FISHERIES ASSESSMENT OF THE MACKENZIE RIVER AT FORT PROVIDENCE, NT - PROPOSED DEH CHO BRIDGE -

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Golder Associates

REPORT ON

FISHERIES ASSESSMENT OF THE MACKENZIE RIVER AT FT. PROVIDENCE, NT - PROPOSED DEH CHO BRIDGE -

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The study was conducted by the following personnel from Golder Associates Ltd.:

Jim O'Neil	Senior Fisheries Biologist, Project Director and Author
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Jim Campbell	Project Fisheries Biologist, Field Coordinator and Author
Nathan Schmidt	Senior Water Resources Engineer, River Engineering Specialist and Author
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EXECUTIVE SUMMARY

The Deh Cho Bridge Corporation (DCBC) of Ft. Providence, NT, is proposing to construct a bridge across the Mackenzie River on the Yellowknife Highway #3. The bridge would replace the existing ferry operation, which commenced in the early 1960's, and the winter ice crossing. To facilitate the north and south ferry landings, rock-fill causeways were built on top of natural peninsulas. The north causeway was stabilized in 1988 through the edition of 1000 m^3 of armour rock. At the present time, the north causeway extends 430 m into the Mackenzie River (which is 1560 m wide at the crossing location); the south causeway extends 165 m into the channel. The approaches and abutments of the proposed bridge would, to a large extent, be built upon the existing footprint. However, the bridge would require lengthening the south causeway by approximately 60 m and shortening the north approach by 80 m. Other modifications to the site would include the removal of the ferry haul out area on the south approach and the installation of eight bridge piers in the river.

Golder Associates Ltd. was retained by Jivko Engineering (Yellowknife), on behalf of DCBC and Andrew Gamble Associates Ltd. (Yellowknife) to undertake a fisheries assessment of the Mackenzie River in the vicinity of the crossing. The principal objectives were to determine the short term (construction related) and long term (operational) impacts of the proposed bridge on fish and habitat resources. The overall significance of these impacts was to be evaluated after considering any benefits that might arise from discontinuing the current ferry and ice crossing. The final objective was to produce a "No Net Loss" plan which accounted for habitat gains and losses, in order to meet the requirements of Section 35 (2) of the federal Fisheries Act.

The 2003 fisheries investigation included summer (30 July to 3 August) and fall (17 to 23 September) field sampling. The field crew, which was comprised of Golder biological staff and assistants from Ft. Providence, used a variety of fish sampling gear (gill nets, fyke nets, boat electrofisher, beach seines, minnow traps). Twelve species of fish were recorded during the study, including eight large types (lake whitefish, round whitefish, northern pike, walleye, Arctic grayling, burbot, longnose sucker, white sucker) and four minnow varieties (emerald shiner, spottail shiner, trout-perch, ninespine stickleback). Of the large types of fish caught, northern pike and lake whitefish were numerically dominant (79% of catch). Lake whitefish, followed by northern pike, also dominated the fish harvest by residents of Ft. Providence over the period 1994 to 2001 (data provided by Department of Fisheries and Oceans, Hay River).

Aquatic habitat in the vicinity of the crossing was described, mapped and quantified during the investigation. The study area contained a high diversity of aquatic habitats, which included the main channel (characterized by deep and high average velocity conditions) and the nearshore margins of the channel (series of backwater, lake-like habitats positioned behind narrow peninsulas extending into the main channel on a north-west to south-east orientation). The outer tip of these extensions provided riffle-run complexes over gravel/cobble riverbed material.

The construction of the proposed bridge would result in the short term disturbance and alteration of main channel and nearshore habitats, primarily due to increased suspended sediment levels. However, with effective scheduling (e.g., avoidance of construction activity during the spring spawning period) and mitigation (e.g., feedback monitoring to maintain satisfactory water quality), construction should not result in significant adverse effects over the long term.

Backwater areas along both shorelines are used extensively by Ft. Providence residents for gillnetting. Through proper planning and notification it will be possible to avoid conflicts with the domestic fishery. Fish movements through the area occur on a seasonal and defined basis. Due to the small portion of the channel affected by construction, in relation to the large size of the river, movement patterns are not likely to be altered significantly.

With respect to the footprint of the proposed bridge, a net gain of 5970 m^2 of aquatic habitat would be achieved. The amount of high quality backwater habitat will be increased by approximately 8500 m^2. The net gain of backwater habitat assumes a loss of 6700 m^2 at the north approach (due to the reduced causeway extension into the channel) and an offsetting gain of 15 200 m^2 at the south approach (due to the removal of the ferry haul out area and extension of the causeway). As such, the proposed bridge appears to meet the “No net Loss” of productive fish habitat objective.

The Deh Cho Bridge would result in a number of benefits apart from the footprint gains. These include: 1) no further sediment input from the ferry operation and ice crossing on an annual basis and 2) reduced risk of a major fuel spill (resulting from a tanker truck accident) at the ice crossing. Although the proposed Deh Cho Bridge appears to meet the stated habitat objectives, there are opportunities to provide compensation if required. The large size and flow volume of the Mackenzie River at the proposed bridge site present difficult conditions for achieving effective and lasting habitat improvements. This being the case, it might be advisable to pursue a habitat improvement initiative in a smaller tributary system near Ft. Providence (e.g., Providence Creek). Prior to proceeding in this direction, however, it would be necessary to discuss the initiative with, and obtain the approval of, the community of Ft. Providence. A local project of this scale could offer good opportunities for community involvement and environmental education benefits.

Regulators have expressed concerns with respect to the presence of ammonia residues and levels of regulated metals in blasted rock used for fill and armouring. The DCBC, in recognition of these issues, has initiated sampling efforts, and integrated them into a systematic water quality monitoring program. The intent of this program will be to ensure that adverse affects are predicted in advance, and subsequently avoided or minimized through planning and timely feedback.

