FISH AND HABITAT ASSESSMENT OF THREE WATERCOURSES NEAR KUGAARUK, NUNAVUT

RL&L

Environmental Services Ltd.

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Prepared for

Jivko Engineering Ltd.
Yellowknife, NT.
and
Hamlet of Kugaaruk, Nunavut

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Guido Tigvareark	*(Assistant Senior Administrative Officer)*
Remi Krikort	*(Deputy Mayor and Wildlife Officer)*
Getan Apsaktaun	*(Road Project Foreman)*

The following staff members of RL&L participated in the field assessment of the crossing sites and in the preparation of the report:

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1.0 INTRODUCTION

The Government of Nunavut (GN), Department of Community Government and Transportation (CG&T) is in the process of constructing a road connecting the Hamlet of Kugaaruk, Nunavut to an existing Forward Operating Location (FOL) owned by the Department of National Defense (DND). The DND is planning the implementation of a multi-year FOL site cleanup commencing 1 August 2001. The connecting road between the hamlet and the FOL site is intended to facilitate clean-up operations at the site. The road will also support future DND activities at the site and supplement local economic and employment conditions in the Hamlet of Kugaaruk.

Approximately 14 km of the 23 km access road section located between the hamlet and the first watercourse crossing on the Aliarusik River was constructed during 2000. A single span bridge structure, supported by gravel filled bin boxes and surrounded by boulder armoring, was placed at this crossing. Both bridge abutments were constructed above the high water marks and there was negligible instream impact on the fish habitat.

The remainder of the access road will cross three watercourses, the upper Aliarusik River and two of its tributaries, all of which were considered fish bearing. In response to the concerns of the Department of Fisheries and Oceans, Habitat Management branch (DFO-HM) in Iqualuit, NU, RL&L Environmental Services Ltd. (RL&L) was retained to provide an assessment of fish habitat conditions at the three watercourse crossings and provide recommendations on potential mitigation and compensation options. This information may also be used to determine if “No Net Loss” of the productive capacity of fish habitat provisions (DFO Fish Habitat Management Policy) will be achieved.

2.0 STUDY AREA

The study area, which is located southeast of the Hamlet of Kugaaruk, involved one bridge crossing of the Aliarusik River and two culvert watercourse crossings on tributaries to the Aliarusik River. The Aliarusik River (11 km in length) originates in Barrow Lake, which is adjacent to the FOL site. This river is a tributary to the Kugajuk River, which flows into St. Peters Bay, Gulf of Boothia near the Hamlet of Kugaaruk. Three proposed watercourse crossings were labeled Crossing 1, 2, and 3 (Table 2.1).

Table 2.1 Crossing designations, structures, and descriptions, 12 and 13 July 2001.

Crossing Number	*Proposed Crossing Structure*	*Description*
1	Two 1 m culverts	Unnamed tributary to the Aliarusik River.
2	Single span bridge	Upper Aliarusik River near Barrow Lake outflow.
3	Two or three 1 m culverts.	Overflow channel to Barrow Lake.

3.0 METHODS

Personnel from RL&L conducted a visual assessment of stream conditions at each proposed watercourse crossing on 12 - 13 July 2001. At each crossing, flow characteristics were described and observations made regarding high-water marks along the stream banks. Fisheries information was gathered from local residents and from onsite observations (where applicable). Habitat conditions at each crossing were described, including characterizations of instream habitat type, substrate, instream cover for fish, water depth, channel width, and water velocity. In addition, the habitat suitability for key local fish species (Arctic char and lake trout) was assessed based on stream conditions at the time of the survey and fisheries information from the local community. Photographs of each site were collected during the site visit.

In addition to the onsite assessment of stream characteristics and habitat suitability, potential impacts related to road construction were identified. Mitigation recommendations and compensation options were developed in conjunction with hamlet administrative staff and senior biological staff at RL&L.

4.0 OBSERVATIONS

4.1 CROSSING 1 – UNNAMED TRIBUTARY TO ALIARUSIK RIVER

The watercourse at Crossing 1 is a tributary to the Aliarusik River (Figure 4.1). The overall length of the stream, which connects a small pond area (Plate 1) to the downstream Aliarusik River, is estimated at less than one km. The Aliarusik River, at the time of the survey, was approximately 80% ice covered (the ice in some areas was in excess of 2 m thick; Plate 2).

