Developer Response to
Fisheries and Oceans Canada

The Developer (Hamlet of Tuktoyaktuk, Town of Inuvik and GNWT Department of Transportation) is pleased to provide the following responses to the conformity review comments provided in Fisheries and Oceans Canada's letter dated June 27, 2011.

This document is provided in addition to the Addendum to the Environmental Impact Statement submitted to the Environmental Impact Review Board (EIRB) in response to the EIRB's letter dated July 15, 2011: *Conformity Statement and Board Direction Regarding the Draft Environmental Impact Statement for the Hamlet of Tuktoyaktuk, Town of Inuvik and GNWT – Construction of the Inuvik to Tuktoyaktuk Highway, Northwest Territories* [02/10-05].

1. TERMS OF REFERENCE - SECTION 10.1.4

Reviewer's Comments:

With respect to erosion, sediment deposition, and sediment re-suspension, the EIS does not seem to discuss the specific impacts of sediment on water quality, but impacts on fish and fish habitat are discussed in Section 4.2.5.1.

With respect to increased turbidity, subsidence, slope stability, flow or water levels including the formation of frost bulbs and related icings at watercourse crossings, specific impacts to water quality do not seem to be discussed in the EIS.

Water withdrawal, volume of water withdrawal, and gravel extraction are discussed in Section 4.2.5.1 but only in the context of impacts to fish and fish habitat but not specifically for water quality/quantity.

Developer's Response:

Discussion of the effects of the Project on water quality due to erosion and sedimentation is provided in Section 4.2.4 (Water Quality and Quantity) of the EIS. The existing terrain conditions along the Primary 2009 Route alignment are discussed in Section 2.3 of the EIS. Key Highway geotechnical issues, including information related to permafrost and permafrost-related features, sensitive terrain, thermokarst, thaw flow slides and pingos is presented in Section 2.4 of the EIS. Additional information on the terrain, geology, soils and permafrost of the general area, including the Primary 2009 Route and alternative alignments considered, is provided in Section 3.1.1.

Particulates discharged or carried to watercourses result in increased turbidity, which is the principle effect on water quality, although changes in water chemistry may also occur due to the composition of the sediment and to contaminants that may adhere to particulate surfaces. However, the most common effect of increased sediment load is the potentially detrimental impact to stream biota. Fine sediment particles that are transported in suspension strongly influence the physical and biological structure of streams.

During high flow events, sediment originating from terrestrial and streambank erosion can result in turbid, inhospitable conditions for many organisms. At lower flows, suspended particulates settle within the interstices of coarser bed material, and, when in sufficient supply, even cover or bury coarser bed material under surface patches of fine sediment. Eventually, fine particles may become more abundant on the bed surface and fill the open space around larger particles, decreasing the overall substrate particle size distribution and reducing the availability and heterogeneity of benthic habitat.

As indicated in the Review Comment, the EIS focussed on effects of sediment on fish habitat, primarily because these are the principle consequences of increased particulate loads within waterbodies.

Specific discussion of icings is not addressed in the EIS because this natural phenomenon is not known or anticipated to occur in the generally low energy streams crossed by the proposed Highway Project. Such icings, or aufeis fields, have been known to occur in the considerably more active floodplains of the Malcolm, Firth and other rivers on the Yukon Coastal Plain (Dome et al. 1982).

Aufeis fields typically consist of ice developed on the ground surface, followed by the progressive build-up of ice upon itself. These icings are typically fed by a combination of sources, including stream water, subsurface flow and groundwater stored in deep aquifers and discharged from bedrock through faults and joints (Kotlyakov 1984). In areas of continuous permafrost, such as within the proposed Highway corridor, the relatively impermeable permafrost acts as a barrier to vertical groundwater flow (Kane and Yang 2004).

However, as reported by TAC (2010), poor drainage conditions along a road over permafrost terrain may cause surface water ponding, thermal erosion, thermokarst and/or the formation of icings. Drainage and erosion control structures should be inspected regularly and repaired when necessary. Culverts are susceptible to ice build-up, particularly if water flows are continuous but low during the late winter months. Ice build-up can occur as the low water flow is forced to the surface of the stream channel. As indicated, such conditions are not typically expected to occur along the Highway because none of the smaller streams will have flows in the winter months and the larger streams will be crossed with bridges.

TAC (2010) advises that an efficient technique to control ice build-up in culverts is to install secondary culverts, or staggered (multi-level) culverts placed above the invert level of the main culvert The staggered culverts, being higher and slightly offset from the main culvert, remain ice-free and can be used during the peak spring flows.

Many potential drainage problems associated with the Highway will be avoided or minimized by careful refinement of the Highway alignment, based on the LiDAR information obtained in September 2011, and further field reconnaissance that will be conducted as necessary to assist with the final design of the Highway.

As discussed in Section 4.2.4 of the EIS, it is recognized that potential alterations of surface drainage patterns due to stream constriction at stream crossing sites or through obstruction of overland drainage are of concern but will be mitigated through the design and use of appropriate stream crossing structures and the installation of appropriately-sized cross culverts to divert and manage highway and surface drainage flows.

The application of such mitigation measures will also serve to prevent or minimize the formation of ponds or other effects on soil moisture, which in turn could lead to localized thermal changes such as thaw subsidence, ground surface heave or the formation of frost bulbs.

Physical data for lakes from which water may be withdrawn for construction or domestic purposes are not provided since such lakes have not yet been identified. Once route selection is finalized, bathymetric information will be collected from candidate lakes, which will then be submitted for review to regulatory agencies before final determination is made as to the suitability for use, and quantity of water that may be withdrawn.

<u>References</u>

Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Inc. (Dome et al). 1983. Hydrocarbon Development in the Beaufort Sea – Mackenzie Delta Region.

Kane, D.L. and Yang, D. 2004. Overview of Water Balance Determinations for High Latitude Watersheds, Northern Research Basins Water Balance, D.L. Kane and D.Yang (eds.), Proc. Workshop, Victoria, Canada, March, IAKS Pres, Wallington, UK, 2004.

Kotlyakov, V. M. (ed.). 1984. Glyatsiologicheskiy Slovar (Glossary of Glaciology). Leningrad, USSR: Gidrometeoizdat, 1984, 528 pp.

Transportation Association of Canada (TAC). 2010. Guidelines for the Development and Management of Transportation Infrastructure in Permafrost Regions.

2. TERMS OF REFERENCE - SECTION 10.1.6-A

Reviewer's Comments:

No drawings or conceptual plans provided for the installation of culverts (in Section 2.6.6 conceptual plans were provided for clear-span bridges).

For the proposed watercourse crossings and temporary vehicle crossing methods, the physical disturbances, flow patterns, etc. are mentioned as impacts but the duration and extent are not clear.