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1.0 INTRODUCTION

1.1 Background

The Deh Cho Bridge Corporation Ltd. (DCBC) of Ft. Providence, NT, is proposing to construct a bridge across the Mackenzie River at Km 23 of the Yellowknife Highway #3. Following construction, the bridge will be operated and maintained by the DCBC, for a period of 35 years. On expiration of the agreement, bridge ownership will be transferred to Government of Northwest Territories (GNWT). The proposed bridge will replace the existing ferry and ice bridge crossings, making Highway #3 an all-weather facility with uninterrupted, year-round service between Yellowknife and southern Canada.

The proposed Deh Cho Bridge Project has the initial approval of the GNWT, and is supported by local residents and the Municipal Authorities of Ft. Providence. A Memorandum of Intent between GNWT and the Deh Cho Bridge Corporation was signed on 15 November 2002 allowing the proponent to proceed with the final design and preparation for construction.

1.2 Objectives

The general objectives of the present fisheries and aquatic environmental assessment for the proposed Deh Cho Bridge Project were as follows:

- to evaluate direct, short-term effects of proposed construction activities on fish habitat;
- to determine the long-term, operational influences on existing and potentially altered fish habitat due to the bridge; and,
- to provide recommendations on mitigation and compensation measures as required to meet the Department of Fisheries and Ocean's (DFO) policy for "No Net Loss" of fish habitat.

1.3 Study Area

The proposed bridge will be constructed at the existing ferry crossing of the Mackenzie River, located approximately 8 km upstream of the Hamlet of Ft. Providence. The site is approximately 25 km downstream of Beaver Lake, a widening of the channel located at the western outlet of Great Slave Lake (Figure 1.1). At the crossing site, the natural river/channel is approximately 1560 m wide. To facilitate ferry operation, which commenced in the early 1960's, partial causeways were built on the north and south shores. The north causeway projects 430 m into the Mackenzie River, whereas the south causeway is considerably shorter (extends 165 m into the channel). The partial causeways were constructed on top of natural peninsulas which projected into the channel. The north causeway was stabilized in 1988, through the addition of 1000 m^3 of armour rock (i.e., to repair and prevent ice damage). At present, the unobstructed portion of the channel (located between the two ferry landing causeways) is 965 m. The study area for the fisheries and aquatic environmental assessment focused primarily on habitats located within 500 m of the proposed bridge (i.e., in the vicinity of the existing ferry landing causeways). However, representative effort was also applied upstream and downstream of the ferry crossing; the total length of river investigated was approximately 12 km. The expanded study area included nearshore habitats adjacent to the ice road causeways, and selected habitats in the vicinity of Providence Rapids. Photographic plates 1-20 (following Literature Cited, which is located on pages 87 to 89) illustrate the study area and relevant aspects of the study.

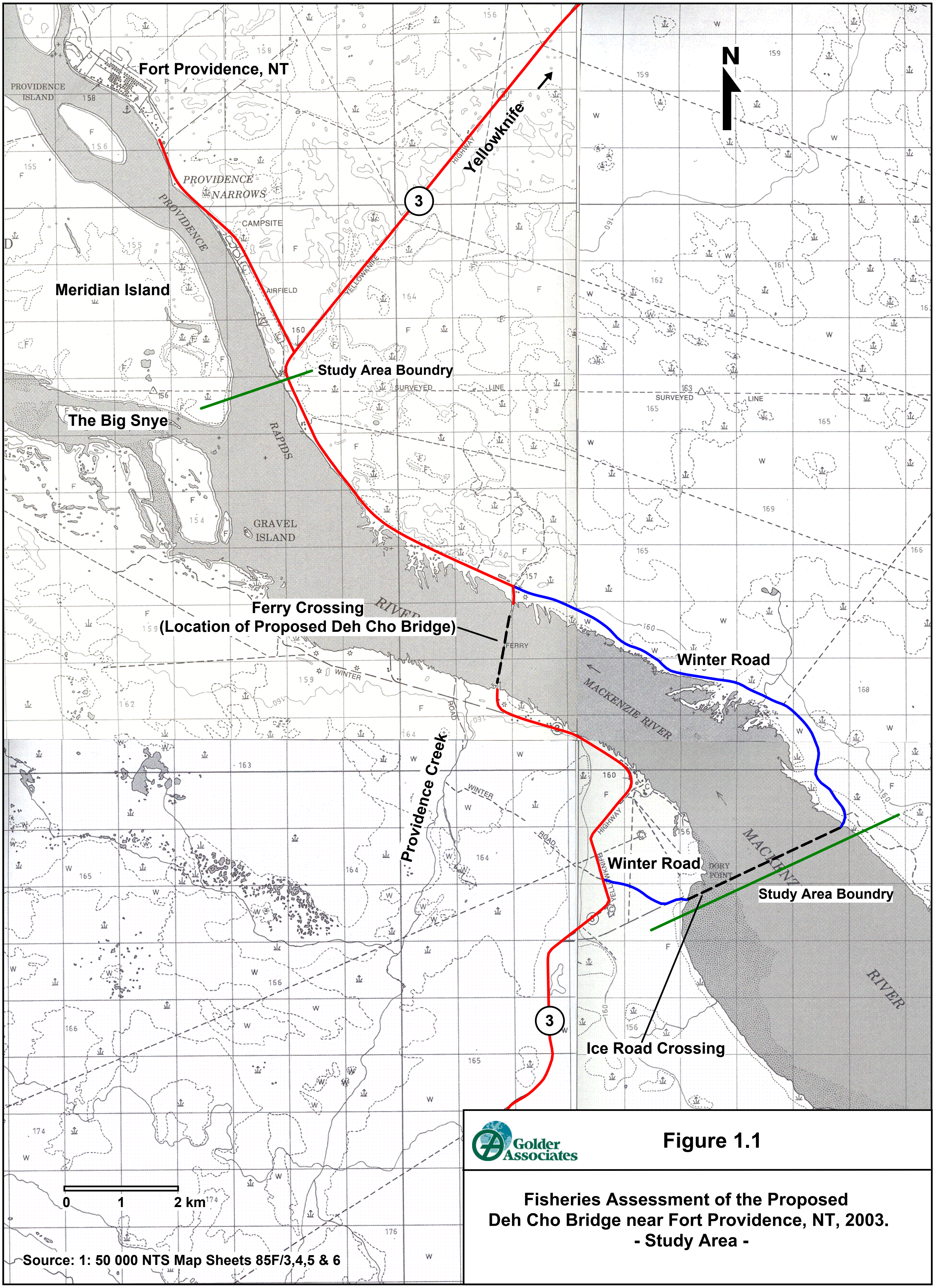

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Figure 1.1

Fisheries Assessment of the Proposed Deh Cho Bridge near Fort Providence, NT, 2003.
- Study Area -