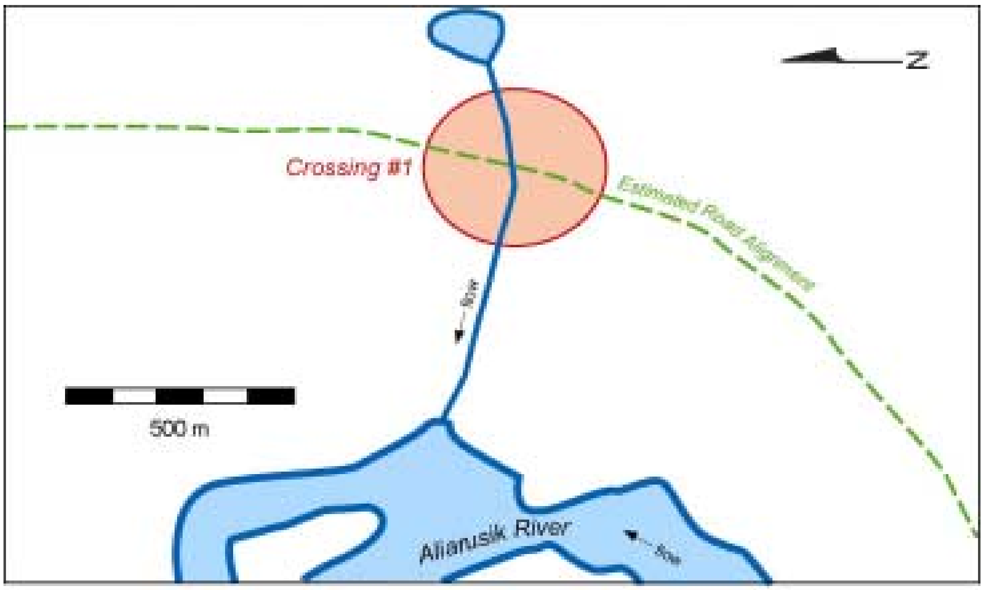

Figure 4.1 Schematic diagram of Crossing 1 location, 12 - 13 July 2001

4.1.1 FLOW CHARACTERISTICS

The flow patterns for this stream were described as ephemeral by members of the local community, higher flow periods typically occur during spring freshet in June (G. Tigvareark, pers. comm.). The stream flow was very low at the time of the survey, although observations of the banks (e.g., high-water marks) confirm that higher flows did occur in this watercourse.

4.1.2 FISH RESOURCES

Local residents of Kugaaruk indicated that it was unlikely that the stream and upstream pond area contained fish. This assessment was based on the ephemeral nature of the stream flows and the fact that the pond likely freezes to the bottom during the winter. However, several unidentified fish were observed in pools along the stream during the survey. The presence of these fish indicated seasonal and flow dependant habitat use.

4.1.3 FISH HABITAT

The stream channel at the Crossing 1 location exhibited a steep gradient (approximately 15 m rise in 50 m; 30%), with channel widths ranging from 0.3 to 1.0 m, and depths up to 0.2 m (Plate 3). The presence of a wider channel was noted at the existing ATV crossing, which is located immediately downstream of the proposed installation (Plate 4, 5 and 6). Instream habitat consisted primarily of riffle-pool complexes and abundant cascades over large rocky substrate. Several sections of the stream were characterized by interstitial flow amongst large boulders (Plate 7). Substrate was predominantly boulder and large cobble, although small discrete areas of finer substrate (e.g., gravel and sand) were evident in association with pool habitat (Plate 8). The D90 for the watercourse was estimated to be 75-cm, which reflects the large bed material. Instream cover was provided by interstitial space amongst the substrate and instream vegetation in the pool areas. Water velocities were considered low (e.g., < 0.25 m/s). The habitat suitability of the stream at Crossing 1 was considered low for all life stages of Arctic char (the predominant fish species in the Aliarusik River system) due to the shallow, ephemeral nature of the watercourse.