Developer's Response:

A concept drawing for a clear span bridge (Figure 2.6.6-1) is provided since the design will be relatively similar in all cases where a bridge crossing is required. Culverts, however, will generally involve a standard culvert design, as was used on the Tuktoyaktuk to Source 177 Access Road. The concept for culvert design and installation is described in the EIS in Section 2.6.6 (Stream Crossing Design Considerations) and Section 4.2.4.1 (Water Quality and Quantity – Potential Effects).

Culverts will typically be sized generously (two to three times the size that would be used in non-permafrost areas) to compensate for design uncertainties, ice, snow and sediment blockage, and subsequent settlement. Alternatively, the use of frequent small culverts will be considered, where appropriate, instead of accumulating large flows by using large-diameter culverts.

Culvert wall thickness in permafrost regions is typically greater than the wall thickness of culverts in non-permafrost regions to account for loss of lateral restraint due to thawing permafrost foundation in soils and winter icing or frost heave. These factors can impose secondary loads. For example, GNWT DOT specifies a 2.8 mm wall thickness for all culverts up to 1,200 mm diameter, regardless of fill height.

Culverts of appropriate size (typically 800 mm - 900 mm) are laid in place with limited disturbance to the existing ground, at locations where drainage paths have been identified in the detailed design. Fill material is then placed around and over the culverts. In some cases, multiple smaller diameter culverts may be used instead of single large diameter culverts to avoid having to cut into the existing ground to maintain the vertical grade or creating a crest curve in the roadway where the embankment is constructed over the culvert. In addition, based on experience gained with construction of the Tuktoyaktuk to Source 177 Access Road, certain culverts (to protect fish habitat) may be installed during the summer season. Appropriate culvert sizing and location will be confirmed in the detailed design stages of the work.

3. TERMS OF REFERENCE - SECTION 10.1.6-B

Reviewer's Comments:

With respect to standards or guidelines related to watercourse crossings that would be applied, in Section 2.6.6 of the EIS, it is stated that culverts will be installed with "little disturbance to the ground", "based on experience gained with construction of the Tuktoyaktuk to Source 177 access road". In Section 4.2.4.1 it states that the INAC Land Use Guidelines and DFO Land Development Guidelines (1993) will be used and both recommend embedding culverts as well as insulating culverts as best practice. The statements made in Section 2.6.6 are not consistent with the guidelines stated in other parts of the EIS. DFO recommends that the guidelines be followed.

Also please note that the DFO's Land Development Guidelines were developed for the Pacific Coast Region, and although the principles of culvert installation remain the same throughout the country, the specific considerations of working in a permafrost region should be considered.

The Standards for explosives have been updated with regards to the NWT. All operations involving explosives near water bodies should be reviewed by DFO. Two useful references are:

- Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies / edited by Armsworthy, Shelley, Peter J. Cranford, Kenneth Lee. Cott, P., B. Hanna. 2005. Monitoring Explosive-Based Winter Seismic Exploration in Water Bodies NWT 2000- 2002.
- Cott, P., B. Hanna, J. Dahl. Canadian Manuscript Report for Fisheries and Aquatic Sciences 2648. 2003. Discussion on Seismic Exploration in the Northwest Territories 2000–2003.

Developer's Response:

Culverts in non-fish bearing streams and cross drainage culverts will be installed with little disturbance to the substrate, generally during the winter months. However, as indicated in Table 3.1.7-8 and in Section 4.2.5.1 (Fish and Fish Habitat – Potential Effects) of the EIS, culverts installed in fish bearing streams will be set into the substrate (in summer) to avoid bed erosion and subsequent culvert perching, as recommended in the INAC and DFO guideline documents. It is recognized that conditions in the north differ from those further south and as such, special consideration will be given to culvert installation techniques that are appropriate for permafrost areas. The design and construction methods employed will be guided by engineers with specialization and experience in such conditions, GNWT DOT requirements for highway construction and the TAC (2010) guidelines for the development and management of transportation infrastructure in permafrost regions.

The Developer has provided additional information in the Addendum to the EIS submitted to the EIRB in response to Category 3 Conformity Request #2. We appreciate being informed of updates to guidelines relating to the use of explosives and will refer to the suggested documents when planning any blasting in the vicinity of watercourses.

Reference:

Transportation Association of Canada (TAC). 2010. Guidelines for the Development and Management of Transportation Infrastructure in Permafrost Regions.

4. TERMS OF REFERENCE - SECTION 10.1.6-C

Reviewer's Comments:

With respect to relevant policies, management plans or other measures to protect or enhance fish and fish habitat, timing restrictions are mentioned and the Protocol for Winter Water Withdrawal in the NWT is discussed. DFO's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998) are no longer relevant in the NWT. Please see comment above.

Erosion and sediment plans and best practices are mentioned as mitigation but are not described further. A draft erosion and sediment control plan should be developed during the EA.

Developer's Response:

As indicated in the response above, all relevant guidelines and documents will be reviewed with respect to the use of explosives in the vicinity of any watercourse.

The development of an erosion and sediment control plan is identified as a required management plan within the Commitments Table (Table F of the EIS), and is referenced in a number of locations within the EIS (Table 4.2.4-1; Section 4.2.4.2; Section 4.2.5.1; Table 6-1). The erosion and sediment control plan will be prepared as a major component of the overall EMP. The Developer has provided additional information in the Addendum to the EIS submitted to the EIRB in response to Category 3 Conformity Request #2 regarding a forthcoming NWT best practices and mitigation manual on erosion and sediment control.

As indicated in Section 4.2.4.2 (Water Quality and Quantity – Project Design and Mitigation Measures), "In recognition of the potential adverse effects of sediment, an environmental management plan (EMP) will be prepared prior to construction and submitted to regulators for approval, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment." The EMP will apply appropriate erosion and sediment control mitigation techniques in the erosion and sediment control manual and those outlined in the DFO (1993) Land Development Guidelines for the Protection of Aquatic Habitat. The guidelines and BMPs that are appropriate for application in this Project setting will be incorporated into the erosion and sediment control plan, to provide site-specific erosion and sediment control.

5. TERMS OF REFERENCE - SECTION 10.1.6-D

Reviewer's Comments:

With respect to disruption of sensitive life stages or habitat including loss of substrate habitat, known sensitive or important sites; sensitive life stages or habitat are not specifically identified in the EIS.

With respect to sensitive or important areas or habitat, some details are provided in Section 3.1.7.10.

Developer's Response:

Section 3.1.7 (Fish and Fish Habitat) of the EIS provides life history and habitat preference information for valued fish species that may be encountered within the proposed Highway corridor. Table 3.1.7-5 includes habitat information for 27 stream crossing locations surveyed as part of the 2010 field studies. Details on field studies underway to gather further fish and fish habitat information are provided in the Addendum to the EIS submitted to the EIRB in response to Category 3 Conformity Request #5.

