APPENDIX C

MEMO

Hatfield
CONSULTANTS

Date: September 2, 2015 HCP Ref No.: CZN7444

From: John Wilcockson

To: Dave Harpley, Canadian Zinc Corp

Subject: **All-season road – response to adequacy review – fish and fish habitat**

This memo presents fish and fish habitat responses to adequacy review (AR) comments written for Canadian Zinc Corp's all-season road Developers Assessment Report (Mackenzie Valley Environmental Impact Review Board, May 22, 2015). For ease of referencing, the responses use the same section heading numbers as provided in the AR document. Five attachments also accompany this memo:

- Attachment A: Stream biographies, habitat descriptions of selected stream crossings – Prairie Creek mine all-season road;
- Attachment B: Crossing habitat matrix;
- Attachment C: Selected analyte concentrations in fish tissue collected from multiple sources at Prairie Creek and Tetcela River (1981-2012);
- Attachment D: Condition factor data as a measure of fish health compiled from multiple sources at various river and creek sites along potential road crossings from Prairie Creek Mine (1981-2013); and
- Attachment E: Assessment matrix – Aquatic environment.

4.16 IMPACTS ON FISH HABITAT DUE TO DEVELOPMENT DURING ALL PROJECT PHASES

Adequacy Review Comment:

Please complete a discussion of habitat fragmentation in addition to any other indirect habitat effects that may affect key harvested species.

Response:

For this and other responses, refer to Attachment E for an effects matrix.

Fragmentation

For fish species, potential habitat fragmentation during all project phases is associated with possible obstructions of fish passage. Most fish species (even resident populations) must migrate between habitat types to complete their life cycle (e.g., spawning and rearing habitats). Consequently, the type of stream crossing is a critical consideration in the road design to ensure fish passage is maintained. Bull trout is a key example of a valued ecosystem component found in the Prairie Creek watershed that migrates between spawning and rearing habitats and therefore could be impacted by improperly designed crossings. Consideration of bull trout migration routes has been included in the design of the proposed all-season road.

Based on current knowledge about bull trout distribution in the area, there is only one known place where the road crosses a possible bull trout migration route. This is at Casket Creek. By placing a clear-span bridge at this location, there should be no effects on bull trout migration. Funeral Creek, a documented bull trout spawning creek, is also crossed by the all-season road; however, the crossing locations are near the headwaters of the creek where channel morphology consist of multiple high-gradient plunge pools that present natural barriers to fish passage. To date, no adult or juvenile bull trout have been found upstream of Km 12.7 where the main stem splits into two forks.

CZN and Allnorth also have proposed either clear-span bridges or open-bottom/buried culverts in any locations known or believed to support fish (i.e., Casket Creek, Sundog Creek, Sundog Tributary [at Cat Camp], tributary to Tetcela River, Tetcela main stem, Grainger River), or having habitat suitable for fish and no known natural migration barriers from waterbodies known to have fish (i.e., some Polje Creek tributaries, Polje Creek, some Grainger River tributaries, and some Liard River tributaries).

Other Indirect Habitat Effects that May Affect Key Harvested Species

Potential indirect habitat effects include physical loss of fish habitat at the crossing locations, increased water turbidity from road surface runoff, siltation of spawning areas with fine material and the impacts of spills. These items have already been discussed in several areas of the DAR.

Turbidity could increase in streams adjacent to the road if there is significant precipitation and erosion of exposed soils, or road material. If erosion is significant, displaced soils could smother spawning substrates; this would be of greatest concern in systems where terrestrial gradients are steep and where the road parallels a creek. Erosion is a common concern with dirt roads, and a specific management plan is to be created to addresses these concerns directly. The periods when road erosion would likely be greatest would correspond to periods when natural turbidity in adjacent streams is also high. Based on our observations, Prairie and Sundog creeks and Tetcela River experience natural periods of high turbidity, normally associated with freshet and significant rainfall. It is likely that any incremental increase in turbidity downstream of the road relative to background levels would not be significant at these times. The absence of unique/critical spawning areas just downstream of the crossings also makes the smothering of spawning substrates less of a concern.

To verify the expected absence of turbidity effects, we recommend regular upstream versus downstream inspection of turbidity at major crossings during open water seasons during all-season road construction, operation and closure as part of the proposed Aquatic Effect Monitoring Program (AEMP). Inspections should be conducted weekly during construction and immediately after any significant runoff events. The weekly frequency can be reduced to twice a month for the first year of operations, and monthly thereafter. Turbidity measurements should be taken during inspections. Additional erosion and sediment control features will be installed at any crossing where monitoring identifies a significant increase in turbidity above natural background levels. CCME numerical guidelines for turbidity will be used to identify reasonable management triggers (CCME 2002). A suitable trigger will also be specified for the collection of a water sample for total suspended sediments (TSS) analysis.

4.17 EXISTING MANAGEMENT PLANS

Adequacy Review Comment:

Please provide these plans in conceptual or draft form as they apply specifically to the Prairie Creek Mine All-season road and Air Strip Project. - AEMP with any updates relevant to the All-season road.

Response:

AEMP Updates to the All-season road

The Mine's Aquatic Effects Monitoring Program (AEMP) will include monitoring activities appropriate to each phase of the all-season road. This section provides a conceptual description of these components. Some of the monitoring will be routine, for instance, monitoring of turbidity and TSS as described above upstream and downstream of crossings, or locations where the road is within 30 m of a creek.

With respect to a spill, the response will depend on the material spilled, and the climatic conditions at the time of the spill. There are three common products that would be regularly transported on the road and could be spilled: mill concentrate, sulphuric acid and fuel oils (DAR Section 9.3.3, p192). If the material spilled is water soluble, such as for acids, the material should remain in the water column and impacts should be short term and acute, rather than longer and chronic. For materials that are not water soluble, i.e., heavy fuels or concentrate, the material could impact sediments for a longer period of time before the system naturally recovers. In addition to the properties of the material spilled, the spill monitoring program would take into account the physical nature of the spill (e.g., large immediate release directly to the stream or a slower release from adjacent soils), the amount (i.e., less than or greater than any threshold for a reportable spill), climatic conditions at the time of the spill and the receiving environment. The monitoring program would be designed, with the input of regulators and representatives of Aboriginal communities, on a site-specific basis. Clean-up actions are covered within the spill response management plans.

Potential measurement endpoints used in a spill related monitoring program could include:

- Visual reconnaissance looking for dead or impaired aquatic organisms or other impacts;
- Water chemistry;
- Sediment chemistry, both < 63 µm fraction and whole sediments (more important for heavy fuel oils and concentrate);
- Acute water toxicity testing (e.g., rainbow trout, or Daphnia magna mortality tests);

- Sublethal water toxicity testing (e.g., *Ceriodaphnia dubia* reproductive test);
- Sediment toxicity testing (i.e., *Hyallela azteca* growth test);
- Benthic invertebrate assemblage assessment;
- Fish abundance;
- Fish health (i.e., condition, size at age, GSI and LSI); and
- Fish tissue chemistry.

Samples collected for chemistry and benthic community assemblage assessment should include at least one upstream sample (for reference purposes) and multiple downstream samples. All other endpoints would normally include an upstream and downstream sample only.

Any spills to Funeral Creek should include an assessment of juvenile occupancy following methodologies developed by Neil Mochnatz, DFO. However, given some spawning bull trout also have to swim past the mine's discharge, it will be important to separate the different effects sources. Consequently, another upstream tributary to Prairie Creek known to host spawning/rearing habitat and previously characterized should be re-assessed concurrently with Funeral Creek. More detail will be provided in the AEMP.

6.3 IMPACTS TO TRADITIONAL HARVESTING AND TRADITIONALLY HARVESTED SPECIES

Adequacy Review Comment:

Please complete effects assessments for the specific impacts identified in Section 7.2.1.12-16. Complete an effects assessment following the example provided in Appendix B of the ToR. Particular items of importance from the ToR include items 14 (disturbance of harvest patterns), 15 (competition amongst harvesters), and 16 (changes to quality) from Section 7.2.1, with special focus on the effects predicted for the months of April to December.

Response:

It is unlikely that the presence of the road will impact populations of fish species used by Aboriginal communities. Historically, the only streams potentially affected by the road that have been fished by Aboriginal communities have been:

- Prairie Creek – at the confluence with the South Nahanni. Historically Arctic grayling and bull trout have been collected here;
- Fishtrap Creek – near the confluence with the South Nahanni;
- Grainger River; and
- Tetcela River.

(DAR, section 4.5.2, p 100).

Discussions between CZN and NDDB harvesters indicate that these locations have likely been fished in the last decade, except for the Tetcela River, since it is less accessible (David Harpley, CZN, pers com. August 15, 2015).

Use of these waterbodies has been predicated largely upon ease of access and availability of desirable fish. None of the other streams crossed or paralleled are known to contain fish large enough or in sufficient abundance to make fishing worthwhile (see stream biographies and crossing habitat matrix, Attachment A and B respectively) considering the distance from communities and more difficult access.

The road only parallels each of the streams listed in the bullets above for a small portion of their entire length, therefore fishing access will still be limited. A possible exception will be improved access to Gap Lake. Winter fishing pressures on this lake may mildly influence stocks of fish in the Grainger River; however, it would seem unlikely that people would drive 35 km off the Liard Highway to go ice fishing on Gap Lake when closer, higher quality, fishing opportunities exist. Also, the only local person who it appears has fished there in the last decade, Raymond Vital, has a cabin at the Lake and is in favour of the road as it will facilitate his access (David Harpley, CZN, pers com. August 15, 2015).

A disturbance of harvest patterns can result from a significant impact to existing fish stocks in a stream. A significant spill to Prairie Creek, Tetcela River, Fishtrap or Grainger River would likely have greater effects on fish abundance than fishing pressures. However, with the possible exception of Fishtrap Creek (which has poor fish habitat in the area near the road), the large flows of each of these streams would rapidly dilute the spilled material. The low flow in upper Fishtrap Creek would also make it easier to contain a spill and remove material before it flows the large distance downstream to the mouth where traditional fishing areas are located.

The quality of fish are unlikely to change based on the construction, operation and closure of the all-season road. Any spill of a material capable of accumulating in fish (i.e., metals in concentrate) will likely be small and exposure duration short.

8.4 SENSORY DISTURBANCE TO FISH, BIRDS AND WILDLIFE

Adequacy Review Comment:

Please include a discussion of how noise effects may be differently experienced by wildlife (including moose and caribou), birds and fish in the spring, summer, fall and winter seasons. Please also clearly explain how the discussion of sound effects on fish accounts for differences in sound propagation in air versus water. Please also clarify the actual predicted noise level at both the road and 0.5 km from the road. Please conduct an assessment of possible effects on fish from noise levels at each predicted level, and discuss mitigation options to minimize the risk of adverse effects.

Response:

We reviewed several documents in order to acquire additional information about noise effects on fish:

- The Northern Land use guidelines; access: roads and trails Volume 5 (AANDC 2015);
- Standard specifications for highway construction in British Columbia (BCMOT 2015); and

- The Environmental Impact Statement For Construction Of The Inuvik To Tuktoyaktuk Highway, NWT, (Kiggiak-EBA Consulting Ltd, 2011).

None of these documents identified traffic noise as a concern to fish. Potential impacts of noise; however, were related to percussion effects due to pile driving and blasting. A Canada/Inuvialuit Fisheries Joint Management Committee Report (Stewart 2003) assessed potential effects of dump trucks carrying crushed rock over the Mackenzie River in winter. This report assessed potential impacts related to a large volume of heavy traffic over the river ice. The concern was that noise from these trucks might result in impacts to fish. The study concluded that the noise from the trucks was unlikely to generate sound pressure levels under the ice sufficient to physically damage fish, or to elicit startle or alarm responses (Stewart 2003). However, it stated that the intensity of noise would be sufficient to cause some species, namely minnows and suckers in the Mackenzie Delta which are more sensitive to noise, to avoid the area. Given that the Prairie Creek Mine traffic or construction vehicles will be driving on roads some distance from streams or driving over structures not in direct contact with water, it is unlikely that noise would be any greater than that reported in the Joint study. The report also indicates that fish become acclimated to continuous sound levels, even when they are very high, unless there is an abrupt change in sound intensity (Stewart 2003).

A recent study showed that blacktail shiner (*Cyprinella venusta*) have difficulty communicating with each other over ambient traffic noise (Holt and Johnson 2015). This study was done on flat (i.e., quiet water) on species that have specialized sensitive hearing structures, required for communication. It is unlikely that the species living in streams adjacent to the Prairie Creek all-season access road, normally in water with riffle morphology, would be affected similarly.

The stream most likely affected by noise, due to its proximity to the all-season road, is Funeral Creek. The resident fish are bull trout, a salmonid species; salmonids are known to have simple, non-specialized, relatively insensitive hearing structures (Popper and Hastings 2009, Stewart 2003). The natural noise of riffles and cascades in Funeral Creek would also act to mask the incremental noise of trucks. Furthermore, entrained bubbles as a result of the riffles and cascades in Funeral Creek would act to attenuate any noise produced by passing trucks. Bubbles are often artificially created into “curtains” around pile-driving activities, to protect aquatic life from deleterious effects from percussion.

In winter, only developing bull trout embryos should be present in Funeral Creek. Therefore it is significant that research reports “no effects on eggs or fry [of species tested] from noise louder than trucks” (Section 11.4.2 of the DAR). Any over-wintering fish may be incrementally susceptible to traffic noise due to the absence of the natural masking by cascading water.

13.0 NOISE

Adequacy Review Comment:

Please complete all of the steps outlined in Section 4.1 and 7.1 of the ToR for the assessment of effects to the subject of note for noise.

Response:

The steps outlined in Section 4.1 and 7.1 of the ToR are followed in Section 16.2 in the responses to the adequacy review. A more detailed assessment of the effect of noise is provided in Section 8.4 above.

15.2 EFFECTS ASSESSMENT (SPECIES AT RISK)

Effects on Traditional Harvesting

Adequacy Review Comment:

Please conduct a complete effects assessment to species at risk as required under section 7.3.6 using methodology in Section 4 of the ToR including the summary table in Appendix B of the ToR. Please respond to all items in this section with a concordance table identifying where a response to each item is located in the DAR. In addition, please improve the baseline information used for the effects assessment (refer to Appendix B).

Response:

An assessment matrix is provided as Attachment E. References to corresponding sections in the DAR and within the responses to the adequacy review are provided in CZN's revised concordance table.

Bull trout is the only aquatic 'species at risk' proximal to the proposed all-season road. It is also only found near the road in creeks closest to the Mine: Prairie Creek, Casket Creek and Funeral Creek (Mochnacz 2013; Mochnacz pers com, July 30, 2013). Bull trout is classified as a species of special concern by COSEWIC (2012), but is currently not ranked in the NWT.

Based on discussions CZN has had with NDDB harvesters, there is no traditional harvesting of bull trout from Prairie Creek near the Mine, Casket or Funeral Creeks because access is difficult and there are nearer, easier harvesting opportunities (David Harpley, CZN, pers com., August 15, 2015). Bull trout may be harvested near the confluence of Prairie Creek with the South Nahanni River, although we understand the prime target of fishers is grayling (David Harpley, CZN, pers com. August 15, 2015); however, it is not clear whether bull trout harvested here have spent much of their life in upper Prairie Creek. It is known that bull trout migrate through Prairie Creek, past the Mine in order to spawn, largely in tributaries to Prairie Creek, upstream of the Mine. It is also believed that a portion of the bull trout population is resident, likely overwintering in deep pools. Work by Neil Mochnatz (DFO 2010) on Dolly Varden, a closely related species, north of 60° latitude, indicates that Dolly Varden often utilize pools fed by warm groundwater springs. It is possible that bull trout, also utilize pools fed by groundwater springs in Prairie Creek.