4.1.4 ADDITIONAL OBSERVATIONS

The road alignment at Crossing 1 is located approximately 10 m upstream of the existing ATV ford crossing. This location offers uniform streambed gradient at the road alignment as well as upstream and downstream. The regular gradient allows for the placement of culvert structures and fish access at either end of the culvert. Given the potential flows in this stream during spring freshet, two one-metre diameter (15 m length) culverts are planned for installation at the crossing location.

Plate 1 Crossing 1, 12 July 2001. Outlet of ponded area upstream of the road alignment. Note narrow channel width and shallow depths at the outlet Some evidence of elevated water levels noted on banks in foreground.

Plate 2 Crossing 1, 12 July 2001. Confluence area of unnamed tributary with Aliarusik River. Tributary enters river from picture right. Note ice cover and ice depth on river.

Plate 3 Crossing 1, 12 July 2001. Upstream view of crossing location. Perched rocks on left side indicate approximate road alignment.

Plate 4 Crossing 1, 12 July 2001. Crossing 1 viewed from top of valley to north of crossing.

Plate 5 Crossing 1, 12 July 2001. ATV crossing located immediately downstream of the proposed road alignment. Note the extensive bank degradation resulting from repeated ATV forded crossings.

Plate 6 Crossing 1, 12 July 2001. Upstream view of ATV crossing in relation to natural undisturbed channel widths. Note change in gradient immediately downstream of the ATV crossing.

Plate 7 Crossing 1, 12 July 2001. Large boulder substrate with interstitial flows evident downstream of the proposed crossing location.

Plate 8 Crossing 1, 12 July 2001. Pool area with finer gravel substrate located downstream of the proposed crossing location.

4.2 CROSSING 2 – UPPER ALIARUSIK RIVER

The Aliarusik River originates in Barrow Lake (Plate 9) and flows approximately 11 km before entering the Kugajuk River. Crossing 2 is located on the Aliarusik River approximately 70 m downstream of its outflow from the lake (Figure 4.2).

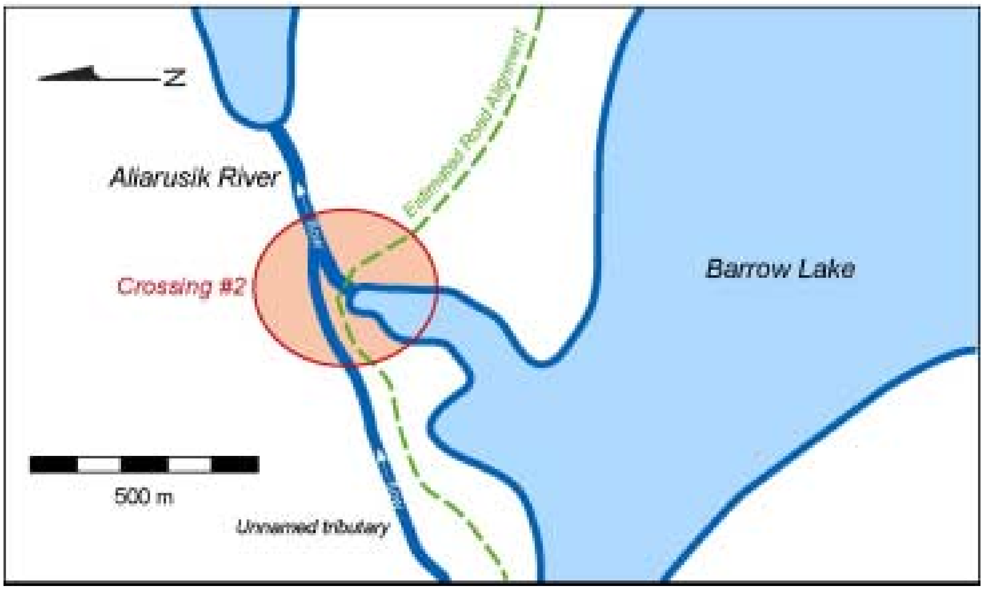

Figure 4.2 Schematic diagram of Crossing 2 location, 12 - 13 July 2001.