2.0 SCOPE OF WORK

2.1 Principal Fisheries Issues

The proposed bridge would involve modification of existing causeway approaches (downsizing of north approach, extension of south approach), construction of eight piers within the Mackenzie River and two abutments, and the fabrication and installation of the superstructure. The proposed bridge would be 1045 m in length. Because of the net reduction in causeway length, the unobstructed channel width would be increased to 995 m (i.e., 3.1% increase over present conditions). The principal fisheries issues and concerns that needed to be addressed in relation to the proposed Deh Cho Bridge Project included the following:

- direct and permanent loss of habitat associated with the footprints of the causeways and piers;
- habitat alteration adjacent to the perimeter of the causeways and piers, due to altered water velocities, water depth, placement of armour rock, etc.;
- temporary disruption of fish habitat resulting from the proposed method of construction and type of material to be used for the in-stream bridge portions, including causeways and pier foundations; and,
- potential interference (delay, deflection) with seasonal fish migrations/ movements past the construction site (i.e., to and from the Great Slave Lake and nearby tributaries of the Mackenzie River).

2.2 Impact Assessment

To define the nature, extent, and significance of principal fisheries issues and concerns, an impact assessment (which included the following project actions and parameters) was carried out:

- definition of the timing and extent of fish migrations and movements within and adjacent to the study area, including an assessment of key fish species (e.g., inconnu, lake whitefish, Arctic grayling, northern pike, and walleye) in the area and their movements during the open water period (i.e., spawning, rearing, feeding, and overwintering);
- quantitative and qualitative assessment of habitat lost under the footprint of the project (e.g., approach causeways and piers), including peripheral habitats within the zone of influence of footprint structures. The focus was to be on the essential fish species and various life-stages, as identified in historical fisheries studies in the area and by local residents with specific Traditional Knowledge;
- evaluation of alternative habitats similar to those potentially affected by the project within the study area (e.g., natural peninsulas along the shorelines, some of which exceed 300 m in length). These alternate habitats were to be described, quantified and compared to the proposed bridge causeway structures. The availability of alternate habitats, of similar or higher quality,

could tend to temper the negative consequences of habitat alteration due to the construction and operation of the bridge;

- description and evaluation of the effects on fish habitat due to the placement of 1000 m^3 armour rock at the North Ferry Landing in 1988 (i.e., to stabilize and protect the structure from ice effects);
- assessment of the effects of discontinuing the ferry operation, and in particular discontinuing the yearly placing of approximately 1000 m^3 of silty gravel in the watercourse;
- assessment of the effects of discontinuing the operation of the winter ice crossing, in view of contamination of the ice with silt and oil imported by traveling vehicles, fuel spills, and the potential effects on fish habitat from vehicles breaking through the ice, etc.;
- assessment of the effects of temporary disruption on fish habitat during the placement of 10,000 m^3 of clean blasted rock for extension and widening of the bridge approaches, and for the temporary road detour-in addition, addressing the effects of temporary disruption on fish habitat from drilling below the riverbed and the installation of cast-in-place pier footings; and,
- a review of relevant literature assessing the impacts of bridge developments on aquatic resources in northern Canada.

2.3 Requirements

The present study identifies, assesses and recommends appropriate mitigation and compensation strategies to satisfy the "No Net Loss" (NNL) guiding principal of the DFO Habitat Management Policy (DFO 1986). This policy was established to maintain the extent and productive capacity of fish habitats. Fish habitat is defined by the Fisheries Act as "spawning ground and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes." To further advance the NNL principle, DFO has published a document entitled, "Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction (HADD) of Fish Habitat" (DFO 1998). The Deh Cho Bridge Project will be required to meet DFO's NNL requirements through the following deliverables:

- development of a NNL strategy that includes a systematic accounting of important/critical habitat losses and gains for key/essential fish species, and provides effective mitigation and compensation strategies;
- assessment of the remediation of the ferry and ice crossing landing and staging areas, (removal /alteration) of existing approach causeways, and an estimation of the rate of recovery of affected fish habitat;
- preparation of a post-construction assessment plan to evaluate newly created fish habitat and to establish the rate of recovery of the excavated and surrounding areas; and,
- preparation of construction monitoring plans DFO frequently requests that monitoring plans be developed and implemented when instream construction

activities take place; such plans are commonly required when a HADD of fish habitat is authorized.

2.4 Stakeholder Consultation

Throughout the implementation of the present study, consultations were maintained with stakeholders directly affected by this project to ensure that all necessary information required for assessments were obtained. Stakeholders included the following:

- Jivko Engineering;
- Andrew Gamble and Associates Ltd.;
- Deh Cho Bridge Corporation Ltd.;
- Ft. Providence Resource Management Board;
- Community of Ft. Providence;
- Department of Fisheries and Oceans;
- Mackenzie Valley Impact Review Board;
- Northwest Territories Water Board;
- Government of Northwest Territories, Department of Public Works & Services; and,
- Government of Northwest Territories, Department of Transportation.

2.5 Wildlife Issues

Golder Associates Ltd. was also requested to assess possible avian wildlife issues resulting from the construction and operation of the proposed Deh Cho Bridge. A memorandum briefly outlining the major issues and recommendations is provided in Appendix F.