The most likely risk to bull trout stocks is related to a major spill of concentrate, sulphuric acid or fuel oils. These products will be commonly transported along the all-season road. A spill within the upper watershed of Funeral Creek would likely have the greatest consequence, especially if it occurs in late fall or early spring, given developing embryos present are sensitive to chemical exposure and dilution in the creek at this time would be limited. In winter, it is anticipated that a spill would largely remain on snow and ice, would be relatively easy to clean up, and may not enter the aquatic environment. A spill to Prairie

Creek would have a smaller consequence due to higher anticipated dilution and also because embryos would not be present. A spill to Casket Creek would also have lower consequence, because the all-season road crosses Casket Creek near it's confluence with Prairie Creek. However, the likelihood of a spill occurring resulting in a discharge to a fish-bearing stream is considered to be low

Bull trout embryos are easily smothered by silt (Montana 2015); therefore, it will be important to minimize erosion from the road parallel to Funeral Creek in fall and spring when embryos are present and the creek isn't iced over. Fortunately, the high velocity of flows in Funeral Creek will tend to prevent fine materials from settling, so minor releases of sediments should have negligible impact. Little water quality data currently exists for Funeral Creek.

The Sediment and Erosion Control Plan will present ways to minimize the release of sediments from the road and outline corrective actions.

16.2 IMPACT ASSESSMENT STEPS

Adequacy Review Comment:

Please complete all of the steps outlined in Section 4.1 and 7.1 of the ToR for the assessment of effects to the subject of note for fish and aquatic habitat. In addition, please improve the baseline information used for the effects assessment (Refer to Appendix B).

Response:

An Assessment Matrix is provided as Attachment E. DAR Section 9.4 (p191-197) and Section 9.5 (p197-200) provide more in-depth review on the possible impact of spills. The responses to the adequacy review, Appendix B Sections 1, 7, 8, and 9 refer to existing baseline data requirements. Attachments C and D address these existing baseline data requirements.

Valued Components (Aquatic)

The aquatic valued components are harvestable fish and forage fish. Species and location of their documented occurrence include:

- Bull trout (Prairie Creek, Casket Creek and Funeral Creek);
- Round whitefish (Prairie Creek, Tetcela River and Grainger River);
- Arctic grayling (Prairie Creek [at confluence with Nahanni River only], Sundog Creek, Polje Creek, Tetcela River and Grainger River);
- Slimy sculpin (Prairie Creek, Sundog Creek, Tetcela River and Grainger River);
- Northern pike (Tetcela River, Grainger River);
- Longnose sucker (Tetcela River);
- Lake Chub (Tetcela River); and
- Longnose dace (Tetcela River).

Bull trout is a species of Special Concern by COSEWIC (2012), and under consideration for inclusion in the federal SARA, but its conservation status has not been ranked in the Northwest Territories (please refer to our response to AR Appendix B, Section 1 below).

The valued components above are also described in the re-alignment and crossing-specific habitat data (Attachments A and B).

Background Conditions

Attachments summarize existing fish and habitat baseline data available for each stream:

- Attachment A: Stream biographies;
- Attachment B: Crossing habitat matrix;
- Attachment C: Selected analyte concentrations in fish tissue; and
- Attachment D: Fish condition factor data.

Potential Impacts

Potential direct and indirect impacts to fish as a result of construction, operation and closure of the all-season road are listed below and summarized in Attachment E. Potential impacts are as follows:

Fragmentation

Fragmentation is described in Section 4.16. For all crossings known to have fish or fish habitat present (in the absence of natural downstream obstructions), a clear-span crossing or a large culvert with natural substrate at the bottom was selected. For more marginal habitats without documented fish present, including many small ephemeral creeks, conventional culverts will be used. Best management practices will be applied, which will include avoiding perched culverts.

With the appropriate crossing type installed, we do not anticipate (i.e., a low likelihood) any impacts to fish migration. Uncertainties for this prediction are low. However, annual or semi-annual culvert inspections, especially during expected spawning periods, would reduce uncertainties further.

Noise

Sound-related potential impacts are described in Section 8.4.

Sound from construction or road traffic is unlikely to result in any effects to fish. Over all, we believe that the likelihood of an impact from traffic and construction noise is low.

Uncertainties for this prediction are low. A juvenile bull trout occupancy assessment is planned every four to five years as part of the Mine AEMP. Although this study would not be specific to noise-related effects (i.e., it is more effective at assessing cumulative effects of the Mine), it would detect impacts to bull trout populations in Funeral Creek. If this assessment indicates that juvenile bull trout populations in Funeral Creek are decreasing, steps could be taken to determine the cause of the effect. If sound is a contributing cause, possible mitigation steps could include adjusting speed limits in key areas closest to the creek.

Spills

The potential impact of accidental spills is described in Section 4.17 as well as DAR Section 9.3.3, p192.

CZN has mitigated the risk of spills by routing the road so it avoids streams where possible and by situating crossings perpendicularly to channels to minimize proximity of the road to streams. CZN also plans to place spill kits at regular intervals along the road. High-risk portions of the road will have designated spill control points, and posted lower speed limits will reduce the risk of accidents leading to spills.

The likelihood of an accidental spill entering aquatic habitat is greatest along the sections of road paralleling Funeral and Sundog creeks, both due to the proximity of the road to the creeks and the steeper topography that the roads must traverse. However, given that approximately 800 loads have already been driven on the historical winter road (DAR Section 1.2, p39) without a single major mishap, the likelihood of a serious spill is considered low. The uncertainties of this prediction are also low.

Required environmental monitoring following a spill is briefly outlined in Section 4.17, under AEMP updates. Briefly, environmental sampling would be conducted that would compare the ecological functioning of upstream versus downstream locations, and may include water and sediment chemistry analysis, benthic community analysis, toxicity testing and fish health/fish tissue chemistry analysis. Monitoring programs would be designed on a site- and spill-specific basis with input from regulatory agencies, DFO and Aboriginal communities.

Sedimentation

The potential impact of increased sedimentation from road surfaces is discussed in the DAR (Sections 11.1.1, p 231 and 11.1.4, p 235) and in Section 4.16. Any impacts should be highly reversible, and sediments would be rinsed out of coarser substrates during periods of higher flow, especially freshet. A Sediment and Erosion Control Plan (see response to Section 16.4) presents ways that CZN will avoid and mitigate impacts related to increased sedimentation.

After implementation of items in the Sediment and Erosion Control Plan, the likelihood of significant stream sedimentation resulting from road erosion is low, as is the likelihood of significant turbidity. We consider the magnitude to be low; however, due to a number of uncertainties, largely associated with unpredictable climatic conditions, we consider the uncertainty to be moderate.

Removal of Riparian Vegetation

Potential impacts related to the removal of riparian vegetation are discussed in Section 16.5. The road runs closest to streams in areas where the existing riparian vegetation is sparse, providing relatively little ecological value. Incremental effects on riparian vegetation are being avoided by largely building on the existing all-season and winter road ROW. The proposed ROW mostly avoids streams, and crossings are perpendicular to streams to minimize incremental loss of riparian vegetation.

The magnitude and likelihood of impacts on fish populations due to removal of riparian vegetation are low. The uncertainty is also considered low. Specific monitoring is not proposed to evaluate potential impacts related to the removal of riparian vegetation.

Overharvesting

Potential impacts related to overharvesting of fish species are discussed in the DAR Section 8.11, p185, and Sections 6.3 and 15.2. Increased accessibility to streams along the road could increase fishing pressures and decrease fish populations. Magnitude of effect would be greatest to the fish population in Gap Lake. Mosquito Lake is further, is in the park, and may not host fish because the lake drains to the poljes. Any effects would be reversible once fishing pressures reduce after road deactivation.

CZN are working on initiatives with Nahanni Butte to control access. During the ice-free season, the Liard River will also limit access, except for those willing to transport vehicles across the river on their own boat. CZN will also forbid employees and contractors from fishing anywhere along the road.

After implementation of mitigation measures, the magnitude and likelihood of significant effects are low. The desirability of fish harvesting in Funeral Creek is likely small. Bull trout in Funeral Creek are small; and it would be a long way to travel to access these fish. Uncertainty is considered moderate because it is hard to predict people’s future desire to catch fish along the road. Possible effects would persist for the duration of road operation, and are reversible after road closure.

Blasting

Potential impacts related to blasting at crossing locations are discussed in Section 16.4. CZN will follow best management practices for blasting and have a management plan specifically designed to mitigate effects on fish. Blasting will only occur in four locations, three in Sundog Creek and one in Grainger River. Two of the Sundog locations are not fish-bearing. The other, and the Grainger location, host grayling, a spring spawner. Blasting will not occur in the spring.

After implementation of mitigation measures, the magnitude and likelihood of a significant effect are low. Reversibility is considered high, because worst case, only a small number of fish in Grainger River would be impacted and fish will return to the site after blasting has been completed.

Cumulative Effects

The potential for cumulative effects in the aquatic environment are highest close to the Mine site. Impacts to water quality from the road (headwaters of Funeral Creek to the Mine) could potentially add to impacts on water quality from mine discharges. Potential physical impacts to bull trout due to the presence of the all-season road could also be additive to potential chemical effects due to mine discharges. However, mine discharge limits will be strict, and the likelihood of spills entering watercourses is low. It is anticipated that any potential cumulative effects observed would start to subside during mine closure and would be minimal or absent post-closure.

The existing draft AEMP for the mine requires monitoring of water, sediment and invertebrate tissue chemistry, benthic invertebrate assemblages and slimy sculpin health. As part of this EEM-style monitoring program, there is an upstream sampling station, a near-field sampling station and two far-field sampling stations. The upstream station is downstream of the confluence with Funeral Creek. For most of these monitoring variables, CZN already has two years of baseline data. In addition, as a component of the AEMP, CZN has committed to carrying out a juvenile bull trout occupancy study in Funeral Creek and another tributary to Prairie Creek every four to five years. This study will supplement more than two years of baseline data collected by Neil Mochnacz (DFO) in the Prairie Creek watershed.

It is anticipated that the existing draft AEMP will be sufficient to identify significant impacts due to cumulative effects of both the all-season road and the mine discharge. Adaptive management plans proposed in the draft AEMP would also be capable of responding to impacts from cumulative effects within the Prairie Creek watershed.

16.3 IMPACTS ON FISH HABITAT DUE TO DEVELOPMENT DURING ALL PROJECT PHASES

Adequacy Review Comment:

Please complete a discussion of habitat fragmentation in addition to any other indirect habitat effects that may affect key harvested species.

Response:

Habitat fragmentation for fish and other indirect habitat effects were discussed in Section 4.16. Effects of habitat fragmentation on fish primarily occur when fish are prevented from migrating. The proposed all-season road crosses several streams known to contain fish or would likely contain fish based on habitat quality. In all cases, the crossing structures at these locations will either be clear-spanned or have open bottoms containing natural stream substrate (DAR section 11.6.1, p 244). The decision criteria for selecting the crossing type was predicated on minimizing effects on fish passage. We do not anticipate there will be any barriers to fish migration created due to these structures.

Work performed during the construction and closure phases of the road will involve the creation and later decommissioning of crossing structures. In order to minimize effects, work will be timed to avoid in-stream activities during sensitive periods (e.g. spawning).

16.4 RELEVANT POLICIES, MANAGEMENT PLANS OR OTHER MEASURES TO PROTECT OR ENHANCE FISH AND AQUATIC HABITAT

Adequacy Review Comment:

Please review DFO’s updated “Measures to Avoid and Mitigate Impacts” and include any updated measures into plans for protecting or enhancing fish and aquatic habitat. Please also review all other relevant DFO guidelines including those mentioned above and include any applicable mitigation measures into project design plans.

Response:

Regarding DFO’s updated “Measures to Avoid and Mitigate Impacts”, several of the items apply more to the creation of good management plans and are thus not discussed in this section in any detail. We discuss relevant items as follows:

- **Timing** – all in-stream works will be performed to avoid sensitive life stages of fish. Consequently, in-stream work will not be done when fish are expected to be spawning. Also in-stream work will be avoided if it is predicted that work will result in significant turbidity resulting in the smothering of downstream developing fish embryos. Existing investigations of fish-bearing crossings indicates that none of the crossings occur in critical fish spawning habitat. Only the habitat in the Tetcela River Tributary and Tetcela Main crossing locations occur at a location where bottom substrate is a suitable size for spawning salmonids (i.e., Arctic grayling and whitefish). However, the habitat does not appear to be unique to the area;

- **Site selection** – the proposed road route has been selected to minimize impacts on terrestrial and aquatic habitats. All crossings run perpendicular to streams to reduce the spatial impacts to riparian vegetation and in-stream habitat. Crossings where streams are naturally narrow were preferred, and generally the road follows the original road route, thus re-using land that is still showing some influence of the historical winter road. The road is typically 30 m away from stream banks on stable material, thus minimizing erosion and reducing the probability of sedimentation from the road reaching streams. However, in some locations, namely on Prairie, Funeral and Sundog Creeks, the topography has forced the road close to the creeks, including the alluvial floodplain for Sundog Creek. Lower Sundog Creek is located in a broad valley with steep walls, where the whole bottom of the valley consists of the alluvial floodplain, although large parts are currently not active and have some vegetation. It is not possible to build a road without locating at least part of the road on the edge of the alluvium;

- **Contaminant and spill management** – This item is addressed in the Spill Contingency Plan;

- **Erosion and sediment control** – This item will be addressed in an Erosion and Sediment Control Plan;

- **Shoreline/Bank re-vegetation and stabilization** – the existing winter road path was preferred where possible, therefore minimizing incremental effects to the shoreline/bank at crossings and where the road closely parallels creeks. Re-vegetation and stabilization are discussed in Section 24.4 below;

- **Fish protection** – stream crossings have been designed to minimize effects on resident fish. Where a creek has habitat capable of supporting fish and where there is no known obstruction to passage, it was assumed that the creek may contain fish. Consequently, a clear-span crossing or culvert with a natural bottom substrate was selected in these situations. Culvert crossings, will be designed to avoid creating water drops on the downstream side (i.e., "perched" culverts will be avoided). Blasting will be needed at four stream crossing, three in the upper reaches of Sundog Creek (km 23, 25 and 28), and one on Grainger River (km 123). The km 23 and 25 locations are upstream of an obstruction to fish passage (a large waterfall), so blasting here will not constitute a hazard to fish. Blasting at the other areas will be done in a way that minimizes impacts on fish by utilizing timing window, encouraging fish to move from the blast area, and minimizing the required blast energy; and

- **Operation of machinery** – machinery used in road building will arrive on site in a clean condition, free of any fluid leaks, invasive species and noxious weeds. Machinery will be operated outside of wetted channels in such a way as to minimize disturbance of banks and channel bed. Fording of fish-bearing streams will most likely not be required, but if needed, will be limited to once-over-and-back, with prior Inspector approval. Temporary crossing structures or at minimum, swamp mats, will be applied to protect banks and stream beds if rutting is likely to result during fording. Equipment will be washed, refueled or serviced away from streams and in such a way as to prevent deleterious substances from entering the water. Fuel and other materials for machinery will also be stored in such a way as to prevent any deleterious substances from entering the water.

16.5 EFFECTS ON RIPARIAN AREAS

Adequacy Review Comment:

Please complete a discussion of the potential effects of the project on riparian areas. This discussion will include:

- A complete habitat assessment of the road alignment including documentation of riparian area habitat types and areal extents;
- An assessment of the importance of riparian areas to fish-health and populations, including a consideration of various uses by species and season;
- An quantitative assessment of the amount of riparian area to be lost or affected by the project; and
- An assessment of the effect of this habitat loss on fish.

Response:

Riparian Vegetation provides numerous ecological services to stream ecosystems. Briefly, riparian vegetation provides the following services:

- Food (from debris and terrestrial invertebrates) and nutrients (from decaying vegetation);
- Water retention – plants retain water thus minimize erosion and water turbidity during precipitation events;
- Shelter and cover for fish – where vegetation overhangs the creek or where roots stabilize bank undercuts, or where large woody debris falls into creeks; and
- Moderates stream climate – over hanging vegetation provides shade in the day and minimizes radiative cooling at night.

In stream biography Attachment A, the types of riparian vegetation adjacent to each major crossing and also the riparian vegetation where the road parallels creeks or rivers is described. Photographs associated with each location (DAR Appendix 9) are referenced in the crossing habitat matrix table in

Attachment B. Below we describe the riparian vegetation likely to be lost or affected. We also provide an estimate of the area lost.