4.2.1 FLOW CHARACTERISTICS

Flows in the upper Aliarusik River at the time of the survey were considered moderate. The high water marks observed on the banks at the crossing were approximately 0.3 to 0.5 m above flows observed during the site visit. Typical flows were described by local residents as being highest during June with low flows evident in mid-July to August (G. Tigvareark, pers. comm.). The upper portion of the Aliarusik River apparently does not freeze during the winter, although substantial ice buildup was mentioned.

4.2.2 FISH RESOURCES

Kugaaruk residents indicted that the river and lake were used by Arctic char during the summer period. The river likely provides a migration corridor for char moving into the lake to spawn or out to the ocean to feed. The majority of fish movements occurred during higher flow periods with the end of the migratory runs typically occurring in August. Lake trout are resident in upstream Barrow Lake, although their use of the Aliarusik River was described as quite sporadic.

4.2.3 FISH HABITAT

The stream channel at Crossing 2 exhibited a moderate gradient (approximately 5 m rise in 50 m; <1%), with wetted widths of 45 m, and depths up to 0.75 m (Plates 10 through 13). The thalweg was located nearest the east river bank (right side facing downstream) with gradually decreasing depths toward the west bank. Instream habitat was predominantly riffle-boulder garden. Substrate was entirely boulder and large cobble; the D90 for the watercourse was estimated to be 100-cm. Instream cover was provided by interstitial space amongst the boulder streambed. Water velocity at the crossing was considered moderate (e.g., between 0.25 and 0.75 m/s). The habitat suitability of the Aliarusik River at Crossing 2 was considered moderate for Arctic char migration/movement during higher water periods. This suitability was likely to decline as water flows diminished later in the year. The suitability of the habitat was considered low for other life stages of Arctic char and lake trout due to the preponderance of very large substrate and shallow depths at the crossing during most of the year.

4.2.4 ADDITIONAL OBSERVATIONS

The bridge to be constructed at Crossing 2 will utilize gravel filled bin boxes as abutments with a single span 36 m bridge span over the river channel (J. Jivkov. pers. comm.). The western abutment is to be constructed above the river high water mark. The eastern abutment will intrude on the wetted river channel approximately 10 m. This portion of the channel was opposite the river thalweg. Depths in the nearshore area at the site of the proposed bridge abutment were up to 0.3 m over large boulder substrate.

Plate 9 Crossing 2, 12 July 2001. Barrow Lake viewed from near Crossing 2. Outflow of the Aliarusik River is on picture right. Note ice cover still present on the lake.

Plate 10 Crossing 2, 12 July 2001. Aliarusik River at Crossing 2 viewed from the west bank. Quad marks the approximate centre of the road alignment. Note river flow is from left to right.

Plate 11 Crossing 2, 12 July 2001. Downstream view along west bank of the Aliarusik River at Crossing 2. Quads mark the road alignment.

Plate 12 Crossing 2, 12 July 2001. Downstream view along east bank of the Aliarusik River at Crossing 2. Note shallow water in nearshore areas.

Plate 13 Crossing 2, 12 July 2001. Panoramic view from the east bank of the Aliarusik River at Crossing 2. Barrow Lake is located to the right of the picture. Note the smaller lake downstream of the crossing location. (Dark arrow indicates approximate location of the proposed bridge.

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4.3 CROSSING 3 – OVERFLOW CHANNEL TO BARROW LAKE

The watercourse bisected by Crossing 3 is a 60 m long overflow channel, which connects an unnamed tributary of the Aliarusik River to Barrow Lake (Figure 4.3). The overflow channel is active, but shallow during freshet (Plate 14) with diminishing flows throughout the summer period.