3.0 STUDY METHODS

3.1 Scheduling and Logistics

The 2003 sampling program at the proposed Deh Cho Bridge included two field sessions (i.e., summer and fall). The summer field session was conducted between 30 July and 3 August (inclusive), whereas the fall field session was carried out from 17 through 23 September (inclusive). During the summer sampling period, activities included the collection of traditional fisheries knowledge, fish sampling (fyke nets, gill nets, beach seines, and minnow traps), and preliminary water and sediment sampling in the nearshore zones. The fall sampling program included collection of background data on water and sediment chemistry (for a comprehensive suite of constituents), systematic fish sampling (including boat electrofishing), and the collection of bathymetry data in the vicinity of the proposed bridge.

Golder equipment and personnel assigned to the project were based out of Yellowknife, NT. Two residents of Ft. Providence were hired through Digaa Enterprises Ltd. to assist with field investigations. All field work was based out of Ft. Providence, NT.

3.2 Community Consultation and Involvement

3.2.1 Stakeholder Meeting: Presentation to DCBC and Hamlet of Ft. Providence

Once the contract was awarded, key agencies were contacted in order to raise awareness of the study. Prior to the first field sampling session, a meeting was held (11 July) with representatives from key stakeholder groups. These included representatives of the DCBC, Ft. Providence Metis Council, Ft. Providence Resource Management Board, and elders. This meeting served to raise awareness of the study (e.g., study design and schedule), and document local concerns. Informal meetings continued throughout the duration of the project.

3.2.2 Training of Local Assistants

Louie Lacorne, Edwin Sabourin, and Joe Lacorne (residents of Ft. Providence), participated in field sampling sessions. They received training from project biologists on-site with respect to: the setting and operation of the directional fyke net, the collection and recording of fisheries data, the use of a range of water quality meters (pH, dissolved oxygen, conductivity) and specialized equipment for conducting transect data collections, and sampling for water and sediments. Due to their previous knowledge of fish and habitat resources in the area, they were able to provide considerable guidance to the project biologists.

3.3 Physical Habitat

Project Footprint

The area directly affected by the footprint of the project and peripheral habitats (within the zone of influence of the structures) was described and quantified as follows:

- calculation of potentially affected area based on technical scale drawings; verification of area involved through field measurements (laser range finder);
- characterization and differentiation of the potentially affected habitat through depth bathymetry, substrate assessment, and description of bottom and shoreline cover (underwater camera); and,
- depth and velocity profiles were recorded representative locations in the main channel and nearshore zones.

Habitat Features

General habitat information describing conditions within the entire study area was recorded. Photographs were taken of noteworthy in-channel and shoreline habitat features (e.g., existing ferry landings, winter road landings, potential overwintering or spawning habitat). A habitat map, covering the detailed study area (4.2 km in length), which included the existing ferry crossing and surrounding sections, was developed. It identified and delineated the area of major instream habitat and nearshore features, according to the following major habitat types:

• **Main Channel (MC)** – The central portion of the channel, which includes the thalweg and accounts for the majority of the flow-through during baseflow periods; the channel is characteristically deep (mean depth of approximately 5.0 m at transects, measured in September 2003) and features high average velocity (mean channel velocities exceeding 1.0 m/s at transects, measured in September 2003). The habitat is relatively uniform, in comparison to nearshore habitats.
• **Backwater (BW)** – Discrete, nearshore areas featuring low velocity, lake-like conditions; located in the lee of natural spur-like peninsulas which extend into the main channel. The setting features a flow reversal (relative to the main current) and is primarily depositional in nature (i.e., substrate dominated by fines and organic detritus). These areas, which generally range in depth from 1.5 m to 3.0 m, feature extensive aquatic macrophyte growths. Water clarity and water temperature often exceed levels attained in the main channel.
• **Riffle Run Complex (RR)** – Localized area of riffles, runs and associated pools located on the offshore terminus of spur-like peninsulas which extend into the channel. Characterized by increased velocities (relative to the adjacent backwaters, coarse substrate (gravel, cobble, boulder) and depths generally ranging from 0.5 m to 1.5 m (at baseflow levels).
• **Deep Runs (DR)** – Deep (generally exceeding 2.0 m), high velocity runs located off the tip of the north and south causeways; characterized by considerable channel scour.
• **Exposed Banks (EB)** – Localized areas, particularly along the ferry approach causeways, that are exposed to river currents and ice flows; shoreline reaches that are typically armoured by large boulders.
• **Sheltered Banks (SB)** – Localized areas, particularly along the ferry approach causeways, that are situated on the leeward side of prevailing river flows; shoreline reaches that are not exposed on a sustained basis to high water velocity, and ice flows; usually border depositional habitats.

The assessment of instream habitat features was carried out in conjunction with fish sampling activities and during a general reconnaissance of the surveyed area. Discrete habitat features were individually recorded and mapped on 1:10 000 air photographs and/or 1:50 000 NTS (National Topographic Series) maps; the areal contribution of each habitat unit was estimated from these sources.

Depth Transects

Channel depth profiles were determined along pre-selected transects within the vicinity of the existing ferry causeways and cross-channel. A Garmin™ GPSMAP 168 depth sounder was employed; it was linked to a laptop computer that stored the paired depth and UTM (Universal Transverse Mercator) coordinates as the boat moved along a transect. Transect data were collected (fall field sampling session), as follows:

- three cross-channel transects (one upstream, one downstream, and one connecting the two ferry landing causeways; and,
- several transects aligned with the flow of the river, and generally corresponding with the deep water areas off of the nose of each causeway.

Depth data were then tabulated and analysed to determine a mean depth reading for each transect. Also recorded were distances from shore at the start and end of each transect, UTM coordinates, and transect direction. Wetted channel widths at each transect location were calculated from recorded GPS coordinates and verified with air photographs (1:10 000 scale).