Generally, the riparian zone is sparse in western portions of the road. Sundog Creek, which the road parallels the most, has a floodplain that covers most of the valley bottom. The road parallels Sundog from km 17 to 40, which is about a third of the distance from Sundog's headwaters to its confluence with Ram River (approximately 60 km). Of this distance, approximately half of the road is within 30 m of the creek. The sides of the valley consist of talus slopes, bedrock and coarse substrate and have little riparian vegetation (please refer to photos in Appendix 9 of the DAR). Given the distance of the riparian vegetation from the channel, it will provide few of the functions listed in the bullets above. There are also places where periphyton is visible on rocks, indicating that in-stream photosynthesis may be contributing to the aquatic food chain (i.e., autochthonous production, Figure 1). The removal of any riparian vegetation adjacent to Sundog for the road should have little effect on fish or other aquatic life. If we conservatively estimate that the road bed footprint results in a 10 m wide vegetation loss on average, over the 11.5 km that the road is within 30 m of the creek, the total maximum riparian habitat loss is 11.5 km x 10 m, which is 115,000 m^2. About 20% at most of this portion of the road is significantly vegetated, which would correspond to a loss of vegetated riparian area of 23,000 m^2.

Figure 1 Periphyton growth on rocks in Sundog Creek near Km 38.

Prairie and Funeral creeks have more riparian vegetation, but are still limited by talus slopes, bedrock and coarse substrates. Approximately 80% of Funeral Creek, from its headwater (of a single tributary) to the confluence with the Fast River is paralleled by the road within 30 m from the stream. Much of this is within talus slopes and coarse substrate; however, the first 2 to 3 km of the road along Funeral (i.e., to about km 11) appears to be within forest and shrubs (Appendix A1_I of the DAR). This is approximately a third of the distance from the confluence with the Fast River to the top of the primary tributary. The all-season road paralleling Prairie Creek and Funeral Creek already exists and was previously permitted as an all-season road. However, Canadian Zinc will likely need to widen the road, which will be done on the slope-side and result in limited additional vegetation loss. It is recognized that juvenile bull trout in Funeral Creek may rely on terrestrial insects from the riparian zone as an important food source. Consequently, CZN will clear vegetation only if required, and only on the up-gradient side of the road (i.e., furthest from the creek). If these steps are taken, effects to rearing juvenile bull trout will be minimized. If we conservatively estimate that the road will need to be widened an average of 2.5 m into the riparian zone, and the road is within 30 m of the creek for approximately 6.5 km, the total area of riparian loss would be 16,250 m^2. However, much of the upslope area within 30 m of the creek is partially vegetated (i.e., < 50% cover), reducing the predicted loss of vegetated riparian area to a maximum of 8,125 m^2.

The length of road paralleling Prairie and Fast Creeks is very small compared to the length of these creeks. Also, only about 50% of the road paralleling Prairie Creek is within the 30 m riparian buffer zone, and where it is, side slopes are steep and mostly bare. Further widening of the existing all-season road here is therefore not expected to have any deleterious effect on fish. If we conservatively estimate that the road will need to be widened an average of 2.5 m into riparian vegetation, and the road is within 30 m of the creek for approximately 3.25 km, the total area of riparian loss would be 8,125 m^2. However, much of the upslope area within 30 m of the creek is sparsely vegetated (i.e., < 30% cover), reducing the predicted loss of vegetated riparian area to a maximum of 2,438 m^2.

The road parallels Grainger River for approximately 4 km (based on the current, not alternate, alignment). Of this distance, less than 20% of the road is within 30 m of the stream. Removal of riparian vegetation in this section is not expected to have any deleterious effect on fish. Assuming that the road bed footprint results in a 10 m wide loss of vegetation on average, over the 0.8 km that the road is within 30 m of the creek, the total maximum riparian habitat lost is 0.8 km x 10 m, or 8,000 m^2. However, much of the road alignment within 30 m of the creek is sparsely vegetated (i.e., < 30% cover) alluvial terraces, reducing the predicted area of lost riparian vegetation to a maximum of 2,400 m^2.

Riparian vegetation is much more developed for Tetcela River, Polje Creek, Fishtrap Creek and numerous smaller, mostly erosional, ephemeral streams that are crossed. For crossings, the area of riparian loss is 600 m^2 (i.e., 10 m wide x 30 m on each bank). This is a relatively very small amount of the riparian area paralleling each of the creaks. Therefore, the removal of riparian vegetation associated with each crossing is anticipated to have minimal effect on fish or fish habitat.

16.6 EFFECTS OF DREDGING OR DISPOSAL OF SEDIMENTS

Adequacy Review Comment:

Please describe the potential effects and mitigation measures available and applicable to minimize adverse impacts of dredging to fish and aquatic habitat.

Response:

It is anticipated that dredging will not be needed at the Liard Crossing. Instead, material will need to be placed on the river banks to create ramps for vehicles to load onto a barge. These ramps should have minimal impact on aquatic habitat in the area. On the contrary, back-eddies on the downstream side of these structures may provide fish with refuge from flow.

24.4 RECLAMATION OF IN-STREAM AND RIPARIAN AREAS

Adequacy Review Comment:

Please provide a conceptual closure and reclamation plan that includes a discussion of reclamation objectives for disturbed riparian and in-stream areas, as well as a list of possible reclamation strategies that will enable these objectives to be met.

Response:

At the end of Project life, road closure will be conducted in a manner that meets the following objectives for riparian and in-stream reclamation:

- Surface drainage at crossings will be restored in a manner that provides free flow of water through a defined channel;
- Reclamation of fish-bearing crossings will be carried out in a manner that maintains fish passage;
- The deactivated road bed will be reclaimed in a manner that prevents erosion and introduction of sediments into natural drainage channels;
- Riparian areas will be stabilized and scarified to encourage colonization of native vegetation from adjacent areas;
- All works will be conducted in a manner that prevents the transport and/or propagation of invasive plants; and
- No significant negative effects on the Funeral Creek Bull Trout population.

Closure and reclamation of in-stream and riparian areas will be done in a way that restores pre-existing conditions, while at the same time preventing soil erosion. Potential reclamation strategies to achieve the above objectives may include, but not be limited to, the following:

Restore Crossings.

Stream crossing structures will be removed and the bed, banks and riparian zone returned to their natural slope. Any stockpiled soils will be distributed above the top of bank. The goal will be to make soils in the riparian zone rough and loose to provide diversity of habitat for natural invasion (Polster 2013). Stream banks will be stabilized as necessary. Where soil erosion is a concern, bioengineering approaches such as wattle fences, modified brush layers and live pole drains will be considered (Polster 2003).

Reclamation to Maintain Fish Passage.

All structures at fish-bearing crossings will be removed. Any introduced material will also be removed or stabilized so as not to be erodible.

The deactivated road bed will be reclaimed in a manner that prevents erosion and introduction of sediments into natural drainage channels.

Erosion of the deactivated road bed may be managed using a combination of the following techniques:

- Introduction of cross ditches, French (pole) drains, swales, and other drainage features as required to maintain natural water conveyance over or under the road prism; and
- Loosening of the road bed to allow native plant species invasion.

Riparian areas will be stabilized and scarified to encourage colonization of native vegetation from adjacent areas.

Riparian areas will be stabilized, as necessary, using wattles, erosion control blankets, or other techniques, until natural vegetation has colonized the areas sufficiently.

All works will be conducted in a manner that prevents the transport and/or propagation of invasive plants.

All machinery will be inspected and cleaned prior to work on site.

APPENDIX B: SUMMARY OF OUTSTANDING BASELINE INFORMATION

1.0 BASELINE INFORMATION REQUIREMENTS – SPECIES AT RISK

Adequacy Review Comment:

Please describe bull trout and potential impacts to bull trout in the same manner as other species at risk in this section and the effects assessment section as a subject of note.

Response:

Bull Trout (Western Arctic)	
NWT Population Summary	
Conservation Status	Assessed as Special Concern by COSEWIC (2012) and not ranked in NWT.
Trend	Population declines observed in AB, not enough information for NWT.
Size	Unknown.
Sensitivities and Threats	Human developments, overharvesting.
Health, Parasites, and Contaminants	No adverse conditions known.
Relationship with the Prairie Creek All-season road	
Expected Presence	In Funeral Creek and Prairie Creek.
Seasons of Use	Year round in Funeral Creek, seasonal in reaches of Prairie Creek.
Key Habitats	Spawning grounds, groundwater springs (overwintering habitat).
Existing Harvest Pressure	Low, only known harvest location is at Prairie Creek confluence with the South Nahanni River.
Traditional Knowledge	Seen and caught at Prairie Creek mouth.

Bull trout are widely distributed throughout the central and southern NWT in the Dehcho, Sahtú and South Slave regions, though in low abundance. In NWT, bull trout inhabit the Mackenzie River system, and have been assessed by COSEWIC as Special Concern (COSEWIC 2012) and are Under Consideration for inclusion in the federal SARA. Bull trout in NWT are part of the Western Arctic subgroup (DU2) that inhabit lakes and rivers in the Yukon, NWT, British Columbia and Alberta.

Western Arctic bull trout exhibit a large range of life history strategies, including migratory and non-migratory (stream-resident) forms. All forms will utilize headwater or tributary streams for fall spawning, but can occupy a range of lotic and lacustrine habitats during other times of the year (Stewart et al. 2007).

Various life-history stages rely on very specific habitat types, and bull trout are considered particularly sensitive to anthropogenic habitat disturbances that reduce habitat quality and connectivity (COSEWIC 2012). Bull trout are also a relative slow-growing and late maturing species that do not always spawn in consecutive years (McPhail and Baxter 1996), which makes them susceptible to overharvesting.

In the NWT, bull trout are widely distributed throughout the Mackenzie River Basin, though they are mostly restricted to rivers on the west side of the Mackenzie River. Bull trout are found throughout the Liard River and South Nahanni River systems (Mochnacz et al. 2012). In the Prairie Creek watershed, adult and/or juvenile bull trout were captured in many of the smaller tributaries during the summer, and observed overwintering within the lower reaches of Prairie Creek (Mochnacz 2012). It is believed that there may be two groups of bull trout in Prairie Creek, a stream-resident form, and one that migrates from the Nahanni River in order to spawn (Mochnacz et al. 2012).

Bull trout are known to spawn in the smaller tributaries of Prairie Creek in the fall, and alevins will develop overwinter in the ice-free interstitial areas within bottom substrates. Mochnacz (2012) found that Funeral Creek contained both adults and juveniles and a large range in fish sizes were caught (35-370 mm); Mochnacz et al. 2012). Funeral Creek bull trout are suspected to be a stream-resident population.

As described elsewhere in these responses, overharvesting of bull trout is not considered to be a significant risk associated with the all-season road. However, due to the proximity of the road to Funeral Creek, impacts to spawning adults, developing embryos and rearing juveniles could occur as a result of a significant spill (Comment 15.2 and summarized in Attachment E), although the likelihood is considered to be low.

7.0 BASELINE INFORMATION REQUIREMENTS – FISH AND AQUATIC HABITAT

Adequacy Review Comment:

Please provide a combined assessment of aquatic habitat including metrics of habitat type abundance, distribution and use along all stream crossings and other potentially affected aquatic habitats of the proposed road alignment.

Response:

This information is provided in Attachment A and summarized in a stream crossing table (Attachment B). Referenced photos are also provided in Appendix 9 of the DAR. There are no known invasive fish or aquatic invertebrate species.

8.0 BASELINE INFORMATION REQUIREMENTS- BASELINE CONTAMINANT CONCENTRATIONS

Adequacy Review Comment:

Please provide baseline information on fish tissue chemistry including any relevant information from the Beak (1981) study or other sampling programs in the assessment of baseline conditions for fish and aquatic habitat. If no previously collected data are available, please provide baseline fish tissue chemistry data during the EA process.

Response:

Beak 1981, Rescan 1994, Boman 2010, and Stantec 2014 report metals concentration in the muscle of fish. With the exception of the Rescan report, which also provides metal concentrations in three fish caught in the Tetcela Mainstem, all reports focus on Prairie Creek and its major tributaries:

- Beak 1981 – provides metals concentrations in fish collected from Prairie Creek (slimy sculpin, and bull trout), and Tetcela River (lake chub and long nose sucker);
- Rescan 1994 – provides metals concentrations in fish collected from Prairie Creek (slimy sculpin, and bull trout), and Tetcela River (lake chub and sucker);
- Spencer 2008 – provides metals concentrations in whole slimy sculpins collected from Prairie Creek; and
- Hatfield 2012 – provides metals concentration in bull trout and grayling muscle samples collected from Prairie Creek.

Fish tissue concentrations could potentially be impacted from a prolonged exposure to metals, for instance, from a significant spill of concentrate directly to a stream. Some of the exposure will be directly from water and the ingestion of sediments, but the majority will likely be via accumulation of metals into the benthic food chain.

Baseline metals concentrations are compiled and summarized in Attachment C. Existing concentrations did not exceed CCME or BCMOE tissue-residue guidelines.

In our opinion, fish tissue assessments should not be necessary for a road in the normal course of operations given no significant ongoing source of contamination from passing traffic is expected; therefore, conducting additional baseline work to characterize current fish tissue concentrations is unnecessary. In the event of a spill, assessment of tissue concentrations in small bodied fish could be conducted over time after the event following a specifically relevant study design developed at that time. Small bodied fish, such as slimy sculpin, are known to be highly territorial and have small home ranges.

Other, larger fish species can live at least part of their life cycle in larger systems; consequently, an apparent effect observed in fish at a site could result from conditions elsewhere.

For Sundog Creek, it is possible for effects to occur to the creek upstream of the natural range for slimy sculpin; therefore, having a baseline data set on these fish would be more useful. However, comparing concentrations in benthic invertebrates, such as heptagenid mayflies (Srimgeour and Boman 2011), would likely be equally useful.

9.0 BASELINE INFORMATION REQUIREMENTS- EFFECTS ON FISH HEALTH

Adequacy Review Comment:

Please provide baseline information on fish-health in the area as well as an assessment of predicted effects to fish health. Please describe any potential updates to the existing Aquatic Effects Monitoring Program, which will enable the developer to monitor and adaptively manage any potential adverse effects to fish-health as a result of the all-season road.

Response:

The following reports provide information on fish health:

- Beak 1981 – provides fish-health for Prairie Creek (slimy sculpin, bull trout, Arctic grayling and mountain whitefish), Sundog at a major tributary (Arctic grayling), Tetcela River (Arctic grayling, northern pike, lake chub, slimy sculpin and burbot) and Grainger River (Arctic grayling, northern pike, lake chub and slimy sculpin). Fish condition is most regularly reported, liver somatic index and gonadotrophic somatic index and age are also reported for a sub-sample of fish. Beak also provides information on catch per unit effort;
- Rescan 1994 – provides fish-health for Prairie Creek (slimy sculpin and bull trout) and Funeral Creek (bull trout). Fish condition is most regularly reported, liver somatic index and gonadotrophic somatic index and age are also reported for a sub-sample of fish. Rescan also provides information on catch per unit effort;
- Spencer 2008 – provides slimy sculpin health data for Prairie Creek; and
- Hatfield 2014 – provides slimy sculpin condition and age data for Prairie Creek.

Fish-health could potentially be impacted from a prolonged increase in water turbidity or from a spill of material that would persist in the system:

- If there is a significant soil erosion issue created by the all-season road, fish may be effected both physiologically (i.e., clogged gills) and behaviorally (not being able to see food). The result of not being able to see and thus capture food could result in lower energy storage (i.e., condition, LSI), growth (size-at-age) and energy use (GSI); and

- A spill of material that can effect benthic invertebrates downstream of a spill site (fuel, concentrate or acid), removes fish-food items and will also result in lower energy storage, growth and energy use.

In our opinion, fish health assessments should not be necessary for a road in the normal course of operations; therefore, conducting additional baseline work to characterize current fish health is unnecessary. Our rationale is the same as that described in 8.0 above.

For Funeral Creek, we recommend collecting condition data on juvenile bull trout, given sculpins do not appear to occupy Funeral Creek. A juvenile occupancy study is already planned as part of the mine's AEMP to monitor potential impacts of mine discharge on bull trout migrating or rearing in Prairie Creek, downstream of the mine's discharge. As part of the existing draft AEMP, lengths of juvenile fish will be recorded. It would be little incremental effort to also record weights of juvenile fish, so that fish condition could be monitored.

