrier under low flow conditions. If fall upstream migration to the larger lake is restricted or precluded, stranded juveniles would have to overwinter in the smaller lake or undertake a migration to Angajurjualuk Lake. Doing so would expose juveniles to numerous stranding risks since much of the stream would present passage challenges under fall low flow conditions. Opening a channel through the boulder field could provide reliable passage moving up, down or both ways. This would provide a net benefit to the local Arctic Char population, but it would be difficult to quantify habitat gain.

3. Spawning habitat enhancement at Mary Lake – Fish population studies conducted at Mary Lake and its tributary streams between 2005 and 2008 provided little evidence of Arctic Char spawning (i.e., presence of pre-spawning adults in the fall or young-of-the-year in the spring). Furthermore, habitat surveys conducted in 2007 and 2010 suggest that suitable spawning habitat amounts to only 4.1 ha, or approximately 0.3% of the total lake area. This suggests that Arctic Char spawning may be limited in Mary Lake and that availability of suitable spawning habitat may be a limiting factor. Pending further investigations and results that confirm spawning is non-existent or limited, artificial spawning reefs could be constructed in Mary Lake to improve spawning potential and increase the overall productive potential of the lake with respect to Arctic Char.

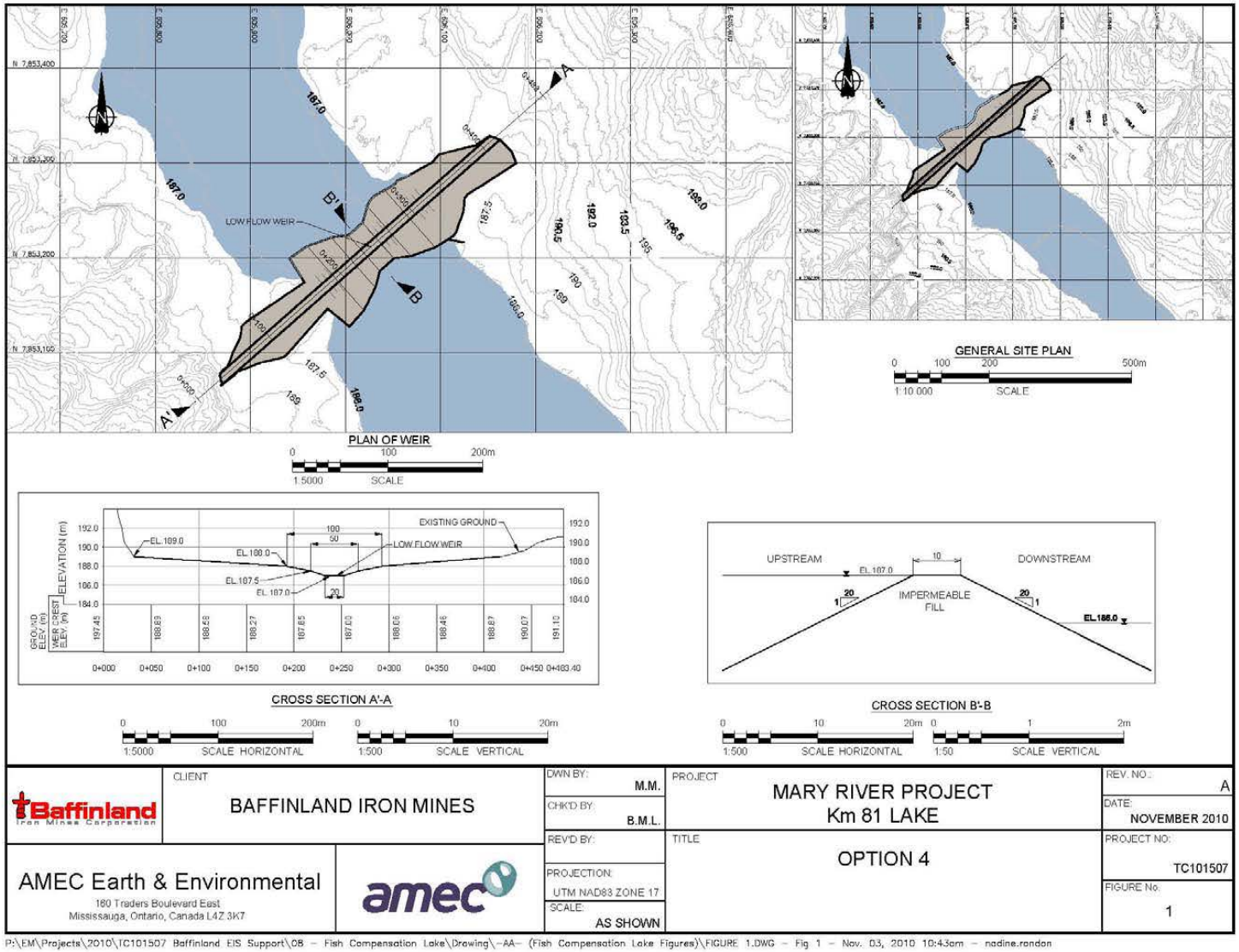

Figure 1 Compensation Lake outlet control weir plan and profile.