3.4 Water and Bottom Sediment

3.4.1 Temperature

Three Vemco™ 8 bit Minilog TR thermographs were deployed at the onset of the summer survey period. One unit was used to record air temperature (north ferry causeway); two others were placed to record water temperatures (one at each of the north and south ferry causeways). The thermographs provided data on seasonal changes and daily temperature fluctuations; they were set to record temperature (± 0.01°C) at 30 min intervals. The air thermograph was suspended in the shade among large boulders, whereas the water thermographs were installed 15 m from shore at a depth of approximately 1.5 m. The thermograph units were retrieved at the end of the fall field sampling session.

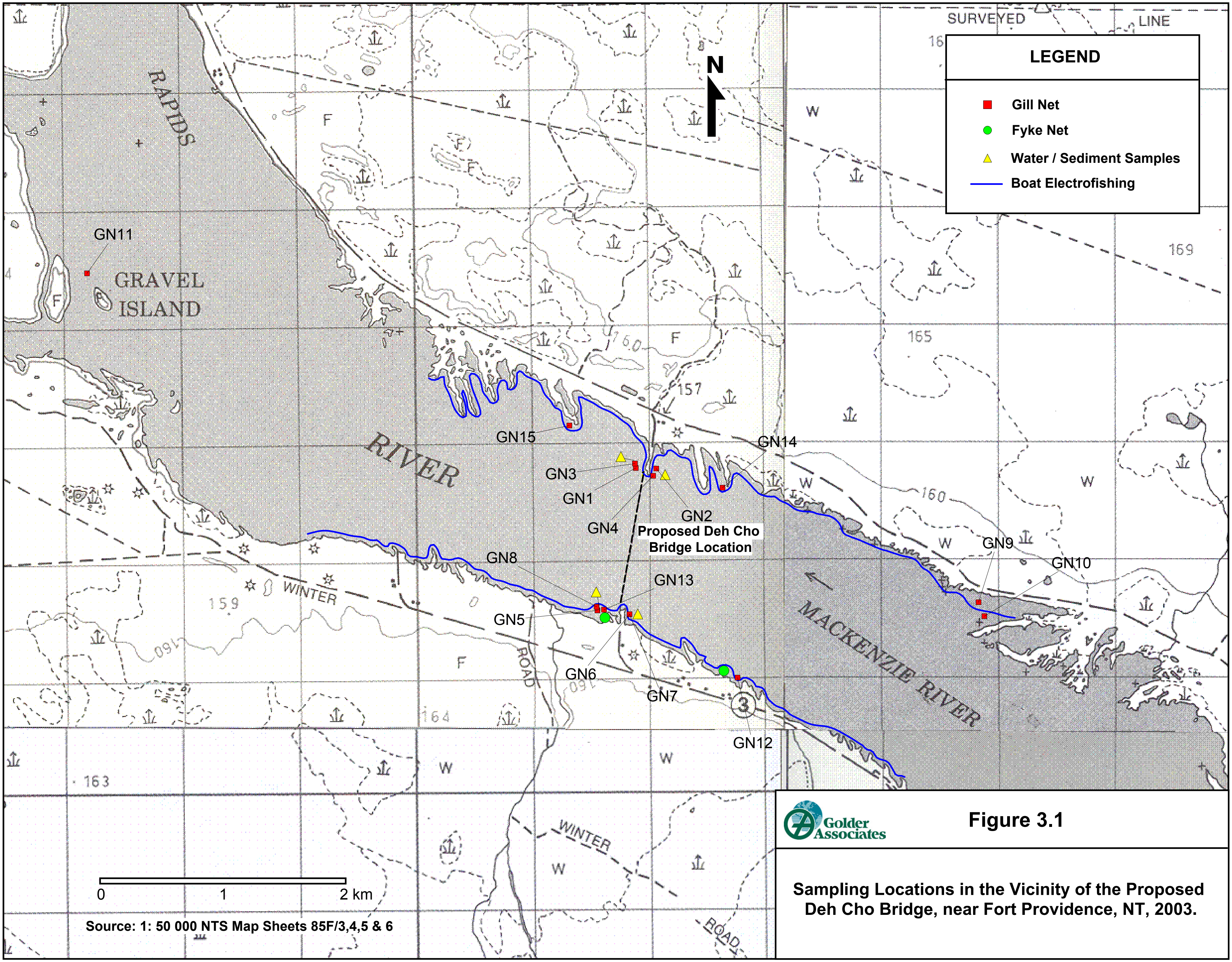


Figure 3.1

Sampling Locations in the Vicinity of the Proposed Deh Cho Bridge, near Fort Providence, NT, 2003.

3.4.2 Water Quality

Field

Selected water quality constituents were recorded in the field. A WTW™ Multi 340i hand-held multi-constituent instrument was used periodically to measure pH, temperature, dissolved oxygen and conductivity. Turbidity was measured using a LaMotte™ 2020 meter and water transparency was determined with a standard Secchi disk, Except for turbidity, water quality was determined from surface waters in-situ (0.5 to 1.0 m water depth; variable for Secchi disk). Turbidity was determined at the end of the field day based on surface grab samples collected earlier in the day.

Laboratory

Surface water samples (0.5 m depth) from four locations (upstream and downstream of the two ferry causeways) were collected during the fall field sampling session (Figure 3.1). The samples were collected using a pre-washed Van Dorn water bottle, and polyethylene gloves were worn to prevent contamination. The samples were placed in pre-washed plastic bottles supplied by Enviro-Test Laboratories in Edmonton. The appropriate pre-measured preservatives supplied by the analytical laboratory were added prior to placing the labeled sample in a cooler.

The samples were kept cool at the site and shipped to the laboratory as soon as possible after collection (within 48 h). Laboratory analyses included a full-range of routine water parameters (including nutrients). Also analysed were: of oil/grease, BTEX (benzenes, toluenes, ethyl benzene, xylenes), TPH (total petroleum hydrocarbon), TEH [total extractable hydrocarbons, includes C5-C10/diesel (C11-C32)], phenols, PAH (polynucleic aromatic hydrocarbons), metals [ICP (inductively coupled plasmaspectrometer) scan], and TOC (total organic carbon).