REFERENCES

Canadian Council of Ministers of the Environment. 2002. Canadian water quality guidelines for the protection of aquatic life: Total particulate matter. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

COSEWIC. 2012. COSEWIC assessment and status report on the Bull Trout *Salvelinus confluentus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 103 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

[DFO] Department of Fisheries and Oceans. 2010. The Dolly Varden Story, Feature Article, located at http://www.dfo-mpo.gc.ca/science/publications/article/2010/10-18-10-eng.html

Hastings MC, Popper AN. 2009. Effects of sound on fish, Subconsultants to Jones & Stokes Under California Department of Transportation Contract No. 43A0139, Task Order 1, Sacramento, CA 95818, January 28, 2005

Hatfield. 2015. Prairie Creek Proposed All Season Road – Stream Crossing Habitat Assessments, August and September, 2014.

Hatfield. 2014. Prairie Creek Mine, Aquatic Effects Monitoring Program, Draft No. 2, Prepared for Canadian Zinc Corporation, Vancouver, BC, January 2014, CZN6335.3

Hatfield. 2012. Metals in muscle tissue of bull trout and Arctic grayling in Prairie Creek and other regional streams, July 2012, Power point presentation given to the Makenzie Valley Land and Water Board, Yellowknife, NWT, November, 20, 2012

Holt DE, Johnston CE. 2015. Traffic noise masks acoustic signals of freshwater stream fish. Biological Conservation, 187:27-33

Kiggiak-EBA Consulting Ltd. 2011. Environmental Impact Statement For Construction Of The Inuvik To Tuktoyaktuk Highway, NWT, report written for the Hamlet of Tuktoyaktuk, Town of Inuvik, and the Government of Northwest Territories, EIRB file NO. 02/10-05

McPhail JD, Baxter JS. 1996. A review of Bull Trout (*Salvelinus confluentus*) life history and habitat use in relation to compensation and improvement opportunities. Fisheries Management Report No. 104, British Columbia Ministry of Environment, Lands and Parks, Victoria, British Columbia. 35 pp.

Mackenzie Valley Environmental Impact Review Board. 2015. Adequacy Review: Prairie Creek All Season Road. Canadian Zinc Corporation. EA 1415-01. May 22, 2015.

Mochnacz NJ, Bajno R, Reist JD, Low G, Babaluk JA. 2013. Distribution and Biology of Bull Trout (*Salvelinus confluentus*) in the Mackenzie Valley, Northwest Territories, with Notes on Sympatry with Dolly Varden (*Salvelinus malma*), Arctic, 66:79 – 93, March 2013.

Mochnacz NJ. 2012. Preliminary Findings of Research Investigating Habitat Use, Movement Patterns , and Population Structure of Bull Trout in the Prairie Creek Watershed. Fisheries and Oceans Canada.

Montana Fish, Wildlife and Parks. 2015. Bull Trout — *Salvelinus confluentus*. Montana Field Guide. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. Retrieved on August 5, 2015, from http://FieldGuide.mt.gov/speciesDetail.aspx?elcode=AFCHA05020

Parris KM. Ecological Impacts of Road Noise and Options for Mitigation, in van der Ree R., D.J. Smith, C. Grilo,. 2015. Handbook of Road Ecology, Published Online: 24 APR 2015, DOI: 10.1002/9781118568170.ch19, John Wiley & Sons, Ltd.

Polster D. 2013. Making Sites Rough and Loose: A soil adjustment technique, Boreal Reclamation Program, Poreal Research Institute, Technical Note, June 2013.

Polster D. 2003. Soil Bioengineering for Slope Stabilization and Site Restoration. Paper presented at the Sudbury 2003: Mining and the Environment III, May 25-28, 2003, Laurentian University, Sudbury, Ontario Canada.

Popper AN, Hastings MC. 2009. Review paper, The effects of anthropogenic sources of sound on fishes, J of Fish Biol, 75:455-489.

Scrimgeour GJ, Bowman MF. 2011. Comparisons of chemical signatures of metals in multiple endpoints in two northern rivers: an evaluation of surrogates to monitor metals in sentinel fish. Internal report produced by Parks Canada Agency, Western and Northern Service Centre, Calgary, Alberta. 66 pp.

Stewart DB, Mochnacz NJ, Sawatzky CD, Carmichael TJ, Reist JD. 2007a. Fish life history and habitat use in the Northwest Territories: Bull Trout (*Salvelinus confluentus*). Canadian Data Reports of Fisheries and Aquatic Sciences No. 2801. Central and Arctic Region, Fisheries and Oceans Canada, Winnipeg, Manitoba. 46 pp.

Stewart DB. 2003. Possible Impacts on Overwintering Fish of Trucking Granular Materials Over Lake and River Ice in the Mackenzie Delta Area. Canada/Inuvialuit Fisheries Joint Management Committee Report 2003-1: v + 12 p.

Wright DG, Hopky GE. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

ATTACHMENTS

Attachment A

Stream Biographies

Attachment A Stream Biographies, Habitat Descriptions of Selected Stream Crossings – Prairie Creek Mine All-season Road

Overview

The proposed all-season road connects the Prairie Creek Mine with the Liard Highway, and is over 170 km long. Much of the road follows the alignment of the approved winter road. The first 17 km, from the Mine to the headwaters of Funeral Creek and Sundog Creek already has a constructed all-season road bed that was created in the early 1980's. Km 0-40 was approved as an all-season road following a previous EA process. The all-season road parallels Prairie Creek (Km 0 to 6.6), Fast Creek (Km 6.6 to 7.5), Funeral Creek (Km 7.5 to 17), Sundog Creek (Km 17 to 39.6), Grainger River (Km 122.5 to 126.3), and Liard River (Km 160 to 174). The streams parallel to the road are outside DFO's 30-m riparian corridor, with the exception of:

- Most of Funeral Creek;
- Much of Sundog Creek; and
- Portions of Grainger River.

The road right-of-way was largely dictated by feasibility, grade and therefore safety considerations. This resulted in the proximity of the road to Sundog Creek, where the valleys tend to be steep and the road is confined in places by an active creek channel, historical outwash, rock walls and talus slopes.

The road crosses numerous small creeks and eight larger streams/rivers (i.e., larger than 2 m across). The following paragraphs provide descriptions of the aquatic habitat at the key proposed all-season road stream crossings. The focus is primarily on waterbodies that are large and/or likely to provide habitat to fish. The km distance marker on the all-season road is shown first, and the corresponding distance on the previously-approved winter road is provided in brackets for reference purposes.

The site-specific information provided here is intended to complement stream information already presented in the all-season road DAR (Section 4.3.1, p 72-80).

Stream-specific information

Prairie Creek Overview. The all-season road that runs parallel to Prairie Creek is pre-existing. The road is generally outside the 30-m riparian buffer zone. Prairie Creek in this section tends to be highly braided. Previous studies indicate that Prairie Creek is highly oligotrophic and has low densities of fish (Spencer 2008, Bowman 2009). Bull trout, slimy sculpin, and whitefish have been documented throughout Prairie Creek, while Arctic grayling, burbot, and white sucker are documented in lower reaches of Prairie Creek near its confluence with the Nahanni River (Beak 1982). Pools occur infrequently, but some are capable of providing overwintering habitat both downstream and upstream of the Mine. Most pools upstream of the park boundary occur at the interface of the valley bottom and bedrock walls (Rescan 1994). Riffles, rapids and runs occur in equal proportions; riffles are common where the stream is divided, and runs where the stream is a single channel (Rescan 1994). Substrates are predominately gravel and cobbles (95%), with boulders (5%), and very little sand or silt (Rescan 1994).

Km 6.2 (6.2 km), Casket Creek crossing. There is an existing bridge at this crossing, and culverts for high water channels where the road crosses an alluvial floodplain. The presence of bull trout (Neil Mochnacz pers com July 30, 2013) has been noted. The creek has a high gradient and much of the flow is cascade/pool morphology, but riffle/run habitat can be found in the large debris fan near the confluence with Prairie Creek.

Funeral Creek Overview. Funeral creek is a dynamic, high-gradient creek. Much of the flow is riffle, with some step-pool morphology (Dillon 2005). Substrate tends to be largely bedrock and large angular substrates (Rescan 1994). Several studies (Neil Mochnacz DFO, pers com August 2013) have demonstrated the presence of juvenile bull trout, indicating its importance to the spawning and rearing of this species. Bull trout are fall spawners and their embryos develop through the winter; therefore, good water quality over this period is especially important. Riparian vegetation bordering the creek consists of small plants, shrubs and small coniferous trees (Figure 1 and 2). The vegetation tends to be fairly sparse, limited by bedrock outcropping and unstable slopes. The all-season road parallels Funeral Creek from its confluence with Fast Creek to its headwaters. Where the road is within 30 m of the stream, it is generally restrained by bedrock or talus slopes. Consequently, road widening in these areas, if required, should result in minimal additional loss of riparian vegetation.

Figure 1 Funeral Creek near mouth.

Photo looking east.

Figure 2 Funeral Creek approximately 3 km from mouth.

Photo looking east.

Figure 3 Funeral Creek near Km 12.8, downstream of crossing.

Photo looking east.

Km 13.4 (13.4 km), Funeral Creek tributary crossing. The proposed crossing occurs near the headwaters of the stream. In this area, the gradient is much steeper and is believed to act as a barrier to fish migration (Figure 3). Electrofishing conducted in the upper reaches of Funeral Creek (downstream of the crossing) in July 2013 by Hatfield and CZN staff did not yield fish (whereas further downstream fish were caught). Based on observations made while at the site, it is unlikely that bull trout would be found at the crossing location. The same is true for other headwater crossings up to the pass.

Sundog Creek Overview. The proposed all-season road follows Sundog Creek from its headwaters (km 17) to Cat Camp (km 40). From Km 29-40, the river meanders through a large flood plain and habitat is subject to washouts (Rescan 1995). Most habitat consists of riffle and runs with the occasional pool. Substrate generally consists of cobble, boulders and gravel. Riparian zones generally have little vegetation, consisting largely of talus slopes, rock faces, rock benches and debris fields from historical slides. Where riparian vegetation does exist, it tends to be sparse, consisting of small plants, shrubs and coniferous trees. In lower portions, extensive gravel bars limit the riparian zone adjacent to the active channel. During flood events, multiple channels can be active and dynamic in terms of location, limiting the growth of riparian vegetation (Golder 2008). The presence of Arctic grayling and slimy sculpin have been confirmed in Sundog Creek (Golder 2008, Hatfield 2014). Most fish habitat appears to be suitable for rearing and migration. The majority of substrate observed tended to be too coarse for grayling spawning. Sculpin spawn on the underside of large rocks or rock faces and therefore, spawning opportunities for sculpins on stream boulders does not appear to be limiting. During fall and winter much of the stream flow goes subterranean, notably a 1.5 km section near KP36, and it appears that there is little if any overwintering potential. Even deep pools in the area have been found dry in the fall (CZN, pers. comm.). However the presence of slimy sculpin in the creek would indicate that there is sufficient flow to keep these fish alive. Golder (2008) stated that residual pool habitat in lower Sundog becomes critical habitat that supports fish populations during periods of low flow.

Km 20.3 (20.3 km), Sundog Creek crossing. This crossing is in the headwaters of Sundog Creek and upstream of a large waterfall, located near Km 25. Due to the size of the waterfall (approximately 10 m; Dillon 2005), it is highly unlikely that fish would be able to migrate upstream and consequently it is unlikely that fish would be found here. Electrofishing upstream of the waterfall by Golder (2008) found no fish.

Km 23.5 (23.2 km), Sundog Creek crossing. Similar to Km 20.3, this crossing is in the headwaters of Sundog Creek and upstream of the large waterfall near Km 25. Consequently it is unlikely that fish would reside here. Electrofishing upstream of the waterfall by Golder (2008) found no fish.

Km 25.3 (NA - new crossing, no winter road crossing here), Sundog Tributary crossing. This tributary to Sundog Creek flows through a very steep bedrock chute at the site of the crossing. There are also several metre-high waterfalls near the crossing. It is unlikely that fish would inhabit the tributary near the site of the proposed crossing.

Km 28.4 (28.4 km), Sundog Creek crossing. This crossing is in the headwaters of Sundog Creek. The creek here is approximately 5 m wide and consists primarily of riffle and fall morphology. The substrate is primarily cobble and boulder and there is little riparian vegetation on either side of the creek. David Harpley, Canadian Zinc, observed grayling in a pool nearby indicating fish use of this section of Sundog (David Harpley pers com September 28, 2015). Based on the coarse nature of the substrate, fish would likely use the section of creek near the crossing for migration and rearing only. The habitat at the proposed crossing is not unique to Sundog Creek in this area.

Figure 4 Sundog Creek at Km 28.4, September 22, 2014.

Photo looking east (downstream).

Km 28.9 (29.2 km), Sundog Creek crossing. This crossing is in the headwaters of Sundog Creek. The creek here is approximately 8 m wide and consists primarily of riffle and fall morphology. The substrate is primarily cobble and boulder. Based on the cobble-boulder substrate, fish would likely use the section of creek near the crossing for migration and rearing only. The habitat adjacent to the proposed crossing is not unique to Sundog Creek in this area.

Km 37 (36.9 km), Sundog Creek realignment location 2. In July 2014, this location contained riffle and some small pools. Flow was generally small; maximum recorded depth (in one of the pools) was 0.72 m. There was little instream and no riparian cover. No fish were captured by electrofishing in this location, but both Arctic grayling and slimy sculpin were caught less than 1 km downstream (DAR Appendix 10) and therefore it is anticipated that both these species may use this location during higher water. Based on available habitat, the location likely provides some rearing habitat for Arctic grayling and possibly some spawning habitat for sculpins; however, the habitat did not appear to be unique to the area.

Figure 5 Sundog Creek at Km 37.5, July 27, 2014.

Photo looking east (downstream).

Km 37.7 (37.6 km), Sundog Creek realignment location 1. In July 2014, this location contained rapids, riffle, a pool, and maximum depth was 1.4 m. There is instream cover provided by cobble, boulders and the vertical face of a rock wall. Electrofishing yielded Arctic grayling and slimy sculpin upstream and downstream of the pool (DAR appendix 10). Most fish were recovered from a small upstream side-channel flowing along a talus slope. The location likely provides some rearing habitat for Arctic grayling and sculpins, and possibly some spawning habitat (both species spawn in the spring). For spawning, grayling would prefer the small riffle zone at the pool tail out. It is unknown if the pools located at this location provide any overwintering habitat; however, it is expected that the depth of the pool in winter would be much shallower than it was in July 2014 and therefore less than 1 m deep. Therefore it is likely that this pool freezes to depth in winter.

Figure 6 Sundog Creek at Km 38.1, July 27, 2014.

Photo looking southwest (upstream).

Km 39.4 (39.8 km), Sundog Creek tributary crossing. This is a large tributary to Sundog creek, joining Sundog at the upstream extent of Cat Camp. At the time of the September 2014 field visit the creek bed was dry. There is staining on rocks suggesting that the tributary drains a mineralized area. Substrate is primarily cobble, with smaller proportions of sand and boulders. There are no known obstructions to fish movement; and therefore it is assumed that Arctic grayling and possibly slimy sculpin inhabit this tributary when water levels are sufficient (likely in the spring). Beak (1981) stated that this tributary has no overwintering habitat, but stated that grayling likely use the tributary for spawning.

Figure 7 Tributary to Sundog creek (bottom middle) and Sundog Creek (top half), as seen from air, looking east (downstream) towards Cat Camp.

Photo looking northeast (downstream).

Km 43.3 (43.0 km), Sundog tributary crossing. This crossing is located on a small tributary to Sundog Creek, approximately 2.5 km upstream of the confluence. Downstream of the crossing, flow runs over more than 400 m of exposed bedrock. Flow is fast and shallow following a series of bedrock chutes and pools, and there are several small waterfalls. It is unlikely that fish will be able to swim up this tributary. At the crossing, habitat appears to be better, consisting of a meandering, unconfined channel with side bars and overhanging banks (Dillon 2005). Stream morphology consisted of 60% riffle, 20% run and 20% pool, and substrate consisted of angular gravel and cobble. Average wetted width at low stage was 2.1 m (Dillon 2005). Despite the presence of good habitat near the crossing location, electrofishing conducted by Dillon (2005) and CZN/Parks employees (Hatfield 2014) near the proposed crossing did not yield any fish.