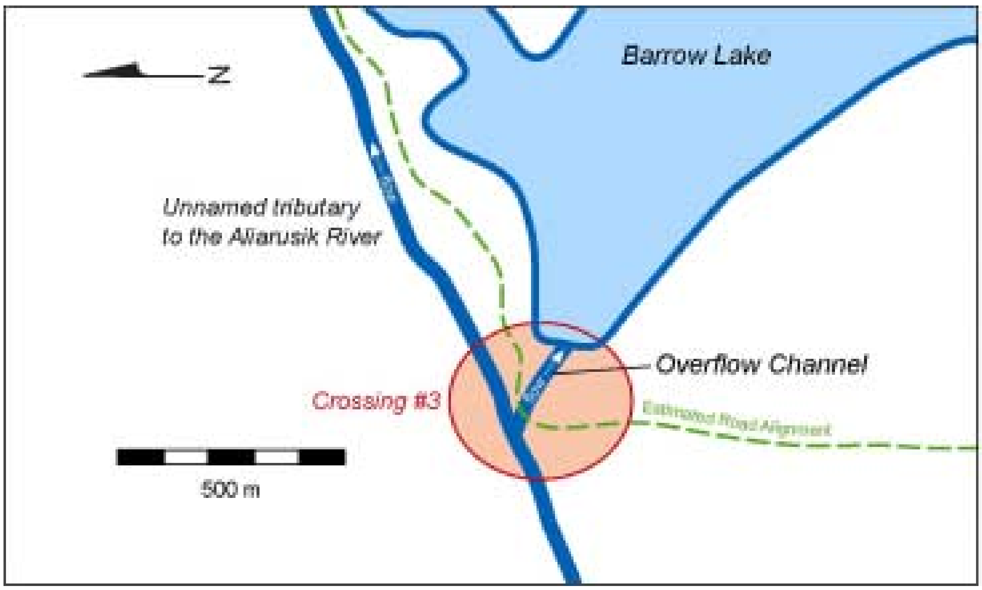

Figure 4.3 Schematic diagram of Crossing 3 location, 12 - 13 July 2001.

4.3.1 FLOW CHARACTERISTICS

Flows in the overflow channel at Crossing 3 at the time of the survey were low to moderate. The flow regime in the overflow channel is similar to that described for Crossing 1 and 2. Typical flows are highest during June with flows diminishing throughout July (G. Tigvareark, pers. comm.). During low flow periods (i.e., after late July), the overflow channel was dry (G. Tigvareark, pers. comm.).

4.3.2 FISH RESOURCES

Kugaaruk residents indicated that the watercourses downstream of the overflow channel (Aliarusik River and Barrow Lake) were used by Arctic char during the high-water period as a migration route to and from the lake. Char or other fish species, however, did not generally use the overflow channel. Very shallow water conditions during high-water and dry channel conditions during low-water likely preclude the use of the watercourse by fish species (Arctic char and lake trout) identified in the watershed.

4.3.3 FISH HABITAT

The stream channel at Crossing 3 was characterized as high gradient (estimated 10 m rise in 60 m; 17%), with wetted channel widths of approximately 15 m. Water depths averaged approximately 0.10 m with maximum depths of 0.30 m. The channel did not have a defined thalweg, although slightly deeper water depths were encountered nearest the east river bank (right side facing downstream). Instream habitat was entirely riffle-boulder garden (Plate 15 and 16). Substrate was composed of boulder and large cobble with discreet areas of finer substrate (usually associated with the lee side of boulders). A larger area of gravel was noted on the west bank near the upstream end of the channel. The D90 for the watercourse was estimated to be 100-cm. Water velocities were considered low to moderate (e.g., < 0.75 m/s). Instream cover for fish was provided by interstitial spaces amongst the substrate. The overflow channel at Crossing 3 was low for habitat suitability for all life stages of Arctic char and lake trout due to shallow instream conditions and the lack of upstream higher quality habitat.

4.3.4 ADDITIONAL OBSERVATIONS

The road crossing at this location will be use two or three one-metre culverts under a roadbed approximately 15 m in width at its base. The crossing will be located at the upstream end of the overflow channel at it narrowest wetted width (approximately 15 m). The majority of the stream channel at this location is shallow (< 0.1 m) with large substrate (boulder) in the flowing portion of the channel and finer substrate (gravel) along the eastern bank.

Plate 14 Crossing 3, 12 July 2001. Overflow channel viewed from the west bank Arrow denotes proposed crossing location.