The constituents analyzed and their detection limits are provided in Appendix A, Table A-1. Methods used by Enviro-Test Laboratories are based on “Standard Methods for the Examination of Water and Wastewater”, 20th Edition, published by the Water Environment Federation (WEF 1998), or on protocols of the United States Environmental Protection Agency (USEPA) as described in “Test Methods for Evaluating Solid Waste, Physical/Chemical Method, SW846”, 3rd Edition (USEPA 1998). Other procedures are based on methodologies accepted by the appropriate regulatory agency. Methodology briefs and the QC (Quality Control) report are provided in Appendix A, Table A-2.

3.4.3 Sediment Characteristics

Sediment samples were collected at the same locations and times as the water samples. The surface layer of sediment (approximately 5 to 10 cm deep) was collected using a Petite Ponar™ grab (15.2 × 15.2 cm sampling area). The sediment samples were shipped to Enviro-Test

Laboratories in Edmonton, Alberta, where they were analyzed to determine particle size distribution and a range of other parameters (see Section 3.3.2).

3.5 Fish Resources

3.5.1 Existing Information

Historical information specific to the Deh Cho Bridge study area is limited to the following:

- environmental review and assessment of proposed dredging in the Mackenzie River. Fisheries information was collected during spring, summer, and fall of 1977 [Renewable Resources Consulting Services Ltd. (RRCS) 1978];
- assessment of Arctic grayling spring spawning migrations in Providence Creek in 1966 (Bishop 1971) and 1976 - 1979 (Falk et. al., 1982);and,
- domestic fisheries harvest data for the Ft. Providence area collected by the Department of Fisheries and Oceans (Hay River); data were available for the years 1995 through 2001.

3.5.2 Local Fisheries Knowledge

In order to obtain information on current and historical use of fish resources in the Ft. Providence area the study team interviewed the local assistants. The information that was obtained during the interview supplemented the material that had been collected on the river during the field surveys. Additional data on domestic fish harvest trends was obtained from DFO (Hay River) and summarized.

3.5.3 Fish Capture

During the fisheries survey in the Deh Cho Bridge study area, several fish capture methods, were applied.

Fyke Net

The main fish sampling gear used in shallow, nearshore habitat was a two-way Arctic fyke net, similar to those used extensively along the Beaufort Sea coast (Bond and Erickson 1989) and along the coast near Kugluktuk (RL&L 1993; Golder 2002). The fyke net consisted of two traps separated by a 45 m lead set perpendicular to shore. This directional set-up allowed the separation of river migrations into eastward (upstream) and westward (downstream) components. However, only one trap was utilized during the summer sampling session, thus precluding collection of directional data during this sampling period. Suitable setting locations for the fyke net were very limited (i.e., restricted to sites along the south shore) (Figure 3.1). During summer, the fyke net was installed immediately downstream of the ferry pull-out area, and during fall it was placed

1000 m upstream of the south ferry causeway. The directional wings on the fyke net were 15 m long and were angled slightly towards the shore (i.e., to deter fish from circumventing the trap entrance). The traps were 3.7 m long and 0.9 m wide, contained two throats (15 × 25 cm each), and were constructed of 1.27 cm dark grey, knotless nylon mesh. Wings and lead were constructed of 2.54 cm dark grey, knotless nylon and were 1.7 m deep. Fyke nets were held in place by metal stakes driven into the river bed.

Fyke nets were checked once or twice daily, depending on the catch rates. On each fyke net lift, trapped fish were removed from the trap and transferred to plastic tubs filled with water. Fish were then measured and released. Sacrificed individuals or capture mortalities were examined internally and then provided to the local community.

Gill Nets

In addition to fyke nets, variable mesh size gill nets were used to capture fish at specific locations in the study area. Each net measured 60 m by 1.8 m, and consisted of two to five monofilament nylon mesh panels (15 m panel length). Mesh sizes included 3.8, 5.1, 6.4, 7.6, 8.9, and 10.2 cm (stretched measure). The nets were continuously monitored during the day (i.e., checked every hour or two); total set times ranged from 1 to 14 hours.

Beach Seine

A 9.1 m long beach seine (0.6 cm mesh with 0.3 cm mesh collection bag) was used to capture fish in shallow, shoreline habitat at several locations in the study area. Typically, a minimum of two seine hauls were performed at each sampling site.

Minnow Traps

Gee™ minnow traps were used to sample at several locations around the existing ferry causeways. The minnow traps (40 cm long, 23 cm in diameter at the middle, and 19 cm in diameter at each end) were two piece wire enclosures with inverted funnel-shaped openings. The traps were baited with cheese or pet food and either tethered to shore or attached to a float.

Boat Electrofishing

A shallow-draught aluminum riverboat (4.9 m) propelled by an outboard-jet motor was used during the fall field sampling session. The boat was equipped with a double-boom anode system and a Smith-Root™ Type VI electrofisher powered by a 4000 W generator. Amperage output produced during sampling ranged from 3.5 to 4.5 A, at a pulse rate of 60 Hz of direct current. The sampling procedure involved drifting downstream (at motor idle) while continuously outputting electricity. Two crew members were positioned on a netting platform on the bow of the boat. These individuals netted the immobilized fish and promptly placed them in a 400 L, onboard livewell. Pertinent data recorded for each sampling run included UTM coordinates at the start and end locations, sampling time (s), electrofisher settings (amperes, volts, pulse width), and number of fish observed but not captured.

Fish Data Collection

All pertinent information regarding fishing effort, location, and habitat type, general water quality and habitat characteristics were recorded for all sampling events. Captured fish were identified and enumerated to species, measured to the nearest millimetre (fork length for most species, total length for species that lack a forked caudal fin), and weighed to the nearest gram (using a digital readout scale). Non-lethal ageing structures were collected from captured sportfish (pelvic fin rays from walleye and northern pike, and scales from whitefish species and Arctic grayling). Stomach content and sexual maturity data were obtained from a small number of fish that succumbed to capture or during processing. No fish were purposely killed in order to obtain life history information. Otoliths, used for aging, were collected from burbot that succumbed during capture.