Km 46.2 (47.0 km) Polje tributary crossing. The creek at this crossing location is small (approximately 0.5 m wide and 17 cm deep in September 2014), with a sand/silt bottom, run-type morphology and good riparian cover. The maximum water velocity at the crossing was 0.3 m/s in September 2014; however, flow was observed going to ground in several locations under sloughed banks. It is anticipated that the creek would freeze to bottom in winter. The creek is unlikely to provide much habitat to fish, if juvenile fish did swim up the creek during higher spring flows, it is possible that they may become stranded during summer.

Figure 8 Tributary to Poljie Creek at km 47.0, September 21, 2014.

Km 49.6 (50.2 km) Polje tributary crossing. The creek at this crossing location is small (approximately 0.5 m wide and 30 cm deep in September 2014), with a sand/silt bottom, run-type morphology and good riparian cover. The maximum water velocity at the crossing in September 2014 was 0.12 m/s. The tributary creek would likely freeze to bottom in winter; however, it may provide rearing habitat for juvenile fish.

Km 53.5 (54.3 km) Polje tributary crossing. The creek at this crossing location is small (approximately 1.6 m wide and 17 cm deep in September 2014), with gravel and cobble substrate, run/pool morphology and good riparian cover. The maximum velocity at the crossing in September was slow, 0.046 m/s. The tributary creek would likely freeze to bottom in winter; however, it may provide rearing habitat for juvenile fish.

Figure 9 Tributary to Polje Creek at Km 53.5, July 28, 2014.

Km 53.6 (54.4 km) Polje Creek main-stem crossing. Polje Creek at the crossing location had a wetted width of 8 m wide in July 2014, and is primarily run and riffle habitat. The maximum depth measured at this location was just over 1 m on July 8, 2012. Beak (1982) observed Arctic grayling during a spring sampling program. Subsequent assessments conducted by Dillon found no fish (2005, 2009); however, they stated that "the fish habitat characteristics were of high quality with a diversity of cover and habitat types…". Grayling are spring spawners; therefore it is possible that fish use Polje Creek only for spawning, which might explain their absence in September when electrofishing was conducted. Substrate at the crossing was primarily gravel with smaller proportions of sand and cobble. With the exception of water depth, there is little cover for fish at the crossing location. However upstream and downstream of the crossing there are undercut banks, overhanging vegetation and large woody debris at the edges of the channel (Dillon 2009). Polje Creek is fed partly by the poljes (i.e., large elliptical depression in karst regions, sometimes containing a lake) to the south and can dry up in summer. Dave Harpley noted that the channel at the crossing was completely dry during a site visit on July 8, 2015 (pers comm. July 28, 2015).

Figure 10 Poljie Creek (Km 53.6), July 28, 2014.

Km 57 to 62 Various small tributaries, draining to the poljes. The creeks crossed by this section of the all-season road are small ephemeral channels, draining to the poljes. It appears that they would be dry much of the year, and would provide limited habitat to fish, if they were accessible, which is unlikely since the lower (First) polje has no surface outlet.

Km 63.6 (64.6 km) Inlet to Mosquito Lake crossing. An airborne assessment was conducted of a small drainage area feeding into Mosquito Lake on July 28, 2014. A ground assessment was made previously in July 2012 as part of bathymetry work. Flow from Mosquito Lake is known to drain to the Poljes, which are inaccessible to migrating fish. However, there is a possibility that Mosquito Lake hosts a resident population (Ker Priestman 1981, as cited in the DAR). From the air, the inflowing drainage appeared to originate from a series of small wetlands (Figure 11). The small channels connecting the wetlands to Mosquito Lake appeared to be low-gradient and filled with aquatic vegetation. The habitat value of the wetlands appears to be similar to the littoral habitat of Mosquito Lake, containing abundant aquatic vegetation. It is unlikely that the channel and upstream habitat provide critical habitat, but they may provide incidental habitat for fish during open water seasons

Figure 11 Inlet of Mosquito Lake, looking upstream away from lake (km63.6), July 28, 2014.

Km 87.2 (87.7 km) Tetcela River tributary crossing. This creek is the main tributary to the Tetcela River. Habitat consists primarily of riffle and run-type morphology and bottom substrate is primarily cobble and boulder at the crossing. Maximum velocity at the crossing in September 2014 was 0.11 m/s, and the stream was 5 m wide, with a maximum depth of 39 cm. Lots of large woody debris was observed on the left bank in September 2014. Dillon (2005) also noted good cover habitat provided by large woody debris, boulders and cut banks. This creek will likely have the same species as the Tetcela River, since there were no observed obstructions to fish movement. Dillon (2005) observed Arctic grayling juveniles holding in a side channel pool. Beak (1982) stated that there is no overwintering habitat in tributaries to the Tetcela; however, Rescan (1995) reported the presence of spawning and rearing habitat. The fish habitat at the crossing does not appear to be unique to the tributary in the area.

Km 89.7 (89.7 km) Tetcela River main-stem crossing. The Tetcela River at the proposed crossing location has primarily run-type morphology with some riffle and bottom consists largely of cobble and gravel with smaller proportions of sand (Hatfield 2014). In September 2014, the wetted width at the crossing was 15 m with a maximum depth of 22 cm. Maximum velocity at the crossing was 0.68 m/s. Tetcela River is known to provide habitat to Arctic grayling, pike, lake chub, longnose dace, burbot, slimy sculpin and longnose sucker (Beak 1981, Rescan 1995). Beak (1981) stated that the Tetcela River is prone to large woody debris due to natural bank erosion, and Beak (1981) noted high turbidity in the spring due to a large natural bank slide approximately 5 km upstream of the crossing. Arctic grayling likely use Tetcela for spawning (Beak 1982). Rescan (1995) stated that there is potential spawning substrate throughout.

Figure 12 Tetcela River Mainstem (Km 89.7), September 24, 2014.

Km 94.9 (95 km) Fishtrap Creek crossing. The creek at this crossing is primarily wetland-type habitat (Rescan 1995). Flow is very low and the channel appears to be deep and filled with macrophytes. Aquatic insects were observed near the crossing locations in July 2014, but no fish were observed. A winter assessment of water quality indicated that oxygen concentrations were too low to support overwintering fish (Beak 1981). A fish survey conducted by Beak (1982) was unsuccessful in catching any fish. The low flow and large density of macrophytes in the channel suggest oxygen concentrations in the channel at night would be low when plants shift from a primarily photosynthetic to a metabolic mode. Beaver dams were visible both up and downstream of the crossing (Dillon 2005). Hence, habitat for fish is poor, and multiple beaver dams likely prevent fish from accessing this section of Fishtrap Creek.

Figure 13 Fishtrap Creek (Km 94.9), July 28, 2014

Km 122.4 (122.8 km) Grainger tributary crossing. The creek at this crossing is primarily riffle and run-type morphology, with bottom substrates consisting primarily of boulder, sand and cobble, and there is moderate instream cover. In September 2014, channel wetted width at the crossing was approximately 1.6 m, with a maximum depth of 24 cm. Maximum velocity was 0.132 m/s. Grainger River main is known to provide habitat to Arctic grayling, pike, lake chub, longnose dace and slimy sculpin. It is conceivable that some of these species may reside in this tributary at the crossing site for part of the year. The tributary at this location will freeze to bottom over winter. If the alternate road alignment is used, this crossing will be avoided. The alternate alignment crosses the valley between the Silent Hills and Nahanni First Range further north. In doing so, it crosses a wetland system (associated with Unnamed Creek) not dissimilar to the Fishtrap crossing, and habitat is expected to be similar. Further south nearer Grainger Gap, the alternate alignment crosses a peak flow outwash channel which is a tributary to Grainger River, and consists of cobbles and boulders. The channel is likely dry except during intense rainfall, high runoff events, and therefore unlikely to be fish habitat.

Grainger River. The portion of the Grainger River paralleling the all-season road is a braided channel located on a wide floodplain with large gravel bars and confined on the south by bedrock outcrops (Dillon 2005). The average wetted width in September 2005 was 5.2 m, while the average depth was 0.3 m. Riffle dominates the channel morphology, and substrate was described as gravel and cobble (Dillon 2005). Grainger River is known to provide habitat to Arctic grayling, pike, lake chub, longnose dace and slimy sculpin. Arctic grayling likely use Grainger River for spawning (Beak 1982), and Rescan (1994) also stated that there is potential spawning habitat throughout.

Km 123.4 (123.7 km) Grainger River crossing. The river at this crossing is largely riffle and run morphology, with bottom substrates consisting mostly of boulder and cobble In September 2014, the river at this location was approximately 6 m wide, with a maximum depth of 23 cm. Maximum flow velocity at the crossing was 0.954 m/s. Fish species, listed above, likely overwinter in Gap Lake, approximately 1km upstream of this crossing. Habitat at the crossing does not appear to be unique to the area. If the alternate road alignment is used, this crossing will also be avoided.

Figure 14 Grainger River at Km 123.4, July 29, 2014.

Photo looking southeast (downstream).

Km 124.8 (125.1 km) Grainger River crossing. The river at this location is largely riffle and run morphology, with bottom substrates consisting mostly of boulder, cobble and gravel. In September 2014, the river at this location was approximately 10 m wide, with a maximum depth of 28 cm. Maximum velocity at the crossing was 0.54 m/s. Fish species, listed above, likely overwinter in Gap Lake, approximately 2.5 km upstream of this crossing. Habitat at the crossing does not appear to be unique to the area.

Km 131.2 (131.3 km) Grainger tributary crossing. The stream at this location is primarily riffle morphology, with bottom substrates consisting largely of boulder, cobble, gravel and sand. There appeared to be good instream and riparian cover. In September 2014, the tributary at the crossing was approximately 0.85 m wide with a maximum depth of 10 cm. Maximum measured velocity was 0.38 m/s. It is possible that some species resident in Grainger River will use this tributary for rearing; however substrates appeared too coarse for spawning. This tributary will likely freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Figure 15 Tributary to Grainger River (Km 131.2), September 26, 2014.

Km 133.2 (133.7 km) Grainger tributary crossing. The creek at this crossing has primarily riffle morphology with coarse substrates. In September 2014, the tributary at the proposed crossing was approximately 1 m wide, with a maximum depth of 13 cm. Maximum velocity recorded at the crossing was 0.25 m/s, and there appeared to be good instream and riparian cover. It is possible that some species resident in Grainger River will use this tributary for rearing; however substrates appeared too coarse for spawning. This tributary will likely freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Km 134.9 (135.6 km) Grainger tributary crossing. The creek at this crossing has primarily run and riffle morphology, with substrates consisting largely of gravel with smaller portions of silt, boulder and sand. In September 2014, the creek was approximately 1 m wide at the crossing with a maximum depth of 10 cm. Maximum velocity at the crossing was 0.23 m/s and there was good instream and riparian cover. It is possible that some species resident in Grainger River will use this tributary for spawning and rearing, since the substrate has a higher proportion of gravel and sand than other sites. This tributary will likely freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Figure 16 Tributary to Grainger River (Km 134.9).

Km 136.5 (136.7 km) Grainger tributary crossing. The creek at this crossing has primarily riffle morphology, with substrates consisting primarily of cobble. In September 2014, the creek was approximately 0.7 m wide with a maximum depth at the crossing of 8 cm. Maximum velocity measured at the crossing was 0.24 m/s. and there appeared to be good instream and riparian cover. It is possible that some species resident in Grainger River will use this tributary for rearing; however substrates appeared too coarse for spawning and flows in fall appeared to be insufficient for fish. This tributary will likely freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Bluefish Creek. Bluefish creek was not assessed because the proposed road alignment does not cross this catchment. Also, the headwaters consist of a series of wetlands and beaver dams, almost as far south as a tributary flowing from Bluefish Lake. Harvesting occurred from Bluefish Lake, approximately 2 km from the road alignment east of the Front Range, and from lower Bluefish Creek downstream of the lake (David Harpley, CZN, pers com August 26, 2015).

Km 144.0 (144.7 km) Liard tributary crossing. The small creek at this crossing is immediately downstream of Triangle Lake. Habitat is primarily pool and slow riffle, the tributary is approximately 1 m wide. Water velocity at the crossing was not measured, but appeared to be low. There appears to be good instream and riparian cover. The presence of fish has not been assessed; however, the crossing is just upstream and downstream of beaver dams, which likely impede fish migration. There were also other beaver dams further downstream. The tributary will freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Figure 17 Tributary to Liard River (creek draining Triangle Lake, Km 144.0), September 25, 2014.

Km 154.9 (154.4 km) Liard tributary crossing. The small creek at this crossing has primarily riffle morphology, with substrates consisting primarily of sand and gravel. In September 2014, the creek at the crossing was approximately 0.75 m wide, with a maximum depth of 10 cm. There was good instream and riparian cover. The tributary will freeze to the bottom in winter. Habitat at the crossing does not appear to be unique to the area.

Figure 18 Tributary to Liard River (Km 154.9), September 23, 2014.

Attachment B

Crossing Habitat Matrix

Attachment B Crossing habitat matrix.

Watershed	Location	All Season Road KM	Winter Road KM	Coordinates	Hatfield Data: Date of Hatfield Visits	Hatfield Data: Assessment from Air Only	Hatfield Data: Site Visit	Hatfield Data: Habitat Sheet Filled Out	Hatfield Data: Hydrometric Data Recorded	Hatfield Data: Discussed in Memos to Parks (from DAR Appendices 8 & 10)	Fish Data (Collected in Stream): Fished	Fish Data (Collected in Stream): Documented Fish Presence	Fish Data (Collected in Stream): Species	Fish Data (Collected in Stream): Tissue Chemistry	Fish Data (Collected in Stream): Health Data	Fish Habitat Data (Collected At Proposed Crossing): Obstruction to Fish Passage	Fish Habitat Data (Collected At Proposed Crossing): Probability of Fish Presence	Fish Habitat Data (Collected At Proposed Crossing): Possible Fish Habitat	Fish Habitat Data (Collected At Proposed Crossing): Possible Habitat at Crossing	Fish Habitat Data (Collected At Proposed Crossing): Uniqueness of Habitat at Crossing	Fish Habitat Data (Collected At Proposed Crossing): Photos (from DAR Appendix 9)
Prairie Creek	Casket Creek	6.2	6.2	--	NA	-	X	-	-	-	-	X	BT	-	-	-	High	X	M, R	Not Unique	
Prairie Creek	Funeral Creek	13.4	13.4	--	NA	-	X[9]	-	-	-	X	X	BT	-	X[3]	X[c,9]	Low	NA	NA	NA	
Sundog Creek	Sundog Creek	20.3	20.3	--	NA	X	-	-	-	-	X[1,6]	X	ARGR, SLSC	-	X[1]	X[b]	Low	NA	NA	NA	
Sundog Creek	Sundog Creek	23.5	23.5	--	NA	X	-	-	-	-	X[1,7]	X	ARGR, SLSC	-	X[1]	X[b]	Low	NA	NA	NA	
Sundog Creek	Tributary to Sundog Creek	25.3	25.3	--	NA	-	-	-	-	-	-	-	-	-	-	X[f]	Low	NA	NA	NA	
Sundog Creek	Sundog Creek	NR	27.1	10 V 418911 6828332	22-Sep	-	X	X	-	-	X[1]	X	ARGR, SLSC	-	X[1]	-	High	X	M, R	Not Unique	1 to 5
Sundog Creek	Sundog Creek	NR	27.5	10 V 419225 6828089	22-Sep	-	X	X	-	-	X[1]	X	ARGR, SLSC	-	X[1]	-	High	X	M, R	Not Unique	6 to 11
Sundog Creek	Sundog Creek	28.4	See Note	--	22-Sep	-	X	X	X	-	X[1]	X	ARGR, SLSC	-	X[1]	-	High	X	M, R	Not Unique	12 to 15
Sundog Creek	Sundog Creek	28.9	29.2	10 V 420601 6827089	23-Sep	-	X	X	-	-	X[1]	X	ARGR, SLSC	-	X[1]	-	High	X	M, R	Not Unique	16 to 19
Sundog Creek	Sundog realignment Location 2	37	37.3	10 V 426324 6829305	27-Jul	-	X	X	-	X	X[1,6,8]	X	ARGR, SLSC[9]	-	-	-	High	X	M, R	Not Unique	23 to 29
Sundog Creek	Sundog realignment Location 1	37.7	38.1	10 V 427040 6829338	27-Jul	-	X	X	-	X	X[1,6,8]	X	ARGR, SLSC[9]	-	-	-	High	X	M, R	Not Unique	31 to 38
Sundog Creek	Tributary to Sundog	39.4	39.8	10 V 428369 6830273	21-Sep	-	X	X	X	-	X[1]	X	ARGR, SLSC	-	-	-	High	X	M, R	Not Unique	40 to 47
Sundog Creek	Tributary to Sundog	43.3	43.5	10 V 431394 6830360	27-Jul	-	X	-	-	X	X[4,8]		-	-	-	X[h]	Low	X[d]		Not Unique	48 to 52
Polje Creek	Polje Ck Trib	45.5	46	10 V 433630 6829300	21-Sep	-	X	-	-	-	-	-	-	-	-	X	Low	-		Not Unique	53 to 55
Polje Creek	Polje Ck Trib	46.2	47	10 V 434240 6829338	21-Sep	-	X	X	X	-	-	-	-	-	-	-	Low	-		Not Unique	56 to 60
Polje Creek	Polje Ck Trib	48.6	49.1	10 V 436400 6829000	21-Sep	-	X	-	-	-	-	-	-	-	-	X	Low	-		-	61 to 63
Polje Creek	Polje Ck Trib	49	49.4	10 V 436740 6829190	21-Sep	-	X	-	-	-	-	-	-	-	-	X	Low	-		-	64 to 66

Attachment B (Cont'd.)