The quality of the habitat identified during the 2009 reconnaissance and 2010 field studies was a major factor in determining locations for the construction of clear span bridges rather than culverts; the latter being of greater risk to fish and fish habitat due to the potential for direct habitat loss, sedimentation, and migration obstruction. Therefore, all sites having the potential to support significant populations of fish (resident or migratory) will be crossed with clear span bridges.

The key results from the 2011 field studies will be provided by the Developer during the Technical Review phase of the EIRB Review Process.

6. TERMS OF REFERENCE - SECTION 10.1.6-E

Reviewer's Comments:

With respect to effects to fish populations and harvest activities, details are not found in EIS.

Developer's Response:

Available information on harvesting activities in the Project area is provided in sections 3.2.8 (Harvesting) and 3.2.9 (Land Use). Potential effects of the Project on harvesting activities are discussed in sections 4.3.7 (Harvesting) and 4.3.8 (Land Use).

Based on an analysis of existing fish and fish habitat characteristics and proposed avoidance and mitigation measures, the effects of the Project on fish and fish habitat are anticipated to be minor (see EIS Section 4.2.5.1) and will not significantly reduce the productive capacity of habitat within the affected streams or associated waterbodies. From the standpoint of construction and Highway operation, therefore, no adverse effects on fish harvest success (in the Husky Lakes, for example) are likely to occur.

However, a measure of uncertainty exists related to the increased access to fisheries resources by the beneficiaries and the general public that will occur as a result of the Highway. The EIS (Section 4.2.5.3 Fish and Fish Habitat – Residual Effects) identifies this as a potential residual effect, and suggests that the development of mitigation strategies, including education, through proactive and cooperative consultations, would minimize risks associated with increased access and resource exploitation. This will involve HTC and community consultations throughout the Highway development process and recognition that effective resource management is dependent on multi-stakeholder involvement.

7. TERMS OF REFERENCE - SECTION 10.1.6-F

Reviewer's Comments:

The activities that will likely require Authorizations (specifically culvert installation) are represented in Table 4.2.5-1 as mitigable by "avoiding critical habitats". There is no mention of the authorization process in this section or a HADD. There is mention of the loss of instream habitat but no discussion on the impacts of this loss of habitat.

Developer's Response:

It is acknowledged that Section 4.2.5 (Fish and Fish Habitat, Impact Assessment) and Table 4.2.5-1 of the EIS do not discuss the Authorization process. This is because our assessment suggests that adverse effects on fish and fish habitat resources are mitigable and that no significant residual effects are likely to occur. This conclusion is based on the construction of clear span bridges to avoid good quality habitat or to ensure that fish migrations are not impeded.

In other areas where habitat or population is deemed to be absent or marginal, Operational Statements and/or appropriate guidelines or best management practices are to be implemented to negate harmful residual effects. However, it is also recognized that situations may be encountered where predictions are incorrect and a HADD may be unavoidable. In such instances, the EIS (Section 1.5.1.4 and Table F – Commitments Table) indicates that DFO will be consulted regarding appropriate compensation strategies, so that applications for Authorization can be submitted.

8. TERMS OF REFERENCE - SECTION 10.1.6-G

Reviewer's Comments:

With respect to the condition(s) to which the ROW (in stream and riparian) and temporary work areas would be reclaimed or restored, and maintained once construction has been completed, details are not found in EIS.

Developer's Response:

Section 2.6.8.6 (Pit Development Plans) of the EIS describes the procedures involved in reclaiming borrow pit sites. These procedures involve re-establishment of natural drainage; replacement of all salvaged topsoil; re-vegetation activities; and, reclamation of access roads. Further vegetation impact mitigation and reclamation concepts are provided in Section 4.2.6.6 (Vegetation – Project Design and Mitigation Measures) and Table 4.2.6-2.

With the application of the proposed mitigation measures, effects on vegetation are generally expected to be limited to the physical footprint, and are considered to be minor in the context of the overall Project area. It is recognized that due to the harsh climate and limited growing season in the North, re-vegetation efforts, combined with slow natural re-vegetation processes, will lead to the slow re-establishment of vegetation characteristic of naturally granular upland areas.

9. TERMS OF REFERENCE - SECTION 10.1.6-H

Reviewer's Comments:

With respect to criteria for evaluating the success of mitigation or reclamation measures, and indicating when and how this evaluation would be conducted, details are not found in EIS. The only monitoring discussed is third party monitoring and monitoring during construction.

The monitoring program for fish and habitat resources of waterbodies along the highway corridor are mentioned in the EIS, but little detail provided.

Developer's Response:

The objectives, criteria, and methods of the monitoring programs to evaluate the success of mitigation and reclamation measures will be detailed in the EMP. Further work is needed, and has been planned, to evaluate fish and habitat resources; additional engineering design is forthcoming. The nature of the monitoring program will be determined based on a complete review of the data and information.

10. TERMS OF REFERENCE - SECTION 10.1.10

Reviewer's Comments:

It is not clear where fish biodiversity is discussed in the EIS.

Developer's Response:

The EIS does not expressly refer to biodiversity with respect to fish populations. This is because it is anticipated that the Project will not result in a significant adverse effect on fish or fish habitat. Stream crossings will be designed and constructed to avoid obstructing fish migrations or downstream effects. As such, populations will not be fragmented and no changes are expected in fish community composition, abundance or diversity.

11. TERMS OF REFERENCE - SECTION 10.2.8

Reviewer's Comments:

More details should be provided on potential impacts to fish and fish habitat from increase access to Husky Lake.

Developer's Response:

Available information on harvesting activities in the Project area is provided in sections 3.2.8 (Harvesting) and 3.2.9 (Land Use). Potential effects of the Project on harvesting activities are discussed in sections 4.3.7 (Harvesting) and 4.3.8 (Land Use).

Based on an analysis of existing fish and fish habitat characteristics and proposed avoidance and mitigation measures, the effects of the Project on fish and fish habitat are anticipated to be minor (see EIS Section 4.2.5.1) and will not significantly reduce the productive capacity of habitat within the affected streams or associated waterbodies. From the standpoint of construction and Highway operation, therefore, no adverse effects on fish harvest success (in the Husky Lakes, for example) are expected to occur.

However, a measure of uncertainty exists related to the increased access to fisheries resources by the general public that will occur as a result of the Highway. The EIS (Section 4.2.5.3 Fish and Fish Habitat – Residual Effects) identifies this as a potential residual effect, and suggests that the development of mitigation strategies, including education, through proactive and cooperative consultation, would minimize risks associated with increased access and resource exploitation. This will involve community involvement throughout the Highway development process and recognition that effective resource management is dependent on multi-stakeholder involvement.

12. TERMS OF REFERENCE – APPENDIX A – WATER QUALITY AND QUANTITY BASELINE

Reviewer's Comments:

Drainage areas are not defined.