To determine feeding habits, stomach contents were analyzed. The contents were described according to Thompson (1959), a modification of the numerical method used by Hynes (1950). Each stomach was examined and evaluated for fullness and allotted a certain number of fullness points (i.e., 20 points for a full stomach and 0 points for an empty stomach). After fullness points were allocated, the stomach was opened and the points were distributed among individual food categories observed based on contribution by volume.

4.0 INVENTORY RESULTS

4.1 Physical Habitat

4.1.1 River Hydrology and Geomorphology

Flow Regime

The proposed bridge is located approximately 65 km downstream of the outlet of Great Slave Lake, from which the majority of the Mackenzie River flow originates. According to Trillium (2002), flows are attenuated by lake storage. As such, the maximum recorded flow of 10 400 m^3/s is approximately twice the mean annual flow of 5320 m^3/s, and the minimum recorded flow of 1040 m^3/s is approximately one-fifth of the mean annual flow.

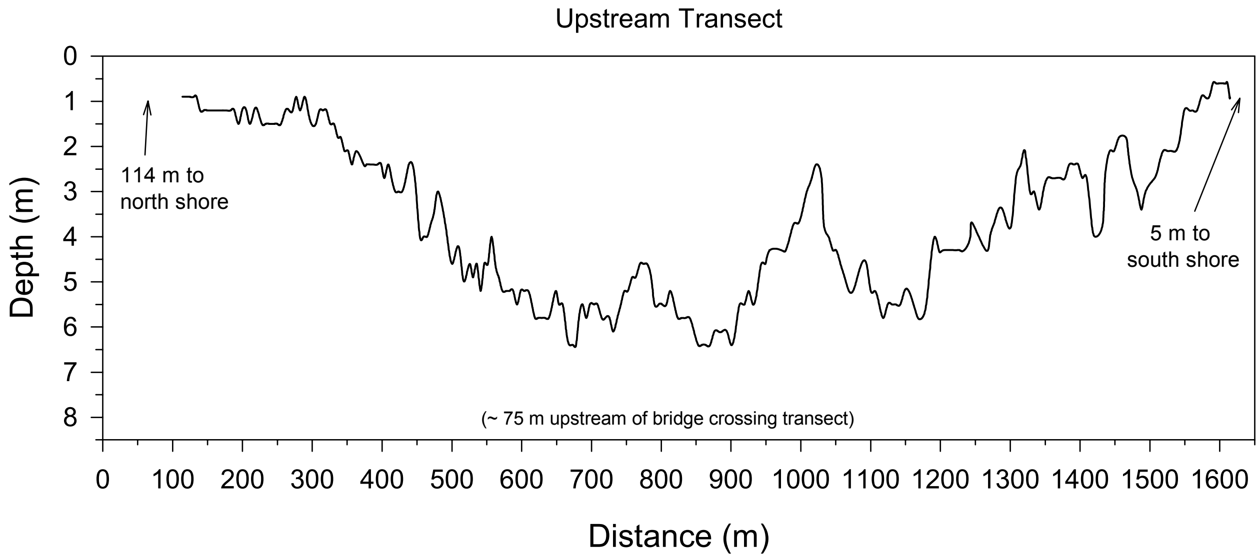
Flows typically range between 1000 m^3/s and 3000 m^3/s from January to mid-April, and begin to increase in mid-April or early May. Open-water flows occur between early June and early November, peaking in June or July and ranging between 4000 m^3/s and 9000 m^3/s. In November, the river below the lake outlet typically begins to freeze over and flows fall to between 2000 m^3/s and 3500 m^3/s by the beginning of December; flows typically continue to decrease until April. The median annual flow is 5320 m^3/s. The median open-water flow is 6600 m^3/s, ranging from 3170 m^3/s to 10 400 m^3/s, and the median ice-covered flow is 2140 m^3/s, ranging from 1160 m^3/s to 4100 m^3/s (Trillium 2002).

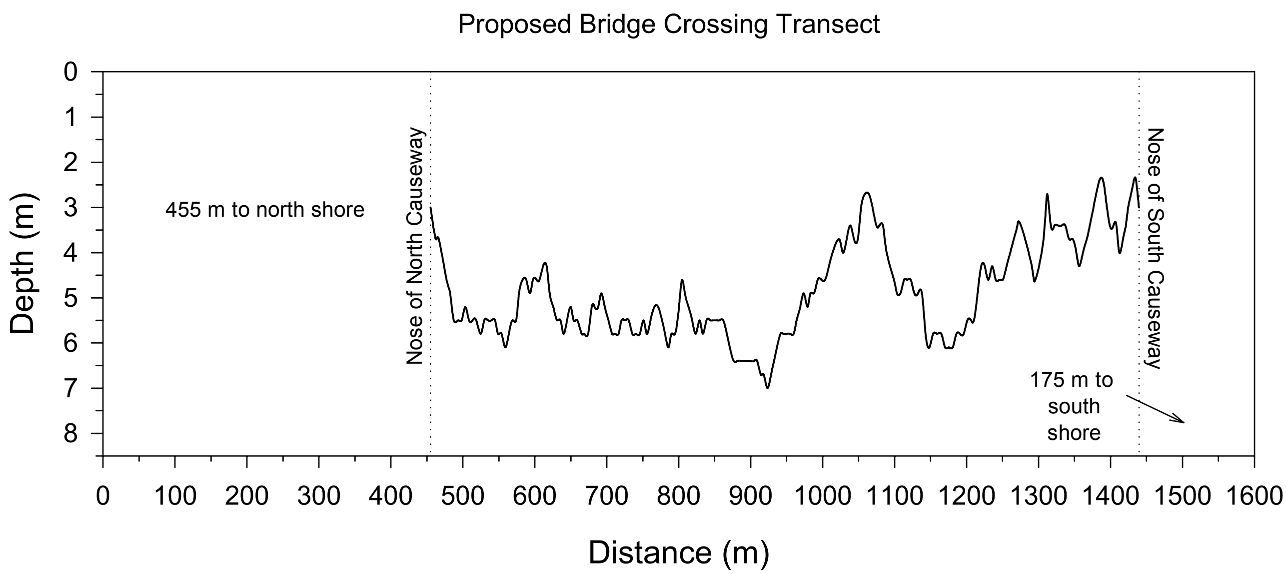
Wind can significantly affect river flows (Trillium 2002). Wind setup on Great Slave Lake can increase flow by hundreds of cubic metres per second. For example, a sustained wind of 60 km/h along the channel fetch in Beaver Lake can cause fluctuations in water level on the order of 0.4 m, and waves of up to 0.9 m in height.