Watershed	Location	All Season Road KM	Winter Road KM	Coordinates	Hatfield Data						Fish Data (Collected in Stream)					Fish Habitat Data (Collected At Proposed Crossing)					
					Date of Hatfield Visits	Assessment from Air Only	Site Visit	Habitat Sheet Filled Out	Hydrometric Data Recorded	Discussed in Memos to Parks (from DAR Appendices 8 & 10)	Fished	Documented Fish Presence	Species	Tissue Chemistry	Health Data	Obstruction to Fish Passage	Probability of Fish Presence	Possible Fish Habitat	Possible Habitat at Crossing	Uniqueness of Habitat at Crossing	Photos (from DAR Appendix 9)
Polje Creek	Polje Ck Trib	49.6	50.2	10 V 436944 6829737	21-Sep	-	X	X	X	-	-	-	-	-	-	-	Low	-		Not Unique	67 to 69
Polje Creek	Polje Ck Trib	53.4	54.2	10 V 440405 6830704	28-Jul	-	X	-	-	-	-	-	-	-	-	-	Low	X		Not Unique	70 to 72
Polje Creek	Polje Ck Trib	53.5	54.3	10 V 440509 6830759	28-Jul	-	X	X	-	X	-	-	-	-	-	-	Low	X		Not Unique	73 to 79
Polje Creek	Polje Creek	53.6	54.4	10 V 440622 6830769	26-Sep and 28-Jul	-	X	X	X	X	X[2]	X	ARGR	-	-	-	High	X[5]	S	Not Unique	80 to 86
Poljes (lakes)	Creeks draining to Poljes	56 to 62		--	28-Jul	X	-	-	-	X	-	-	-	-	-	X	Low	-		Not Unique	
Mosquito Lake	Inlet to Mosquito Lake	63.6	67	10 V 446766 6825508	28-Jul	X	-	-	-	X	-	-	-	-	-	X	Low	-		Not Unique	88 to 89
Tetcela River	Tetcela main tributary (Tetcela first crossing)	87.2	87.7	10 V 460369 6813941	24-Sep	-	X	X	X	-	-	-	-	-	-	-	High	X	M, R, S	Not Unique	90, 91, 94 to 97
Tetcela River	Tetcela River second crossing	89.7	90.1	10 V 461330 6815569	28-Jul and 24-Sep	X	X	X	X	X	X[1,3]	X	ARGR, PIKE, LACH, LODA, BURB, SLSC	X[3]	X[1]	-	High	X	M, R	Not Unique	98 to 103
Fishtrap Creek	Fishtrap Creek	94.9	94.9	10 V 465062 6813912	28-Jul	-	X	-	-	X	[1]	-	-	-	-	X[a]	Low [a]	X[a]	M, R	Not Unique	104 to 109
Grainger River	Grainger Trib (via Gap Lake)	122.4	122.8	10 V 477151 6798715	23-Sep	-	X	X	X	-	[4]	-	-	-	-	-	High	-	-	Not Unique	111 and 112
Grainger River	Grainger Main	123.4	123.7	10 V 478319 6799043	23-Sep	-	X	X	X	-	[4]	X	ARGR, PIKE, LACH, LODA, SLSC	-	X[1]	-	High	X	M, R	Not Unique	128 to 134
Grainger River	Grainger Main	124.8	125.1	10 V 479157 6799517	23-Sep	-	X	X	X	-	X[1]	X	ARGR, PIKE, LACH, SLSC	-	X[1]	-	High	X	M, R	Not Unique	135 to 139
Grainger River	Grainger Trib	131.2	131.3	10 V 481988 6794966	26-Sep	-	X	X	X	-	-	-	-	-	-	-	Moderate	-	-	Not Unique	140 and 142
Grainger River	Grainger Trib	133.2	133.7	10 V 482671 6793161	24-Sep	-	X	X	X	-	-	-	-	-	-	-	Moderate	-	-	Not Unique	143 to 145
Grainger River	Grainger Trib	134.9	135.6	10 V 482380 6791274	25-Sep	-	X	X	X	-	-	-	-	-	-	-	Moderate	-	-	Not Unique	146 to 149

Attachment B (Cont'd.)

Watershed	Location	All Season Road KM	Winter Road KM	Coordinates	Hatfield Data						Fish Data (Collected in Stream)					Fish Habitat Data (Collected At Proposed Crossing)					
					Date of Hatfield Visits	Assessment from Air Only	Site Visit	Habitat Sheet Filled Out	Hydrometric Data Recorded	Discussed in Memos to Parks (from DAR Appendices 8 & 10)	Fished	Documented Fish Presence	Species	Tissue Chemistry	Health Data	Obstruction to Fish Passage	Probability of Fish Presence	Possible Fish Habitat	Possible Habitat at Crossing	Uniqueness of Habitat at Crossing	Photos (from DAR Appendix 9)
Grainger River	Grainger Trib	136.5	136.7	10 V 483132 6790094	26-Sep	-	X	X	X	-	-	-	-	-	-	-	Moderate	-	-	Not Unique	150 to 152
Liard River	Liard Trib	144	144.7	10 V 486550 6784259	25-Sep		X	-	-	-	-	-	-	-	-	X[e]	Low	-	-	Not Unique	153 to 159
Liard River	Liard Trib	154.9	154.4	10 V 486500 6774900	23-Sep	-	X	X	X	-	-	-	-	-	-		Moderate	-	-	Not Unique	166 to 168

References

[1] Beak Consultants Ltd. 1981. Prairie Creek Project Fisheries and Invertebrate Studies. Prepared for Cadillac Explorations Ltd., Calgary, Alberta. September 1981, K4606.

[2] Beak Consultants Ltd. 1982. Summary Document Prairie Creek Project Water Quality and Aquatic Biology. Prepared for Cadillac Explorations Ltd., Calgary, Alberta. February 1982, K4606B.

[3] Rescan. 1994. Prairie Creek Mine; fisheries and aquatic resources baseline studies.

[4] Bathurst and Dillon. 2005. Appendix 1, Fisheries and fish habitat assessment of water course crossings and road rehabilitation areas. Canadian Zinc Prairie Creek Mine Winter Access Road Liard River (KM 175,5) to Prairie Creek Mine (km 0).

[5] Dillon Consulting Ltd. 2009. Prairie Creek mine winter road re-alignment A, B. C, re-routing to Nahanni Butte, Polje Creek Bypass Air and Ground Stream Crossing Fish Habitat Assessments. Letter to David Harpley, CZN, Written by Craig Thomas, Dillon Consulting Ltd., November 25, 2009.

[6] Golder Associates. 2008. Overview of fish compensation opportunities. Memo from J. David Hamilton, August 26, 2008, Job # 08-1365-0081.

[7] Hatfield Consultants. 2014. Habitat Assessment of Sundog Creek Channels for Realignment. Memo to Dave Harpley from John Wilcockson. September 9, 2014, CZN6788.

[8] Hatfield Consultants. 2014. All Season Road - Review of Stream Crossings in NNPR - DRAFT. Memo to Dave Harpley from John Wilcockson. September 4, 2014, CZN6788.

[9] Hatfield Consultants. 2013. Juvenile Bull Trout assessment.

[a] Fish have been observed near the mouth of Fishtrap Creek; however, the high temperature observed during a site visit in July 2014, and beaver dams, would suggest that fish are not present at the crossing. Beak 1981 measured very low DO under ice, suggesting this creek is not good for overwintering.

[b] ~10 m waterfall at km 25 prevents fish from inhabiting Sundog Creek upstream.

[c] Series of cascades with very little pooling. Electrofished, but nothing caught.

[d] Frozen to bottom in winter (Beak 1981).

[e] Beaver dam at outflow from lake and downstream. Fish passage would be difficult.

[f] Steep bedrock chute. Multiple several metre waterfalls. Braided outwash fan junction with main stem Sundog Creek.

[h] Downstream chute and high water velocity likely pose a barrier to fish.

BT=Bull Trout; ARGR = Arctic Grayling; PIKE = Northern Pike; LACH = Lake Chub; LODA = Longnose Dace; BURB = Burbot; SLSC = Slimy Sculpin

Possible Habitat-at-crossing code: M = Migration, R = Rearing, S = Spawning, OW = Overwintering

NR = New Route, therefore no comparable mileage.

Attachment C

Fish Tissue Concentrations

Attachment C **Selected analyte concentrations in fish tissue collected from multiple sources at Prairie Creek and Tetcela River (1981-2012).**

Source	Location	Species[†]	Sample ID	*n*	Analyte (µg/g)								
					Arsenic	Cadmium	Copper	Iron	Lead[1]	Mercury[2]	Nickel	Selenium[3]	Zinc
Beak 1981	Prairie Creek	SLSC	1 (M1,M1A,M2)	14	0.46*	<0.97*	3.5*	-	2.1*	0.16*	-	-	39*
	Prairie Creek	BLTR	2 (M1A,M2)	3	<0.16*	<1.2*	1.7*	-	<2.4*	<0.033*	-	-	7.2*
	Prairie Creek	BLTR	3 (M1A)	1	0.24	<0.77	1.4	-	<1.6	0.058	-	-	6.6
	Prairie Creek	BLTR	4 (M1A)	1	<0.15	<1.1	<1.1	-	<2.2	0.034	-	-	4.8
	Prairie Creek	BLTR	5 (M1A)	1	<0.21	<1.5	1.5	-	<3.1	0.048	-	-	7.8
	Prairie Creek	BLTR	6 (M2)	1	0.18	<0.83	2.2	-	<1.7	0.07	-	-	4.9
	Prairie Creek	BLTR	7 (M2)	3	<0.34*	<2.5*	3*	-	<5.0*	<0.034*	-	-	11*
	Prairie Creek	MNWH	8 (M2)	1	0.27	<0.81	0.81	-	<1.6	<0.023	-	-	5.9
	Prairie Creek	MNWH	9 (M2)	1	<0.13	<0.94	2.1	-	<1.9	<0.023	-	-	5.6
	Prairie Creek	MNWH	10 (M2)	1	<0.16	<1.2	1.7	-	<2.6	<0.03	-	-	8.1
	Prairie Creek	SLSC	11 (M4,M5)	12	0.21*	<0.78*	1.1*	-	<1.6*	0.2*	-	-	48*
	Prairie Creek	BLTR	12 (M4)	1	<0.1	<0.98	0.98	-	<2.0	0.094	-	-	4.2
	Prairie Creek	BLTR	13 (M4)	1	0.092	<0.99	<0.99	-	<2.0	0.044	-	-	4.2
	Prairie Creek	BLTR	14 (M4)	1	<0.29	<1.3	2.1	-	<2.6	<0.028	-	-	4.3
	Prairie Creek	BLTR	15 (M4,M5)	2	0.4*	<0.97*	<0.97*	-	<1.9*	0.034*	-	-	2.9*
	Prairie Creek	MNWH	16 (M5)	1	0.32	<1.5	<1.5	-	<2.9	0.033	-	-	11
	Prairie Creek	MNWH	17 (M5)	1	<0.34	<1.1	1.7	-	<2.1	0.028	-	-	4.4
	Prairie Creek	MNWH	18 (M5)	1	0.21	<1.2	2.5	-	<2.5	0.026	-	-	6.8
	Prairie Creek	MNWH	19 (M5)	1	0.25	<0.97	2.1	-	<1.9	<0.031	-	-	4.4
	Prairie Creek	MNWH	20 (M5)	1	<0.18	<1.1	2.1	-	<2.1	<0.031	-	-	4.6
Rescan 1994	Prairie Creek	SLSC	Sculpin 1	1	0.408	0.05	0.785	214	0.133	0.017	0.389	3.1	56.2
	Prairie Creek	SLSC	Sculpin 2	1	0.313	0.051	0.745	82.8	0.065	0.021	0.414	1.78	16.1
	Prairie Creek	SLSC	Sculpin 3	1	0.31	0.112	0.842	224	0.366	0.042	0.468	2.19	28.3
	Tetcela River	WHSC	Sucker	1	0.252	0.032	0.122	218	0.046	0.028	0.392	1.06	23.3
	Tetcela River	LKCH	Lake Chub	1	0.119	0.021	0.908	55.8	0.035	0.023	0.288	4.32	13.1
	Tetcela River	LKCH	Lake Chub	1	0.071	0.079	1.11	227	0.061	0.065	0.507	0.853	35.5
	Prairie Creek	BLTR	Bull Trout 1	1	0.039	0.033	0.467	72.4	0.02	0.037	0.084	0.532	14.3
	Prairie Creek	BLTR	Bull Trout 2	1	0.115	0.011	0.666	68.5	0.01	0.042	0.088	0.678	16.8
	Prairie Creek	BLTR	Bull Trout 1	1	0.085	0.005	0.655	63.5	0.014	0.03	0.07	0.754	17
	Prairie Creek	SLSC	Sculpin (wet wt)	1	0.193	0.072	1.55	22.7	0.0925	0.0216	0.431	0.944	68.2
Spencer 2009	Prairie Creek	SLSC	-	6	0.172*	0.021*	0.335*	9.525*	0.13*	0.028*	0.095*	1.25*	43.5*
	Prairie Creek	SLSC	-	6	0.142*	0.028*	0.34*	11.56*	0.172*	0.066*	0.102*	1.06*	64.6*
	Prairie Creek	SLSC	-	6	0.066*	0.016*	0.254*	6.82*	0.077*	0.078*	0.024*	1.16*	49.6*