Developer's Response:

Drainage area calculations are provided in Section 3.1.6 (Hydrology) for Hans Creek (329 km^2) and Trail Valley Creek (68.3 km^2). The only other significant stream along the route, in terms of water flow, is Zed Creek, through which Parsons Lake drains to the Husky Lakes.

Reviewer's Comments:

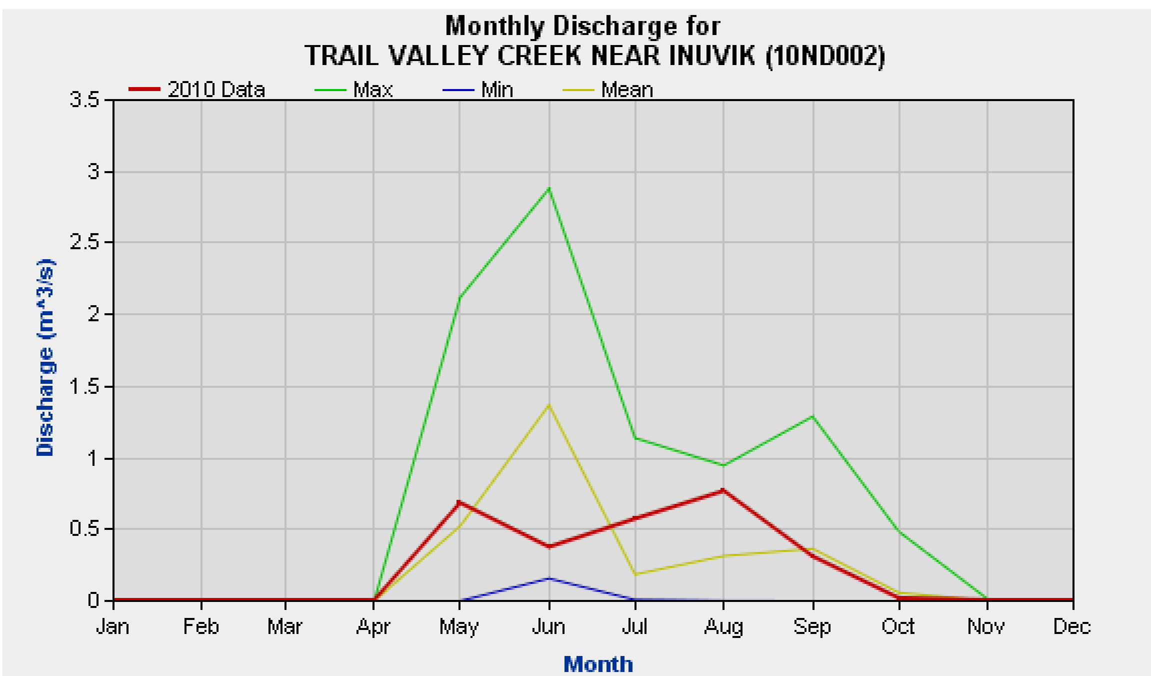
Details are not found in the EIS for watercourses that have year-round flow. The proponent assumes that all watercourses along the route freeze to the bottom. This has not been determined in the field and the larger watercourses should be assessed for year-round flow. The same should be assessed for the deeper, larger lakes along the route for overwintering habitat and water withdrawal.

Developer's Response:

Daily stream gauge information is available from the Water Survey of Canada for Trail Valley Creek and Hans Creek, two of the largest streams within the Project footprint. The following hydrographs for Trail Valley Creek (Figure 1; previously provided in Section 3.1.6 of the EIS) and Hans Creek (Figure 2) summarize daily flow data over a considerable time period and show that neither stream flows during the winter months.

A review of tabular monthly data for these stations, also shown below, reveals that Trail Valley Creek, the smaller of the two streams, generally stops flowing by the end of October, although very small discharges have been recorded during November in some years (Table 1). Flow in Hans Creek typically stops by the end of November or into December, depending on climatic conditions in any given year (Table 2). For both streams, flows typically resume in May, increase rapidly through the month due to snowmelt, and peak near the beginning of June. Although hydrographic data are not available for Zed Creek, it is assumed that the annual flow conditions would be similar to those recorded for Hans Creek.

Observations of both streams suggest a similarity in both stream size and flow rates. All other streams crossed along the proposed Highway corridor are considerably smaller than Trail Valley Creek and Hans Creek, and are, therefore, all assumed to freeze completely during winter.

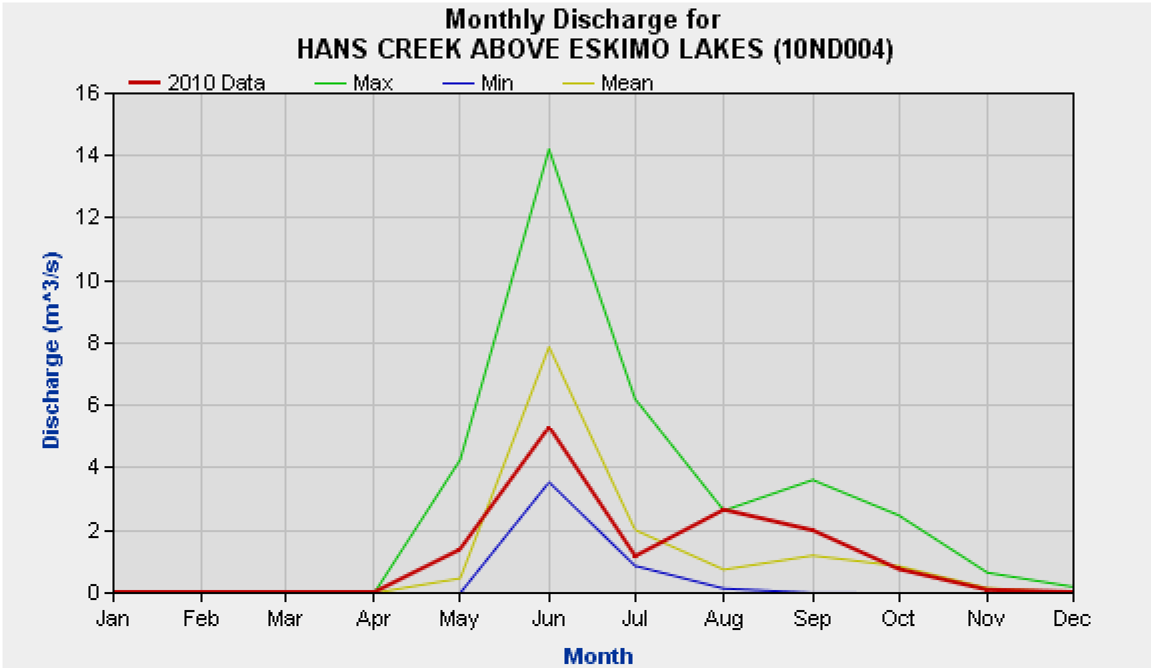


Source: Water Survey of Canada
Note: Statistics corresponding to 33 years of data recorded from 1977 to 2010.