Plate 15 Crossing 3, 12 July 2001. Downstream view from upstream end of overflow channel toward Barrow Lake. Note abundance large boulders and high stream gradient.

Plate 16 Crossing 3, 12 July 2001. Upstream view of the overflow channel from near Barrow Lake inflow. Note shallow depths amongst riffle-boulder garden.

5.0 DISCUSSION

Fish and habitat conditions at each of the three crossings along the proposed road alignment were assessed based on local knowledge of the fishery in the Aliarusik River and Barrow Lake and on a site visit conducted by RL&L in mid-July. Kugaaruk residents indicated that the Aliarusik River provides a migration route for Arctic char moving upstream to Barrow Lake to spawn or downstream from the lake to the ocean to feed. Spawning Arctic char typically make use of clean gravelly areas in lakes or low velocity pools in river systems (Scott and Crossman 1973). The char migrations, according to local residents, occurred typically during July and August during periods of elevated river flows. Studies conducted in 1979-80 on several rivers in the Pelly Bay (Kugaaruk) area revealed a similar period of river use by char (Kristofferson et al. 1982).

Habitat suitability at the three crossing locations was rated between moderate and low for char migration and low for other life stages of char in the system. The low suitability generally reflects the diminishing stream flow conditions and water depths after the freshet period. Crossing 1 and 3 were described as ephemeral, with little or no flow in late July and August and consequently were rated low for fish habitat suitability. The Aliarusik River at Crossing 2 retains flowing water throughout the year, although water depths would likely be reduced due to reduced flows after freshet. The habitat suitability of the watercourse at Crossing 2 was consequently rated moderate for migration of char and low for other life stages.

The Department of Fisheries and Oceans has adopted a “No Net Loss” policy in regards to the maintenance of productive capacity of fish habitats (DFO 1986). Fish habitat is defined by the Fisheries Act as “spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes”. To further the “No Net Loss” principle, DFO has also published a document on “Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction (HADD) of Fish Habitat” (DFO 1998b), with respect to the Fisheries Act, Section 35.

DFO (1998b) has designed a hierarchy to compensate for HADD, which includes the following:

- create similar habitat at or near the development site within the same ecological unit;
- create similar habitat in a different ecological unit that supports the same stock or species;
- increase the productive capacity of existing habitat at or near the development site and within the same ecological unit;
- increase the productive capacity of a different ecological unit that supports the same stock or species;

- increase the productive capacity of existing habitat for a different stock or a different species of fish either on or off site; and
- artificial propagation.

A review of the potential impacts associated with the three stream crossings, recommended mitigation procedures and several compensation options are presented and discussed in the following sections.

5.1 POTENTIAL IMPACTS

There are potentially four aquatic impacts that can be associated with the construction activities planned for the three watercourse crossing locations along the road alignment.

5.1.1 INSTREAM HABITAT LOSS

Instream habitat loss at road alignment can result from unmitigated construction practices (e.g., lack of sediment control) as well as the replacement of natural stream channel with culvert structures or bridge abutments. A summary of the expected habitat loss due to culvert/abutment installation at each crossing is presented in Table 5.1. In total, instream habitat loss was calculated to be 405 m^2 based on the permanent instream footprint of culverts, bridge abutments, and the road base.

Table 5.1 Summary of instream habitat loss from crossing structure placement.

Crossing Number	*Crossing Structure*	*Area*	*Description*
1	Two 1 m culverts	30 m^2	Two 15 m culverts X 1 m channel width.
2	Single span bridge	150 m^2	One 15 m wide abutment X 10 m extension into wetted channel.
3	Two or three 1 m culverts.	225 m^2	15 m wide road base X 15 m wetted channel width.
Total Area		**405 m^2**	

5.1.2 OBSTRUCTION OF FISH MOVEMENT

A second potential impact identified during the assessment was the obstruction of fish movements by instream structures. Improperly designed and placed culverts can restrict fish passage due to hydrology issues related to flow constriction through the culvert. Bridge abutments placed in the wetted channel may also restrict fish movements past the bridge, however, given the location of the proposed abutment (nearshore, shallow east bank) and the low habitat suitability assigned to this area for fish migration, the potential for obstruction of fish movements was considered minimal.