Source	Location	Species†	Sample ID	*n*	Analyte (µg/g)								
					Arsenic	Cadmium	Copper	Iron	Lead[1]	Mercury[2]	Nickel	Selenium[3]	Zinc
Scrimgeour 2011	Prairie Creek	SLSC	PC-1	1	0.1	0.07	0.5	9.7	0.14	-	0.1	1.2	43
	Prairie Creek	SLSC	PC-2	1	0.1	0.09	0.5	19	0.04	-	0.1	1.4	49
	Prairie Creek	SLSC	PC-3	1	0.1	0.1	4.9	30	0.19	-	0.2	1.5	63
	Prairie Creek	SLSC	PC-4	1	0.1	0.34	0.5	13	0.26	-	0.1	1.3	52
	Prairie Creek	SLSC	PC-5	1	<0.1	0.08	0.5	35	0.12	-	0.2	1	68
	Prairie Creek	SLSC	PC-6	1	0.1	0.13	0.6	32	0.33	-	0.2	1.2	79
	Prairie Creek	SLSC	PC-7	1	0.1	0.07	0.5	21	0.1	-	0.1	1.3	63
Hatfield 2012	Prairie Creek	BLTR	BLTR 1 DORS	1	0.0113	0.002	0.22	2.88	0.004	0.0702	0.02	0.563	3.31
	Prairie Creek	BLTR	BLTR 2 DORS	1	0.0182	0.002	0.32	5.07	0.004	0.0833	0.02	0.429	4.36
	Prairie Creek	BLTR	BLTR 3 DORS	1	0.0113	0.002	0.17	2.32	0.004	0.0783	0.02	0.383	3.18
	Prairie Creek	BLTR	BLTR 4 DORS	1	0.0177	0.002	0.28	4.08	0.008	0.0768	0.07	0.441	4.48
	Prairie Creek	BLTR	BLTR 5 DORS	1	0.0071	0.0027	0.217	4	0.004	0.0771	0.01	0.342	2.8
	Prairie Creek	BLTR	BLTR 6 DORS	1	0.0085	0.003	0.169	1.7	0.004	0.0065	0.024	0.288	3.57
	Prairie Creek	BLTR	BLTR 7 DORS	1	0.0099	0.0034	0.171	2.78	0.008	0.0639	0.129	0.393	3.63
	Prairie Creek	BLTR	BLTR 8 DORS	1	0.0105	0.0033	0.32	4.23	0.004	0.0376	0.05	0.391	3.21
	Prairie Creek	BLTR	BLTR 9 DORS	1	0.0084	0.0025	0.169	3.01	0.004	0.0417	0.01	0.365	2.88
	Prairie Creek	BLTR	BLTR 10 DORS	1	0.0102	0.005	0.37	8.25	0.004	0.0677	0.013	0.398	3.79
	Prairie Creek	BLTR	BLTR 11 DORS	1	0.0126	0.005	0.26	3.38	0.012	0.0536	0.028	0.474	3.98
	Prairie Creek	BLTR	BLTR 12 DORS	1	0.0139	0.0045	0.25	3.48	0.004	0.0466	0.016	0.441	4.14
	Prairie Creek	BLTR	BLTR 13 DORS	1	0.0113	0.002	0.3	3.02	0.004	0.093	0.02	0.478	5
	Prairie Creek	BLTR	BLTR 14 DORS	1	0.0097	0.002	0.2	4.63	0.004	0.0905	0.03	0.355	4
	Prairie Creek	BLTR	BLTR 15 DORS	1	0.0139	0.002	0.4	3.74	0.004	0.0623	0.05	0.464	4
	Prairie Creek	BLTR	BLTR 16 DORS	1	0.015	0.002	0.3	3.46	0.004	0.0851	0.02	0.433	4.09
	Prairie Creek	BLTR	BLTR 17 DORS	1	0.0105	0.002	0.2	2.71	0.004	0.0693	0.03	0.472	4
	Prairie Creek	BLTR	BLTR 18 DORS	1	0.0121	0.002	0.2	2	0.004	0.0472	0.02	0.565	4
	Prairie Creek	BLTR	BLTR 19 DORS	1	0.0122	0.002	0.2	3	0.004	0.0574	0.02	0.429	5
	Prairie Creek	BLTR	BLTR 20 DORS	1	0.0089	0.002	0.2	2.32	0.004	0.051	0.01	0.416	4
	Prairie Creek	BLTR	BLTR 21 DORS	1	0.0093	0.002	0.2	2.76	0.004	0.069	0.03	0.445	4
	Prairie Creek	BLTR	BLTR 22 DORS	1	0.0104	0.002	0.3	4.05	0.004	0.0595	0.02	0.377	4
	Prairie Creek	BLTR	BLTR 23 DORS	1	0.0099	0.002	0.327	5.27	0.004	0.0524	0.077	0.461	3.7
	Prairie Creek	BLTR	BLTR 24 DORS	1	0.009	0.002	0.167	2.49	0.004	0.0545	0.021	0.454	3.2
	Prairie Creek	BLTR	BLTR 25 DORS	1	0.0089	0.002	0.162	4.41	0.0055	0.106	0.01	0.451	3.2
	Prairie Creek	BLTR	BLTR 26 DORS	1	0.0094	0.002	0.157	2.97	0.004	0.061	0.01	0.357	3.2
	Prairie Creek	BLTR	BLTR 27 DORS	1	0.0119	0.002	0.182	3.94	0.0042	0.0722	0.01	0.328	3.1

Attachment C (Cont'd.)

Source	Location	Species†	Sample ID	*n*	Analyte (µg/g)								
					Arsenic	Cadmium	Copper	Iron	Lead[1]	Mercury[2]	Nickel	Selenium[3]	Zinc
Hatfield 2012 (Cont'd.)	Prairie Creek	BLTR	BLTR 28 DORS	1	0.0135	0.002	0.313	4.82	0.0055	0.0676	0.01	0.39	4
	Prairie Creek	BLTR	BLTR 29 DORS	1	0.0073	0.002	0.186	2.15	0.004	0.0425	0.01	0.352	3
	Prairie Creek	BLTR	BLTR 30 DORS	1	0.0113	0.002	0.169	2.6	0.004	0.0816	0.031	0.366	3
	Prairie Creek	ARGR	ARGR-1 DORS	1	0.025	0.0051	0.188	4.17	0.004	0.0541	0.01	0.631	3.8
	Prairie Creek	ARGR	ARGR-2 DORS	1	0.02	0.002	0.244	5.73	0.004	0.0569	0.08	0.583	3.54
	Prairie Creek	ARGR	ARGR-3 DORS	1	0.025	0.0056	0.547	9.35	0.0284	0.0304	0.01	0.882	6.14
	Prairie Creek	ARGR	ARGR-4 DORS	1	0.03	0.0028	0.293	6.41	0.0065	0.0207	0.01	0.787	4.17
	Prairie Creek	ARGR	ARGR 5 DORS	1	0.0084	0.002	0.147	3	0.004	0.0348	0.01	0.654	2.88
	Prairie Creek	ARGR	ARGR-6 DORS	1	0.025	0.002	0.298	3.05	0.0065	0.0359	0.018	0.713	3.32
	Prairie Creek	ARGR	ARGR-7 DORS	1	0.0098	0.002	0.2	2.66	0.0384	0.0971	0.01	0.207	3.3
	Prairie Creek	ARGR	ARGR-8 DORS	1	0.0123	0.0028	0.2	3	0.004	0.0302	0.031	0.688	5.63
	Prairie Creek	ARGR	ARGR-9 DORS	1	0.0126	0.002	0.3	4.94	0.004	0.0361	0.01	0.603	5.67
	Prairie Creek	ARGR	ARGR-10 DORS	1	0.0112	0.002	0.299	3.29	0.004	0.0332	0.01	0.732	4.34
	Prairie Creek	ARGR	ARGR-11 DORS	1	0.0173	0.0055	0.27	3.47	0.004	0.04	0.068	0.922	4.61
	Prairie Creek	ARGR	ARGR-12 DORS	1	0.015	0.002	0.3	5.09	0.004	0.0259	0.01	0.882	3.7
	Prairie Creek	ARGR	ARGR-13 DORS	1	0.0123	0.0039	0.295	9.85	0.0093	0.0762	0.01	0.549	5.54
	Prairie Creek	ARGR	ARGR-14 DORS	1	0.0125	0.002	0.331	4.78	0.004	0.0314	0.01	0.672	3.34
	Prairie Creek	ARGR	ARGR-15 DORS	1	0.0142	0.003	0.18	2.76	0.0057	0.0658	0.01	0.532	4.33
	Prairie Creek	ARGR	ARGR-16 DORS	1	0.0107	0.0026	0.256	3.67	0.004	0.0409	0.015	0.709	3.65
	Prairie Creek	ARGR	ARGR-17 DORS	1	0.0138	0.002	0.215	2.24	0.0083	0.0419	0.052	0.54	3.31
	Prairie Creek	ARGR	ARGR-18 DORS	1	0.0127	0.0021	0.314	4.06	0.0093	0.0295	0.199	0.767	3.82
	Prairie Creek	ARGR	ARGR-19 DORS	1	0.0176	0.0034	0.297	2.91	0.004	0.0323	0.068	0.959	3.37
	Prairie Creek	ARGR	ARGR-20 DORS	1	0.0199	0.0042	0.517	7.8	0.0049	0.0348	0.134	0.826	4.03
	Prairie Creek	ARGR	ARGR-21 DORS	1	0.0139	0.0034	0.27	3.64	0.0069	0.0359	0.013	0.919	5.1
	Prairie Creek	ARGR	ARGR-22 DORS	1	0.0078	0.002	0.229	2.62	0.004	0.0307	0.01	0.646	3.63
	Prairie Creek	ARGR	ARGR-23 DORS	1	0.016	0.002	0.415	4.49	0.004	0.0286	0.1	1.21	5.71
	Prairie Creek	ARGR	ARGR-24 DORS	1	0.0182	0.0038	0.6	5.06	0.0087	0.0269	0.191	0.859	4
	Prairie Creek	ARGR	ARGR-25 DORS	1	0.0131	0.0054	0.5	8.49	0.0109	0.0657	0.533	0.686	3.67
	Prairie Creek	ARGR	ARGR-26 DORS	1	0.0143	0.0046	0.241	3.8	0.004	0.0415	0.114	0.819	4.37

* Mean measurement (n>1).
[1] BCMOE (1987) lead guideline for Human Health (0.8 µg/g).
[2] CCME (2006) mercury guideline for the Protection of Wildlife (0.033 µg/g); Health and Welfare Canada (1979) mercury guideline for Human Health (0.2 µg/g).
[3] BCMOE (2014) selenium guideline for the Protection of Aquatic Life (0.89 µg/g), and Human Health (high fish intake: 1.8 µg/g; low fish intake: 18.7 µg/g).
Bold values denote exceedances in listed guidelines.
† Species key: Arctic Grayling (ARGR), Bull Trout (BLTR), Lake Chub (LKCH), Mountain Whitefish (MNWH), Slimy Sculpin (SLSC), and White Sucker (WHSC).

Attachment D

Fish Health

Attachment D **Condition factor data as a measure of fish health compiled from multiple sources at various river and creek sites along potential road crossings from Prairie Creek Mine (1981-2013).**

Source	Location	Species†	Station	Sex	Fork Length (cm)	Weight (g)	Condition
Beak 1981	Tetcela River	NRPK	R#5	J	22.4	79.46	0.707
	Tetcela River	ARGR	R#5	J	7	3.29	0.959
	Tetcela River	ARGR	R#5	J	6.2	2.21	0.927
	Tetcela River	ARGR	R#5	J	8.5	5.66	0.922
	Tetcela River	ARGR	R#5	M	15.3	33.44	0.934
	Tetcela River	ARGR	R#5	F	19.3	68.13	0.948
	Tetcela River	ARGR	R#5	F	20.4	80.3	0.946
	Tetcela River	ARGR	R#5	F	18.4	70.05	1.124
	Tetcela River	ARGR	R#5	M	11	16.29	1.224
	Tetcela River	ARGR	R#5	J	14.6	33.03	1.061
	Tetcela River	ARGR	R#5	J	15.1	33.62	0.976
	Tetcela River	ARGR	R#5	F	15.3	46.83	1.308
	Tetcela River	LKCH	R#5	J	6.7	2.98	0.991
	Tetcela River	LKCH	R#5	J	6.3	2.33	0.932
	Tetcela River	LKCH	R#5	J	5.4	1.23	0.781
	Tetcela River	LKCH	R#5	J	5.3	1.19	0.799
	Tetcela River	LKCH	R#5	J	5.5	1.44	0.866
	Tetcela River	LKCH	R#5	J	3	1.18	4.370
	Tetcela River	LKCH	R#5	J	3	0.31	1.148
	Tetcela River	SLSC	R#5	-	4.8	1.64	1.483
	Tetcela River	BURB	R#5	J	23.7	71.74	0.539
	Grainger River	NRPK	R#7	M	34.3	274.91	0.681
	Grainger River	NRPK	R#7	J	16.9	34.54	0.716
	Grainger River	NRPK	R#7	F	55.1	1200	0.717
	Grainger River	NRPK	R#7	F	57	1325	0.715
	Grainger River	ARGR	R#7	F	24.8	156.08	1.023
	Grainger River	ARGR	R#7	J	12.7	19.41	0.948
	Grainger River	ARGR	R#7	J	15.7	36.03	0.931
	Grainger River	LKCH	R#7	F	10.7	15.24	1.244
	Grainger River	LKCH	R#7	F	9.8	12.95	1.376
	Grainger River	SLSC	R#7	-	6	2.08	0.963
	Grainger River	SLSC	R#7	-	6.5	2.1	0.765
	Grainger River	SLSC	R#7	-	5.2	1.71	1.216
	Grainger River	SLSC	R#7	J	3.3	0.49	1.363
	Sundog Creek	ARGR	R#3	F	22.6	115.02	0.996
	Sundog Creek	ARGR	R#3	F	22.6	141.35	1.225
	Sundog Creek	ARGR	R#3	F	22.4	128.27	1.141
	Sundog Creek	ARGR	R#3	F	20.4	95.3	1.123
	Sundog Creek	ARGR	R#3	M	15.7	34.86	0.901

Source	Location	Species†	Station	Sex	Fork Length (cm)	Weight (g)	Condition
Beak 1981 (Cont'd.)	Sundog Creek	ARGR	R#3	F	21.4	125.44	1.280
	Sundog Creek	ARGR	R#3	M	22.8	101.56	0.857
	Prairie Creek	BLTR	M#1A	J	12.4	19.04	0.999
	Prairie Creek	BLTR	M#1A	J	13.6	25.7	1.022
	Prairie Creek	BLTR	M#1A	A	24.6	147.77	0.993
	Prairie Creek	BLTR	M#1A	-	20.6	96.45	1.103
	Prairie Creek	BLTR	M#1A	-	17.6	55.55	1.019
	Prairie Creek	RMWF	M#1A	-	22.2	118.87	1.086
	Prairie Creek	RMWF	M#1A	-	20.8	103.9	1.155
	Prairie Creek	RMWF	M#1A	-	16.8	41.77	0.881
	Prairie Creek	SLSC	M#1A	F	7.6	4.47	1.018
	Prairie Creek	SLSC	M#1A	-	6.3	2.31	0.924
	Prairie Creek	SLSC	M#1	-	7.8	4.97	1.047
	Prairie Creek	SLSC	M#1	-	7.1	3.73	1.042
	Prairie Creek	SLSC	M#1	-	4.6	1.08	1.110
	Prairie Creek	SLSC	M#1	-	4.8	1.21	1.094
	Prairie Creek	SLSC	M#1	-	4	0.62	0.969
	Prairie Creek	BLTR	M#2	A	23.4	123.82	0.966
	Prairie Creek	BLTR	M#2	J	12.1	23.08	1.303
	Prairie Creek	BLTR	M#2	J	10.4	12.35	1.098
	Prairie Creek	BLTR	M#2	J	11.2	14.66	1.043
	Prairie Creek	BLTR	M#2	J	9.9	9.95	1.025
	Prairie Creek	RMWF	M#2	A	23	113.83	0.936
	Prairie Creek	RMWF	M#2	A	22	105.39	0.990
	Prairie Creek	RMWF	M#2	A	19.6	84.78	1.126
	Prairie Creek	RMWF	M#2	A	20.8	92.38	1.027
	Prairie Creek	RMWF	M#2	A	21	98.57	1.064
	Prairie Creek	RMWF	M#2	-	18.3	75.06	1.225
	Prairie Creek	RMWF	M#2	-	15.7	39.04	1.009
	Prairie Creek	RMWF	M#2	-	16.2	35.36	0.832
	Prairie Creek	RMWF	M#2	-	14.6	38.03	1.222
	Prairie Creek	RMWF	M#2	-	14.2	29.48	1.030
	Prairie Creek	RMWF	M#2	-	11.8	15.18	0.924
	Prairie Creek	RMWF	M#2	A	26.9	179.91	0.924
	Prairie Creek	RMWF	M#2	A	23.4	120.13	0.938
	Prairie Creek	RMWF	M#2	A	24.1	135.16	0.966
	Prairie Creek	SLSC	M#2	-	8.8	7.92	1.162
	Prairie Creek	SLSC	M#2	-	8.1	7.33	1.379

Attachment D (Cont'd.)