Figure 1: Monthly Discharge for Trail Valley Creek (1977-2010)

TABLE 1: MONTHLY MEAN DISCHARGE AT TRAIL VALLEY CREEK, NEAR INUVIK (10ND002)													
Monthly Mean Discharge (m^3/s)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
1977	-	-	-	-	2.12	2.37	0.271	0.503	0.254	-	-	-	-
1978	-	-	-	-	-	2.29	0.803	-	-	-	-	-	-
1979	0	0	0	0	0.785	0.692	0.087	0.362	1.10	0.108	0	0	0.261
1980	0	0	0	0	0	-	0.051	0.736	0.867	0.001	0	0	-
1981	0	0	0	0	0.833	2.19	1.14	0.733	0.256	0.020	0	0	0.432
1982	0	0	0	0	0.010	2.88	0.132	0.031	0.135	0.091	0.014	0.001	0.271
1983	0	0	0	0	0.000	1.60	0.008	0.008	0.057	0.013	0	0	0.139
1985	0	0	0	0	1.26	0.982	0.022	0.001	0	0	0	0	0.189
1986	0	0	0	0	0.001	1.73	0.018	0.048	0.082	0.008	0	0	0.155
1987	0	0	0	0	0.001	1.42	0.045	0.502	0.229	0.018	0	0	0.184
1988	0	0	0	0	0.003	1.14	0.049	0.339	0.477	0.014	0	0	0.167
1989	0	0	0	0	0.565	1.09	0.163	0.518	0.777	0.103	0.000	0	0.268
1990	0	0	0	0	0.572	0.652	0.313	0.016	0.020	0.005	0	0	0.132
1991	0	0	0	0	0.884	0.389	0.032	0.358	0.557	0.095	0	0	0.194
1992	0	0	0	0	0.306	1.61	0.024	0.001	0.002	0	0	0	0.160
1993	0	0	0	0	0.748	1.46	0.042	0.025	0.609	0.022	0	0	0.241
1994	0	0	0	0	1.14	0.720	0.072	0.148	0.263	0.049	0.001	0	0.200
1995	0	0	0	0	1.98	0.737	0.161	0.066	0.355	0.049	0	0	0.282
1996	0	0	0	0	0.783	1.69	0.085	0.221	0.566	0.032	0	0	0.279
1997	0	0	0	0	0.418	1.31	0.189	0.281	0.312	0.053	0	0	0.214
1998	0	0	0	0	1.29	0.157	0.621	0.731	1.12	0.094	0.003	0	0.337
1999	0	0	0	0	0.387	1.22	0.041	0.525	0.216	0.020	0	0	0.201
2000	0	0	0	0	0	2.40	0.086	0.112	0.023	0.001	0	0	0.216
2001	0	0	0	0	0	2.17	0.054	0.099	0.355	0.046	0	0	0.225
2002	0	0	0	0	0.081	1.31	0.124	0.472	0.104	0.026	0	0	0.176
2003	0	0	0	0	0.000	0.963	0.187	0.161	0.227	0.486	0.006	0	0.169
2004	0	0	0	0	0	2.19	0.068	0.078	0.058	0.004	0	0	0.197
2005	0	0	0	0	0.267	0.852	0.235	0.381	0.409	0.072	0.003	0	0.185
2006	0	0	0	0	-	-	0.364	0.449	0.274	0.168	0.003	0	-
2007	0	0	0	0	0.077	1.10	0.018	0.176	0.048	0.038	0.002	0	0.121
2008	0	0	0	0	0.004	1.09	0.030	0.287	0.372	0.069	0	0	0.153
2009	0	0	0	0	1.06	1.65	0.051	0.948	1.29	0.120	0.000	0	0.427
2010	0	0	0	0	0.680	0.372	0.569	0.764	0.306	0.015	0	0	0.228
Mean	0.000	0.000	0.000	0.000	0.524	1.37	0.186	0.315	0.366	0.059	0.001	0.000	0.221
Max	0.000*	0.000*	0.000*	0.000*	2.12	2.88	1.14	0.948	1.29	0.486	0.014	0.001	0.432
Min	0.000*	0.000*	0.000*	0.000*	0.000*	0.157	0.008	0.001*	0.000	0.000*	0.000*	0.000*	0.121

Source: Water Survey of Canada
Note: * - occurs more than once.



Source: Water Survey of Canada
Note: Statistics corresponding to 21 years of data recorded from 1988 to 2010.

Figure 2: Monthly Discharge for Hans Creek (1988-2010)

TABLE 2: MONTHLY MEAN DISCHARGE AT HANS CREEK, ABOVE ESKIMO LAKES (10ND004)													
Monthly Mean Discharge (m³/s)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
1988	0	0	0	0	0.001	5.61	0.994	0.212	1.92	0.667	0.066	0	0.781
1989	0	0	0	0	0	6.11	1.61	1.10	2.57	1.56	0.389	0.059	1.11
1990	0.002	0	0	0	0.053	6.97	2.47	0.374	0.019	0.019	0.000	0	0.823
1991	0	0	0	0	1.80	4.12	0.999	0.322	1.23	1.46	0.068	0	0.834
1992	0	0	0	0	0.007	8.52	1.89	0.166	0.004	0	0	0	0.873
1993	0	0	0	0	0.008	9.68	1.72	0.250	0.590	0.945	0.099	0.001	1.10
1994	0	0	0	0	1.78	5.46	1.85	-	-	0.575	0.010	0	-
1996	-	0	0	0	0.005	10.6	-	-	1.39	1.08	0.248	0.007	-
1997	0	0	0	0	0.003	7.05	2.83	0.864	0.737	0.678	0.285	0.004	1.04
1998	0	0	0	0	4.27	3.55	2.15	-	-	1.55	0.321	0.006	-
1999	0	0	0	0	0.008	7.23	-	-	-	0.612	0.170	-	-
2000	-	-	-	-	-	-	-	-	0.388	0.101	0.028	0.001	-
2001	0	0	0	0	0	9.89	2.65	0.143	0.498	-	-	-	-
2002	0	0	0	0	0.004	7.89	2.21	-	-	0.062	0	0	-
2003	0	0	0	0	0	8.32	1.68	0.539	0.694	2.28	0.651	0.196	1.19
2004	0.000	0	0	0	0	14.2	2.02	0.260	0.110	0.035	0.001	0	1.37
2005	0	0	0	0	0.000	7.32	1.85	0.699	1.61	0.680	0.003	0	1.01

TABLE 2: MONTHLY MEAN DISCHARGE AT HANS CREEK, ABOVE ESKIMO LAKES (10ND004)													
Monthly Mean Discharge (m^3/s)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
2006	0	0	0	0	-	-	6.22	1.18	2.13	1.23	0.603	0	-
2007	0	0	0	0	0.008	-	-	-	-	-	-	-	-
2008	0	0	0	0	0.015	8.78	0.871	0.459	0.876	0.439	0	0	0.942
2009	0	0	0	0	0.097	13.2	1.20	2.02	3.62	2.49	0.080	0.000	1.88
2010	0	0	0	0	1.37	5.28	1.15	2.64	1.98	0.739	0.074	0	1.10
Mean	0.000	0.000	0.000	0.000	0.471	7.88	2.02	0.749	1.20	0.860	0.155	0.014	1.08
Max	0.002	0.000*	0.000*	0.000*	4.27	14.2	6.22	2.64	3.62	2.49	0.651	0.196	1.88
Min	0.000*	0.000*	0.000*	0.000*	0.000*	3.55	0.871	0.143	0.004	0.000	0.000*	0.000*	0.781
Source: Water Survey of Canada Note: * - occurs more than once.													