5.1.3 SEDIMENTATION

A third potential impact is the introduction of sediment. Sediment may be introduced to the stream channel during construction or from erosion of the roadway and ditches. The effects of introduced suspended sediment on fish are many and varied, ranging from direct mortality (in extreme cases) to various sub-lethal effects including: habitat avoidance and redistribution, reduced feeding and growth, respiratory impairment, and reduced tolerance to disease (Waters 1995). Deposited sediment has the potential to alter the diversity and density of benthic macroinvertebrates (a major food source for stream-dwelling fish populations) and reduce habitat suitability for a range of critical life-requisite functions (e.g. spawning, incubation of eggs, rearing, overwintering). Sediment may potentially be re-suspended into the water column during construction activities. Sedimentation effects can be minimized if the appropriate mitigative measures are implemented.

5.1.4 PETROLEUM SPILLS

Petroleum spills may occur at the crossing locations during equipment refueling, equipment malfunction (e.g., hydraulic leaks), or because of an accident involving construction or refueling equipment. Petroleum spills affect both aquatic and terrestrial habitat.

5.2 MITIGATION RECOMMENDATIONS

In order to reduce the degree of disturbance at the three watercourse crossings due to instream activities related to road construction, several mitigation options are recommended:

1. **Minimize the project's instream footprint:**

   Wherever possible, the instream area affected by the road or crossing structure (i.e., length of stream replaced by culvert structure, area covered by bridge abutment) should be minimized.

Where feasible, design specifications should be altered to reduce or eliminate instream disturbance.

The proponent has already undertaken the reduction of the potential instream footprint at Crossing 2. The original bridge design at this location entailed the use of a 32 m span bridge. After discussions with DFO-HM personnel, the span was increased to 36 m, which resulted in a reduction in impacted instream area (approximately 60 m^2).

A reduction in impacted instream area at Crossing 1 and 3 was not possible. The road design at these crossings specified the minimum instream area required for the crossing.

2. Sediment control measures:

It is recommended that sediment control be a priority during and after crossing construction to prevent damage to instream habitat through the introduction of deleterious materials, including sediments, into any flowing water. This should involve the implementation of effective surface water management practices. There is a potential for sediment to be introduced downstream into watercourses from bank erosion, particularly during significant precipitation events. Therefore, construction-related mitigation techniques should include the use of short-term and long-term erosion and sediment control devices. For example, sediment control devices (e.g., silt fences, filter material on the substrate) could be installed along the stream banks and in runoff areas (e.g., road ditches) to reduce or eliminate surface flows that may cause erosion.

3. Fish friendly culvert design specifications:

Culvert crossing structures should be designed and placed to allow fish passage during high and low flow events. The culvert should retain the same gradient as the original streambed and the downstream outlet of the structure should allow for easy access of fish of all life stages. Where possible, rock or other flow interrupting devices should be placed along the floor of the culvert such that fish passing through the culvert have velocity refugia to assist them in passage through the culvert. Additional specifications for culvert designed to allow fish passage can be found in *Fish Habitat Manual – Guidelines and Procedures for Watercourse Crossings in Alberta* (Alberta Infrastructure 1999).

4. Construction timing:

It is also recommended that instream construction be conducted during low water periods outside the period when fish are actively using the watercourses for migration (i.e., late July, August, early September).

To ensure that construction activities occur after fish migration is completed, the proponent has committed resources to monitor the Arctic char migration through the Aliarusik River to Barrow Lake. Members of the local community will utilize a trap net near the crossing sites to document fish movements. Construction activities will commence approximately one week after the completion of the fish migration.

5. Petroleum spill and leak precautions:

The final mitigation recommendation entails the complete inspection of machinery being used near the watercourses for hydraulic and petroleum leaks. All machinery should be clean and in good mechanical condition. Refueling will accomplished using a fuel truck with fuel transfer occurring at least 500 m from the watercourse. A comprehensive Spill Contingency Plan should be prepared in accordance with the *Environmental Protection Act, Spills Contingency Planning and Reporting Regulations*.