Source	Location	Species†	Station	Sex	Fork Length (cm)	Weight (g)	Condition
Beak 1981 (Cont'd.)	Prairie Creek	SLSC	M#2	-	7.5	4.38	1.038
	Prairie Creek	SLSC	M#2	-	8	6.61	1.291
	Prairie Creek	SLSC	M#2	-	6.9	4.31	1.312
	Prairie Creek	SLSC	M#2	-	7.1	3.26	0.911
	Prairie Creek	SLSC	M#2	-	3.9	0.53	0.893
	Prairie Creek	BLTR	M#4	A	31.1	345.99	1.150
	Prairie Creek	BLTR	M#4	A	25.2	169.28	1.058
	Prairie Creek	BLTR	M#4	-	18.9	60.55	0.897
	Prairie Creek	SLSC	M#4	-	16.8	57.22	1.207
	Prairie Creek	SLSC	M#4	-	9.7	9.7	1.063
	Prairie Creek	SLSC	M#4	-	8.8	7.29	1.070
	Prairie Creek	SLSC	M#4	-	9.1	10.05	1.334
	Prairie Creek	SLSC	M#4	-	7.2	4.32	1.157
	Prairie Creek	BLTR	M#5	-	10.2	12.07	1.137
	Prairie Creek	RMWF	M#5	-	22.8	104.26	0.880
	Prairie Creek	RMWF	M#5	-	21.2	89.73	0.942
	Prairie Creek	RMWF	M#5	-	20.5	82.79	0.961
	Prairie Creek	RMWF	M#5	-	21.4	95.82	0.978
	Prairie Creek	RMWF	M#5	-	18.1	69.84	1.178
	Prairie Creek	RMWF	M#5	J	5.8	1.88	0.964
	Prairie Creek	SLSC	M#5	-	8.1	7.33	1.379
	Prairie Creek	SLSC	M#5	-	8.1	6.1	1.148
	Prairie Creek	SLSC	M#5	-	8.2	8.3	1.505
	Prairie Creek	SLSC	M#5	-	7.9	8.12	1.647
	Prairie Creek	SLSC	M#5	F	7.4	7.85	1.937
	Prairie Creek	SLSC	M#5	-	7	3.32	0.968
	Prairie Creek	SLSC	M#5	-	6.8	4.9	1.558
	Prairie Creek	SLSC	M#5	-	5.9	2.36	1.149
	Prairie Creek	RMWF	M#5A	-	19.4	82.78	1.134
	Prairie Creek	RMWF	M#5A	-	21	96.78	1.045
	Prairie Creek	RMWF	M#5A	-	17.8	79	1.401
	Prairie Creek	RMWF	M#5A	-	16.6	45.84	1.002
	Prairie Creek	RMWF	M#5A	-	12.8	19.75	0.942
	Prairie Creek	RMWF	M#5A	J	6.7	2.66	0.884
	Prairie Creek	ARGR	M#6	M	24	163.52	1.183
	Prairie Creek	ARGR	M#6	F	28.2	354.69	1.582
	Prairie Creek	ARGR	M#6	M	34.5	510	1.242
	Prairie Creek	ARGR	M#6	M	32.6	475	1.371
	Prairie Creek	ARGR	M#6	M	32	460	1.404
	Prairie Creek	BLTR	M#6	M	15.8	41.31	1.047
	Prairie Creek	BLTR	M#6	M	30	286.41	1.061
	Prairie Creek	BLTR	M#6	M	31	320.71	1.077

Attachment D (Cont'd.)

Source	Location	Species[†]	Station	Sex	Fork Length (cm)	Weight (g)	Condition
Beak 1981 (Cont'd.)	Prairie Creek	RMWF	M#6	F	19.3	74.58	1.037
	Prairie Creek	RMWF	M#6	M	19.8	90.05	1.160
	Prairie Creek	BLTR	M#6	M	31	320.71	1.077
	Prairie Creek	RMWF	M#6	F	19.3	74.58	1.037
	Prairie Creek	RMWF	M#6	M	19.8	90.05	1.160
	Prairie Creek	RMWF	M#6	M	14.2	27.77	0.970
	Prairie Creek	RMWF	M#6	J	6.8	3.02	0.960
	Prairie Creek	RMWF	M#6	F	22.6	131.03	1.135
Rescan 1994	Prairie Creek	BLTR	PC-EF1	M	19	62	0.904
	Prairie Creek	BLTR	PC-EF4	F	20.4	76.3	0.899
	Prairie Creek	SLSC	PC-EF1	F	6	2.3	1.065
	Prairie Creek	SLSC	PC-EF2	F	6.8	2.7	0.859
	Funeral Creek	BLTR	FU-EF1	M	16.5	40	0.890
Spencer 2009	Prairie Creek	SLSC	Upstream	M	-	-	0.802*
	Prairie Creek	SLSC	Near-field	M	-	-	0.909*
	Prairie Creek	SLSC	Far-field	M	-	-	0.900*
	Prairie Creek	SLSC	Upstream	F	-	-	0.768*
	Prairie Creek	SLSC	Near-field	F	-	-	0.901*
	Prairie Creek	SLSC	Far-field	F	-	-	0.904*
Hatfield 2013	Prairie Creek	SLSC	PC13-FF-PB	-	5.4	1.7	1.080
	Prairie Creek	SLSC	PC13-FF-PB	-	5.6	2.1	1.196
	Prairie Creek	SLSC	PC13-FF-PB	-	6	2.2	1.019
	Prairie Creek	SLSC	PC13-FF-PB	-	6	2	0.926
	Prairie Creek	SLSC	PC13-FF-PB	-	6.3	2.3	0.920
	Prairie Creek	SLSC	PC13-FF-PB	-	6.5	2.3	0.838
	Prairie Creek	SLSC	PC13-FF-PB	-	6.5	2.5	0.910
	Prairie Creek	SLSC	PC13-FF-PB	-	7.2	3.3	0.884
	Prairie Creek	SLSC	PC13-FF-PB	-	7.3	3.2	0.823
	Prairie Creek	SLSC	PC13-FF-PB	-	7.3	3.4	0.874
	Prairie Creek	SLSC	PC13-FF-PB	-	8.75	5.1	0.761
	Prairie Creek	SLSC	PC13-FF-P	-	5.3	1	0.672
	Prairie Creek	SLSC	PC13-FF-P	-	6.2	2.5	1.049
	Prairie Creek	SLSC	PC13-FF-P	-	6.6	3	1.043
	Prairie Creek	SLSC	PC13-FF-P	-	6.8	3	0.954
	Prairie Creek	SLSC	PC13-FF-P	-	7	3.7	1.079
	Prairie Creek	SLSC	PC13-FF-P	-	7.4	3.5	0.864
	Prairie Creek	SLSC	PC13-FF-P	-	7.7	2.9	0.635
	Prairie Creek	SLSC	PC13-FF-P	-	7.7	3.8	0.832
	Prairie Creek	SLSC	PC13-FF-P	-	7.8	5	1.054
	Prairie Creek	SLSC	PC13-FF-P	-	7.8	4.2	0.885

Attachment D (Cont'd.)

Source	Location	Species†	Station	Sex	Fork Length (cm)	Weight (g)	Condition
Hatfield 2013 (Cont'd.)	Prairie Creek	SLSC	PC13-FF-P	-	7.8	4.5	0.948
	Prairie Creek	SLSC	PC13-FF-P	-	8	4.7	0.918
	Prairie Creek	SLSC	PC13-FF-P	-	8	4.4	0.859
	Prairie Creek	SLSC	PC13-FF-P	-	8.4	5.5	0.928
	Prairie Creek	SLSC	PC13-FF-P	-	8.4	5	0.844
	Prairie Creek	SLSC	PC13-FF-P	-	8.5	5.2	0.847
	Prairie Creek	SLSC	PC13-FF-P	-	8.6	5.7	0.896
	Prairie Creek	SLSC	PC13-FF-P	-	9	6.3	0.864
	Prairie Creek	SLSC	PC13-FF-P	-	9.5	8.5	0.991
	Prairie Creek	SLSC	PC13-FF-P	-	9.5	7.9	0.921
	Prairie Creek	SLSC	PC13-FF-P	-	9.7	8.3	0.909
	Prairie Creek	SLSC	PC13-NF	-	5.6	1.6	0.911
	Prairie Creek	SLSC	PC13-NF	-	6	2	0.926
	Prairie Creek	SLSC	PC13-NF	-	6.3	2.3	0.920
	Prairie Creek	SLSC	PC13-NF	-	6.5	2.5	0.910
	Prairie Creek	SLSC	PC13-NF	-	6.5	2.2	0.801
	Prairie Creek	SLSC	PC13-NF	-	6.8	3.2	1.018
	Prairie Creek	SLSC	PC13-NF	-	6.8	2.8	0.890
	Prairie Creek	SLSC	PC13-NF	-	6.9	2.9	0.883
	Prairie Creek	SLSC	PC13-NF	-	7	3.2	0.933
	Prairie Creek	SLSC	PC13-NF	-	7	3.3	0.962
	Prairie Creek	SLSC	PC13-NF	-	7	3.3	0.962
	Prairie Creek	SLSC	PC13-NF	-	7.3	3.3	0.848
	Prairie Creek	SLSC	PC13-Ref	-	5.4	1.7	1.080
	Prairie Creek	SLSC	PC13-Ref	-	5.4	1.3	0.826
	Prairie Creek	SLSC	PC13-Ref	-	5.5	1.3	0.781
	Prairie Creek	SLSC	PC13-Ref	-	5.6	1.7	0.968
	Prairie Creek	SLSC	PC13-Ref	-	6	1.7	0.787
	Prairie Creek	SLSC	PC13-Ref	-	6	1.7	0.787
	Prairie Creek	SLSC	PC13-Ref	-	6.2	2	0.839
	Prairie Creek	SLSC	PC13-Ref	-	6.3	2	0.800
	Prairie Creek	SLSC	PC13-Ref	-	6.4	2.5	0.954
	Prairie Creek	SLSC	PC13-Ref	-	6.5	2.2	0.801
	Prairie Creek	SLSC	PC13-Ref	-	6.6	2.1	0.730
	Prairie Creek	SLSC	PC13-Ref	-	6.6	2.5	0.870
	Prairie Creek	SLSC	PC13-Ref	-	7.3	3.7	0.951

* Mean condition factor calculated from Spencer (2009) sample sizes (Prairie Creek reference: Males n = 8, females n = 17; Prairie Creek near-field: Males n = 18, females n = 14; Prairie Creek far-field: Males n = 21, females n = 10).

† Species key: Arctic Grayling (ARGR), Bull Trout (BLTR), Burbot (BURB), Lake Chub (LKCH), Northern Pike (NRPK), Round Mouth Whitefish (RMWF), Slimy Sculpin (SLSC), and White Sucker (WHSC).

Attachment E

Assessment Matrix

Attachment E Assessment matrix – Aquatic environment.

Impact	Significance (High/Moderate/Low)	Summary of Rationale (including section in the document)	Uncertainty (High/Moderate/Low)	Geographic Range (Area or Distance)	Timing (Duration, Frequency, and Extent)	Magnitude (High/Moderate/Low)	Reversibility (High/Moderate/Low)	Likelihood (High/Moderate/Low)
Reduction of fish population due to Sundog Creek realignment.	Low	Re-alignment of the creek will result in no net loss of fish habitat.	Low	Only associated with two locations on Sundog Creek; approximately 50 m long each.	25 years – construction of road, operation and reclamation.	Low (channel will be redirected into an existing, currently dry channel, area affected is very small)	High	Low
Reduction of fish population due to fragmentation of fish habitat (i.e., barriers to fish movement).	Low	Many fish species found in the Nahanni watershed must migrate in order to complete their life cycle. (DAR 11.6.1, p244; Item 4.16 and 16.3 in response to adequacy review).	Low	Only associated with crossings, but can affect fish travelling long distances.	20 years – life of mine + reclamation.	Low (CZN will mitigate the magnitude by installing clear span bridges at major crossings over fish habitat. At other creeks, installation of culverts will follow best management practices).	High	Low
Reduction of fish population due to noise from passing trucks on fish.	Low	Small geographic range, but could affect fish in critical habitat (i.e., overwintering or spawning locations). (DAR 11.4.2, p241; Item 8.4 in response to adequacy review).	Low	Possibly up to ½ km from crossing or road (although unlikely).	20 years – life of mine + reclamation.	Low (clear-span bridges will minimize noise at major crossings; fish will acclimate to small incremental amount of noise adjacent to roads).	High	Low
Reduction of fish population due to accidental spill of concentrate.	Low (due to very low likelihood and leaching)	Could affect spawning/rearing habitat downstream of the spill site. (DAR 9.4 & 9.5, p 191 - 200; Item 6.3 in response to adequacy review).	Low	Downstream of spill location; distance dependent on flow velocity, time and dilution from downstream confluences.	15 years – life of mine.	Low to moderate, depending on the amount of material spilled and size of stream affected.	Moderate to high – smaller volumes discharged to larger creeks will be more reversible. Fortunately fish are typically found in larger creeks. A complete season may be required to flush sediments.	Low (with effective mitigation measures, likelihood should be negligible).
Reduction of fish population due to accidental spill of acid or fuel to other creeks.	Low (due primarily to very low likelihood)	Could be acutely toxic to fish and other aquatic life. (DAR 9.4 & 9.5, p 191 - 200; Item 6.3 in response to adequacy review).	Low	Downstream of spill location; distance dependent on flow velocity, time and dilution from downstream confluences.	25 years – construction of road, operation and reclamation.	Low to high, depending on the amount of material spilled and size of stream affected.	Moderate to high – smaller volumes discharged to larger creeks will be more reversible. Fortunately fish are typically found in larger creeks.	Low (with effective mitigation measures, likelihood should be negligible).
Reduction of fish populations due to road-related sedimentation and consequent smothering of spawning habitat.	Low	Could affect spawning/rearing habitat downstream of the spill site.	Moderate	Distance dependent on flow velocity, time and dilution from downstream confluences.	25 years – construction of road, operation and reclamation. In-frequent, if occurs, despite mitigation measures, would be associated with heavy precipitation.	Low (sediment and erosion control plan will mitigate possible impact).	High – one season may be required to flush sediments. Fish should quickly recolonize impacted sections.	Low for significant events that might result in an effect.
Reduction of fish populations due to road-related sedimentation and consequent smothering of benthic invertebrate assemblages (fish food items).	Low	Could reduce biomass of dietary items used by smaller fish.	Moderate	Distance dependent on flow velocity, time and dilution from downstream confluences.	25 years – construction of road, operation and reclamation. In-frequent, if occurs, despite mitigation measures, would be associated with heavy precipitation.	Low (sediment and erosion control plan will minimize possible impact).	High – one season may be required to flush sediments. Fish should quickly recolonize impacted sections. Bull trout returning to Funeral Creek may take longer to recolonize (therefore "moderate").	Low for significant events that might result in an effect.

Attachment E (Cont'd.)

Impact	Significance (High/Moderate/Low)	Summary of Rationale (including section in the document)	Uncertainty (High/Moderate/Low)	Geographic Range (Area or Distance)	Timing (Duration, Frequency, and Extent)	Magnitude (High/Moderate/Low)	Reversibility (High/Moderate/Low)	Likelihood (High/Moderate/Low)
Reduction of fish populations due to removal of riparian vegetation.	Low	Removal of riparian vegetation could result in loss of habitat including food items (Item 16.4, response to adequacy review).	Low	Usually will be small portion of creeks under consideration, longer where road parallels creeks within 30 m.	35 years – construction of road, operation and reclamation. Plus time for succession.	Low (most crossings have very limited riparian vegetation, and widening of the road will not remove much additional vegetation).	High (once road is decommissioned, riparian vegetation will be returned to its natural state).	Low for significant effects.
Reduction of fish populations due to road blasting near creeks.	Low	Percussion waves can damage swim bladders of fish, injuring or killing fish (Item 16.4, response to adequacy review).	Low	Blasting at only one crossing location where fish are known to exist. No species of special concern at either location.	Maximum one week per location during construction.	Low (fish will be encouraged to leave immediate area before and during blasting). Other mitigation procedures as provided in blasting management plan. No species of concern resident at site.	High – fish will return to site after blasting has been completed.	Low
Reduction of fish populations due to overharvesting of fish species.	Low	Increased access to fishing along the all-season road could affect stocks of traditionally harvested fish species. (DAR 4.5.2, p 100; Item 6.3, 15.2 in response to adequacy review).	Moderate	Sections of several larger creeks and two lakes.	20 years – life of mine + reclamation.	Likely low due to low desirability of fish along the road.	High	Low for significant overharvesting (knowing that fish stocks are not highly desirable, controls on use of road will minimize access by fishermen).