Physical data for lakes from which water may be withdrawn for construction or domestic purposes are not provided since such lakes have not yet been identified. Once route selection is finalized, bathymetric information will be collected from candidate lakes, which will then be submitted for review to regulatory agencies before final determination is made as to the suitability for use, and quantity of water that may be withdrawn.

Reviewer's Comments:

With respect to extent of connectivity to adjacent watercourses including any potential seasonal variation, there is discussion of the large freshet in the area; however the extent of connectivity is not detailed for the specific area. Just because the connectivity throughout the area is short, does not mean it is unimportant; it could in fact be more important due to its brevity. The connectivity with regards to the larger watercourses is important and should be presented in the environmental assessment.

Developer's Response:

Based on the field work carried out in 2010, 17 of the 27 stream crossing watercourses included in the field work program were assessed to be ephemeral. The remainder, were small streams, but with sufficient upstream drainages or headwater lakes to contain flow for the open water season. In 2009, field reconnaissance also included observations of the three major streams along the proposed route, Trail Valley Creek, Hans Creek, and Zed Creek, all which were observed to possess good flow and connectivity with the Husky Lakes throughout the open water season.

It is recognized that connectivity with larger downstream water bodies, even for brief periods, can be critical for ephemeral streams, to permit spawning fish passage to upstream bodies of water, or to permit instream spawning for Arctic grayling. However, the value of such connectivity is tempered by the fact that most of the ephemeral streams are likely so because of very small headwater lake systems, which would not provide good habitat conditions for most fish species. Such lakes are usually shallow, have silt and/or organic substrates, and importantly, freeze to the bottom or are anoxic in winter. As such, these lakes can become sinks for fish migrating to them, particularly because of the very rapid decline in stream water levels following the end of the freshet period, which would prevent downstream migration. Similarly, most of these streams provide poor spawning and rearing habitat for spring spawners such as grayling because of the very limited time that flows are sufficient to sustain eggs or fry.

Notwithstanding the poor habitat conditions in most of the ephemeral streams, crossing structures will be designed, sized, and installed to maintain fish passage at all times when water is flowing, thereby ensuring connectivity between downstream and upstream water bodies. Larger, perennial streams assessed to possess good fish habitat conditions will be crossed by clear span bridges to avoid any obstruction of water flow and fish passage.

Reviewer's Comments:

Details are not found in the EIS for:

- seasonal and perennial springs including ephemeral streams located within or near the boundaries of the study area(s);
- naturally occurring icings;
- describe the recharge ability of lakes that will be used for winter road watering or ice mining;

Developer's Response:

Investigations were not carried out to determine the existence or location of springs. Since the Highway corridor is underlain by permafrost, which creates an effective aquitard, preventing groundwater discharge (Andersen and Pollard 2002), it is highly unlikely that springs exist within the Project area. In areas of continuous permafrost, such as within the proposed Highway corridor, the relatively impermeable permafrost acts as a barrier to vertical groundwater flow (Kane and Yang 2004). The only known cold springs in permafrost on earth exist on west central Axel Heiberg Island in the Canadian High Arctic (Andersen and Pollard 2002).

Specific discussion of icings was not addressed in the EIS because this natural phenomenon is not known or anticipated to occur in the generally low energy streams crossed by the proposed Highway Project. Such icings, or aufeis fields, have been known to more commonly occur in the considerably more active floodplains of the Malcolm, Firth and other rivers on the Yukon Coastal Plain (Dome et al. 1982).

Aufeis fields typically consist of ice developed on the ground surface, followed by the progressive build-up of ice upon itself. These icings are typically fed by a combination of sources, including stream water, subsurface flow and groundwater stored in deep aquifers and discharged from bedrock through faults and joints (Kotlyakov 1984).

Physical data for lakes from which water may be withdrawn for construction or domestic purposes have not been provided since such lakes have not yet been identified. Once route selection is finalized, bathymetric information will be collected from candidate lakes, which will then be submitted for review to regulatory agencies before final determination is made as to the suitability for use, and quantity of water that may be withdrawn.

Reference:

Andersen, D.T. and W.H. Pollard. 2002. Cold springs in permafrost on Earth and Mars. J. of Geophysical Research, Vol. 107, No. E3, 5015, p. 4-1 – 4-7.

Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Inc. (Dome et al). 1983. Hydrocarbon Development in the Beaufort Sea – Mackenzie Delta Region.

Kane, D. L., and D. Yang. 2004. Overview for Water Balance Determinations for High Latitude Watersheds. Int. Assoc. of Hydrological Sciences Publication 290. pp. 1-12.

Kotlyakov, V. M. (ed.). 1984. Glyatsiologicheskiy Slovar (Glossary of Glaciology). Leningrad, USSR: Gidrometeoizdat, 1984, 528 pp.

Reviewer's Comments:

For the following requirement: "describe the hydrological characteristics for each major drainage or major watercourse, including flow regimes, variability and sources of variability, seasonal flow patterns, channel and bed morphology, and stability", the majority of the references used in this section outline the water chemistry of the area. Some information within the 2010 Aquatic Field Report.

Developer's Response:

The hydrological characteristics of two of the three major drainages (Trail Valley Creek and Hans Creek) within the Project corridor are provided in Tables 1 and 2, Figures 1 and 2 and their corresponding descriptions in a previous response. It is assumed that the general hydrological characteristics of Zed Creek are similar to those of Hans Creek.

Channel morphological characteristics (width, depth, substrate, overhead cover, instream cover, and habitat type) for Trail Valley Creek and Zed Creek at the sites of the proposed bridge crossings are provided in EIS Table 3.1.7-3. Based on reconnaissance observations made in 2009, channel characteristics at Hans Creek were similar to those of Zed Creek.

All three channels appeared stable at the proposed crossing locations, as indicated by the lack of streambank erosion, the high degree of channel confinement, and the condition of the riparian vegetation.

Reviewer's Comments:

The EIS states that the proponent will adhere to the DFO's Winter Water Withdrawal Protocol for Ice-covered Water Bodies in the Northwest Territories.