5.3 COMPENSATION OPTIONS

The development of an effective compensation package to replace or improve aquatic habitat in a remote northern community may require flexibility and ingenuity because of practical and logistical concerns. The natural environment in the north is relatively undeveloped and inaccessible, relative to southern regions of Canada, and habitat compensation and improvement activities may simply create the disturbance they were designed to alleviate. For example, access to streams with construction equipment does not exist, and community resources for such projects are limited.

Several compensation options were developed in conjunction with members of the local community of Kugaaruk, Nunavut, Jivko Engineering, and RL&L Environmental Services Ltd. These options, presented below, were developed to make use of the proposed access road to the FOL Cleanup Site and to minimize/eliminate disturbances in other areas.

1. Elimination of Instream Traffic:

Prior to the installation of the bridge crossings of the Aliarusik River, local All Terrain Vehicle (ATV) traffic forded the river an estimated twenty times per day (G. Tigvareark, pers. comm.). The ATV traffic is concentrated in a 50 m (approx.) section of the river and the instream disturbance of vehicle traffic instream occurs throughout the flowing water period.

The installation of the bridges will effectively eliminate the instream vehicle crossings of the Aliarusik River. In addition, local residents will be encouraged to make use of the bridge rather than persist with instream crossings. It is estimated that an area of approximately 2500 m^2 (50 m length X 50 m wetted width) will no longer be disturbed by ATV's.

2. Crossing 1 Channel Remediation:

The present ATV crossing location at Crossing 1 (unnamed tributary to the Aliarusik River) consists of a track through the stream channel. The banks on either side of the crossing have been disturbed by repeated crossings (Section 4.1, Plate 5). The culvert structures for Crossing 1 are to be placed approximately 10 m upstream of the existing ATV ford crossing.

The ATV crossing will be rebuilt while construction equipment is working in the area. The banks and streambed will be rebuilt using clean rocky material from the culvert site. All work on this stream (including culvert installation and channel remediation) will be done in the late summer or fall period after the stream has ceased to flow. The stream improvement area is estimated to be approximately 10 m^2 (10 m length X 1 m stream width).

3. Kugaaruk Park – Traditional Fish Weir Site:

The Hamlet of Kugaaruk is committed to establishing a park near the outflow of the Aliarusik River at a traditional fish weir site. The park area would include ATV parking and would restrict ATV traffic to and through the river at this traditional fish weir site.

4. Restricted Period of Use of the Access Road for Fuel Hauling:

One main purpose for the access road to the FOL site was to provide a route for trucks transferring fuel from the barge landing at Kugaaruk to the DND site. To reduce the potential damage to fish resources in streams along the road alignment resulting from accidental fuel spills, the Kugaaruk administration has agreed to transfer fuel by truck to the FOL site after the period of fish migration (i.e., late July and August).

5. **Barrow Lake Shoreline Cleanup:**

The Barrow Lake area was previously used by DND during active operations at the FOL site. The lake served as a landing strip during winter and likely as a water source for the shoreline FOL warehouse site. After deactivation, much of the onsite material and refuse remained. According to local residents, many used 45-gallon drums litter the shoreline of Barrow Lake (G. Tigvareark, pers. comm.). While many of the drums are empty, some (including one located at Crossing #2) are partially filled with petroleum (e.g., diesel fuel).

As part of the compensation package, the community of Kugaaruk has agreed to remove the drums from the lake shoreline. This cleanup would be conducted during the summer and utilize a boat for the shoreline cleanup. Because the barrels are located along the shoreline, instream activity would not occur.

The Barrow Lake cleanup option was felt to be a positive viable compensation option because it affected a large area, including the majority of the Barrow Lake watershed. The cleanup would positively affect water quality (through a reduction in the potential for petroleum leaking from the barrels into the aquatic environment) throughout Barrow Lake, the Aliarusik River, and the Kugajuk River downstream of the Aliarusik River confluence.

It is the professional opinion of RL&L Environmental Services Ltd. that the implementation of these strategies will adequately compensate for HADD resulting from the access road project.

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