Turbidity measurements were taken for the crossings covered by the 2010 Aquatic Field Study. Discussion of seasonal or temporal variability in water quality was not found.

Developer's Response:

The Developer and its contractor(s) will adhere to DFO's winter water withdrawal protocol. Bathymetric and habitat information will be collected for lakes that are identified as suitable candidates for water withdrawal.

Seasonal variability in water quality was not discussed due to limitations of the field program. However, as discussed in the EIS, the effects on water quality from this Project are not anticipated to be significant. Furthermore, as noted in the EIS, most of the Highway construction activities will occur in the winter period when the streams are typically frozen. For the purposes of construction monitoring related to summer work (embankment grading, compaction, specific culvert installation and maintenance of culverts, water samples will be collected upstream and downstream of stream crossings during these activities to determine changes in turbidity and to take corrective action if turbidity levels exceed allowable limits.

Reviewer's Comments:

Details are not found in the EIS for a description and map of groundwater resources within the Project Study Area, including quality and quantity.

Depth and flow measurements were taken for the crossings covered by the 2010 Aquatic Field Study. Discussion of recharge and discharge areas was not found except for page 149 "*The numerous tundra ponds in the Arctic are recharged during spring freshet, which results from snowmelt*."

Details are not found in the EIS for hydrogeological conditions in near surface materials or deeper formations, where relevant to proposed Project routes, components and activities.

Developer's Response:

The Project corridor is underlain with permafrost. In areas of continuous permafrost, such as within the proposed Highway corridor, the relatively impermeable permafrost acts as a barrier to vertical groundwater flow (Kane and Yang 2004). As such, no mapping of groundwater resources was carried out, since no large scale aquifers are anticipated in this area. It is our understanding that recharge of tundra ponds and lakes takes place almost exclusively due to spring freshet flows, and to a minor extent, from summer rain storms. As such, it was felt that the discussions provided in sections 3.1.1.4 (Permafrost Conditions) and 3.1.6 (Hydrology) of the EIS are sufficient to cover this topic, especially since drainage and stream crossing designs will be based on existing hydrological characteristics.

The Highway is to be constructed on the surface of the land, such that no significant excavations into the active layer will be required, except for the development of borrow sources.

<u>Reference:</u>

Kane, D. L., and D. Yang. 2004. Overview for Water Balance Determinations for High Latitude Watersheds. Int. Assoc. of Hydrological Sciences Publication 290. pp. 1-12.

13. TERMS OF REFERENCE - APPENDIX A – FISH AND FISH HABITAT BASELINE

Reviewer's Comments:

With respect to providing a description of the existing fish and fish habitat at each of the planned water crossings in the Project area, only 25km on either end of the proposed route have been assessed for fish habitat. It is DFO's understanding that further studies will be conducted in the 2011 season. DFO will need to see the results of this program before assessing impacts.

Developer's Response:

The Developer has provided an updated discussion of fish and fish habitat field studies in the Addendum to the EIS submitted to the EIRB in response to Category 3 Conformity Request #5.

Reviewer's Comments:

A partial list of species with potential to exist in the area of the Highway is provided. Forage fish were not included.

The seasonal and life cycle movements, sensitive periods, and habitat requirements for each life stage were completed for the ten larger fish species, not the forage fish.

Developer's Response:

Forage fish species are recognized as being ecologically important within the streams and lakes of the Project area. While not utilized directly in recreational, commercial, or traditional fisheries, they represent an important food supply for valued fish species and essential links in the food web. The EIS does not specifically identify these species because it was determined that protection of anthropogenically-valued species and their habitat would automatically result in the protection of forage fish species. However, to supplement the information provided in the EIS, the following provides life history and habitat preference information for the forage species anticipated to be present within the Highway Project area.

The ninespine stickleback was the only forage species captured or observed during 2010 field studies. However, it is possible that some of the streams within the Highway corridor support slimy sculpin (*Cottus cognatus*) and/or lake chub (*Couesius plumbeus*). In a study carried out for the GNWT Department of Transportation related to a proposed Inuvik to Tuktoyaktuk road, Rescan (1999) identified ninespine stickleback in Zed (Parsons) Creek and slimy sculpin in Hans and Zed creeks. No fish were sampled in Trail Valley Creek and lake chub were not found in any of the study streams. However, Scott and Crossman (1973) indicated that lake chub were widely distributed in the Northwest Territories, including the Project area, and are therefore included as a species that may possibly be encountered during Highway construction.

A brief synopsis of the life history and habitat requirements of these three species are provided below:

Ninespine Stickleback

The ninespine stickleback is ubiquitous in the Northwest Territories and is also found throughout rivers and lakes in north central Canada and in portions of the Arctic Islands (Richardson et al. 2001; Evans et al 2002). It is found in a variety of habitats and includes lacustrine, riverine, and anadromous life histories.

<u>Spawning and Egg Development</u>

Ninespine stickleback spawn in lakes or streams from May to mid-July in nests built by the males in shallow, weedy waters. Nests are built from vegetation and debris, which is glued together using kidney secretions. Nests can also be made in burrows in muddy substrates and between or under rocks along lake shores. Males guard the nests and tend fertilized eggs by fanning the nest entrance to create a current of oxygenated water.

<u>Larvae and Juveniles</u>

Eggs hatch in about one week, after which the male guards the fry a further two weeks in a nursery area constructed above the nest, until they are free swimming and disperse into shallow, vegetated waters (Richardson et al. 2001). The young move into deeper water to overwinter.

<u>Adults</u>

In streams, ninespine sticklebacks are usually found in shallow, slow flowing areas over sand or mud substrates (Evans et al. 2002). Their food consists of aquatic insects and crustaceans, and occasionally small fish fry and fish eggs (Scott and Crossman 1973). These sticklebacks generally mature within the first year of life (Scott and Crossman 1973; Richardson et al. 2001) and have a life span of about three years. These fish are common prey for other fish species.

<u>Anthropogenic Factors Influencing Survival</u>

The selection of shallow, weedy habitats in streams and at lake margins suggests that the habitat of the ninespine stickleback may be affected by either increasing or decreasing water levels. Increasing water velocities could result in displacement of juveniles and adults, which are adapted to slow flowing waters. In addition, excessive erosion and sedimentation due to construction activities have the potential to affect spawning success and prey availability.

Slimy Sculpin

The slimy sculpin is found in cold, well oxygenated waters throughout the Northwest Territories, in addition to its wide distribution elsewhere in northern North America. It is typically found in flowing waters, from rivers to small creeks, and also in lakes (Richardson et al. 2001; Evans et al. 2002; Birtwell et al. 2005).

<u>Spawning and Egg Development</u>

Spawning sites are selected by sculpin males in May, usually under a rock, ledge, or submerged woody debris; over sand, gravel, or rock substrates. Deposited eggs adhere to the ceiling of the nest and are subsequently guarded and tended by territorial males, sometimes up to the time that fry begin to feed (Scott and Crossman 1973). Egg incubation takes approximately one month, after which fry fall to the bottom of the nest and exist on absorbed yolk for 3-6 days (Evans et al. 2002).

Larvae and Juveniles

Free swimming sculpin fry remain in shallow water over sand or gravel substrates, and where velocities are generally less than 0.5 m/s. (Evans et al. 2002). As the fish grow, they may move into faster water over coarser substrates where they reside in contact with the stream bottom. In lakes, juveniles shift to deep water as they grow (Richardson et al. 2001; Birtwell et al. 2005).

Adults

Adult slimy sculpin in streams are found in moderate to fast areas of streams, in contact with gravel or cobble substrates, which they use as refugia, although they also select sand and silt bottoms (Evans et al. 2002). In lakes, adults occupy a wide range of depths, but tend to choose depths of less than 10 m in small northern lakes. They consume a variety of prey items, but particularly benthic invertebrates and crustaceans (Scott and Crossman 1973; Birtwell et al. 2005). Adults tend to be relatively immobile in streams, choosing spawning areas near feeding habitats. Maturity of sculpin in the north usually occurs at ages 3-4. Slimy sculpin are eaten by predaceous fish species.

Anthropogenic Factors Influencing Survival

The potential factors leading to adverse effects on slimy sculpin due to the Highway Project include significant changes in water flow and sedimentation of stream habitats.

Lake Chub

Lake chub, a member of the Cyprinidae family, occurs throughout Canada in small streams, rivers, and lakes. In the Northwest Territories, this species occurs throughout all the major watersheds (Scott and Crossman 1973). Despite its almost ubiquitous distribution, very little is known about its life history.

Spawning and Egg Development

Adults undergo spawning migrations from lakes to streams in the summer in the NWT, possibly as late as August. Although information on post-spawning survival is sparse, a study reported by Scott and Crossman (1973) suggested that post-spawning mortality does occur. Spawning occurs over rock or gravel; sinking eggs settle into crevices within these substrates. No nests or redds are constructed. The eggs hatch after incubating for about 10 days.

Larvae and Juveniles

Young lake chub feed mainly on zooplankton. Little else is known of their habitat selection.

Adults

Adult lake chub feed on terrestrial and aquatic insects, but may also feed on algae, zooplankton, and even small fishes, and have been known to scavenge on decaying fish. Fish mature in their third or fourth year, and rarely survive past age five (Scott and Crossman 1973). Adult lake chub are preyed upon by larger fish, including northern pike and burbot, but also by predaceous birds.

Anthropogenic Factors Influencing Survival

Direct and indirect effects on lake chub survival and productivity may result from activities resulting in sediment releases that reduce the availability and quality of spawning and juvenile rearing areas. Sedimentation of these habitats fills interstitial spaces into which eggs normally settle and affects benthic invertebrate productivity and species composition. In addition, zooplankton availability is reduced in turbid waters.

References:

Birtwell, I.K., S.C. Samis and N.Y. Khan 2005. Commentary on the management of fish habitat in northern Canada: Information requirements and policy considerations regarding diamond, oil sands and placer mining. Canadian Technical Report of Fisheries and Aquatic Sciences 2606.

Evans C.L., J.D. Reist, and C.K. Minns. 2002. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on riverine habitat requirements. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2614.

Rescan Environmental Services Ltd. (Rescan). 1999a. Proposed Inuvik to Tuktoyaktuk Road: Environmental/ Socioeconomic Baseline Report. Prepared for Government of the Northwest Territories Department of Transportation by Rescan Environmental Services Ltd. Yellowknife, NWT.

Richardson, E.S., J.D. Reist, and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat requirements. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2569.

Scott, W.B., and Crossman, E.J. 1973. Freshwater Fishes of Canada. Fisheries Resources Board Canada Bulletin 184 (Reprinted 1990). 966 pp.

Reviewer's Comments:

For local and regional abundance, distribution and use of habitat types, including aquatic and riparian vegetation, some information is found in the 2010 Aquatic Field Program Report; however it is not completed for the remaining area of the road. Therefore assessing the abundance and distribution of habitat types along the highway corridor is not completed.

Developer's Response:

The Developer has provided an updated discussion of field studies and result schedules related to fish and fish habitat in the Addendum to the EIS submitted to the EIRB in response to Category 3 Conformity Request #5.

Reviewer's Comments:

The EIS does not specifically define the most sensitive habitats that may exist in the highway corridor for the species discussed. It defines the risk to the fish species as "low, moderate, or high", however does not describe the risk that the highway would pose with respect to the life stages of the fish. The EIS consistently describes MOST of the headwater lakes as not adequate for spawning as they freeze to the bottom; however the headwater lakes that could be adequate habitat are not identified or described along with their associated crossings.

Developer's Response:

Risk levels identified in the EIS refer to habitat productive capacity, since this is the benchmark identified in the DFO Policy for the Management of Fish Habitat. Avoidance and mitigation measures will therefore be designed to prevent a net loss of productive capacity, and therefore conservation of fish productivity and community composition. The key to preventing harmful alteration, disruption and destruction (HADD) of fish habitat is to maintain existing habitat conditions as much as possible. For this reason, streams possessing good fish habitat or good fish habitat potential, including those that are assessed as being sensitive, will be crossed by clear span bridges to avoid stream disturbance. Streams with marginal habitats will generally be crossed by culverts, although even in such situations, culverts will be designed and installed to maintain fish passage potential and minimize erosion and downstream sedimentation.

Reviewer's Comments:

For species of concern, Arctic Grayling is identified as "sensitive" by the Government of the NWT but the specific location, limits, size, sensitivity and limiting factors are not discussed.

Developer's Response:

The EIS recognizes that Arctic grayling is identified as "sensitive" and notes (EIS Section 3.1.7) that grayling is the species most likely to be affected by Highway construction activities because of its dependence on stream habitats for spawning, juvenile rearing, and adult life stages. As such, their productivity within a system is highly sensitive to perturbations that degrade or alter migration access or habitat quality. Previous investigations identified grayling in Zed and Hans creeks and sampling during the 2010 studies found grayling in two of the seven streams sampled (sites 39 and 39a).

The EIS states that grayling require clean, well oxygenated gravel-cobble substrates to complete their life cycle, which is implied as a limiting factor (aside from unimpeded access) to grayling productivity and abundance. Due to the nature of this Highway Project, sedimentation of spawning and rearing areas and fish passage obstruction are the two potential effects that pose a risk to grayling populations. As such, the EIS focuses on protective measures to avoid or mitigate adverse effects from these stressors. These include erosion and sediment control, appropriate design and installation of culverts, and the use of clear span bridges over streams that are known, or assessed to provide good habitat conditions for grayling.