Channel Characteristics

The reach of the Mackenzie River where the bridge is proposed is located between Beaver Lake (upstream) and Meridian Island (downstream). The river width in this reach varies from 1.1 to 1.6 km, and the river cross-section typically contains a 100 to 400 m wide deep channel, which meanders within the shallower full width of the channel. Under median open-water flow conditions (6600 m^3/s), the mean and maximum channel depths are 3.0 and 7.2 m, respectively. The mean bed slope in the reach at the proposed crossing is 0.33 m/km (Trillium 2002).

Cross-channel depth profiles were collected at three transects on 19 September 2003 by Golder field crews (Figure 4.1). The transects were situated at the proposed bridge crossing (i.e., at the ferry crossing), upstream approximately 75 m, and downstream approximately 175 m. Main channel depths (i.e., the river section between the north and south ferry causeways), ranged from 1.2 to 7.9 m; mean water depths upstream, at the proposed crossing, and downstream of the





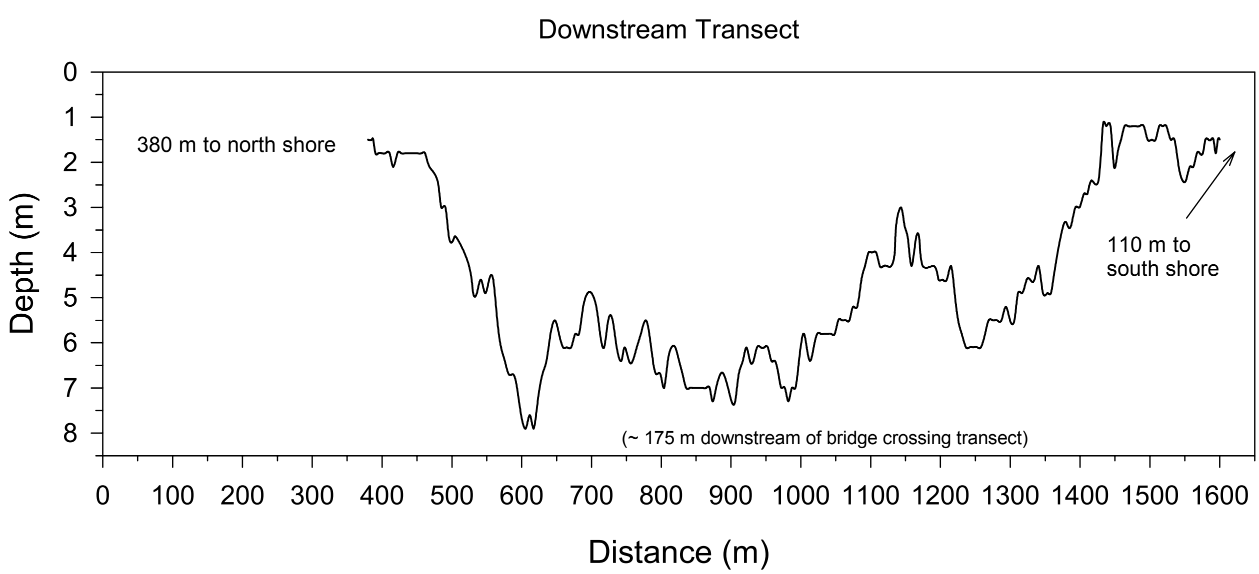


Figure 4.1 Channel depth distribution of the Mackenzie River, in the vicinity of the proposed Deh Cho Bridge, 19 September, 2003.

proposed crossing were similar (4.7, 4.9, and 5.1 m, respectively). The depth profiles exhibited a meandering thalweg and a corrugated river bottom that featured a mid-channel ridge.

Flow Velocity

Trillium (2002) indicated a mean channel velocity under median open-water flow conditions of 1.7 m/s, and a 100-year mean velocity in the bridge waterway (constricted section) of 1.8 m/s.

During the fisheries investigations conducted on 19 September 2003, a transect measured through the constricted section showed a flow area of 4912 m^2. The mean daily discharge, derived from Environment Canada stage data for 19 September 2003 and open water stage-discharge data for 2002, was 5820 m^3/s; indicating a mean channel velocity of 1.2 m/s on the day.

During the fisheries investigation conducted on 1 August 2003, velocities were measured at various locations and depths, including along a transect through the constricted section (proposed bridge crossing section). The estimated mean daily discharge on the day was 6900 m^3/s. Mean water column velocities ranged from 0.9 to 1.4 m/s, and maximum velocities within the water column varied from 1.1 to 1.7 m/s (Appendix B, Table B-1).

The constriction of flow by the existing approaches, and by the approach causeways on the proposed bridge, will increase local flow velocities and scour potential at the bridge abutments. The presence of instream piers will increase local flow velocities and scour potential by reducing local flow area and forming horseshoe vortices around the nose of each pier.

Bed Material and Scour Susceptibility

Trillium (2002) reported the river bed material as clay till overlain by a layer of alluvial material ranging in size from sand to small boulders and in thickness from 0 to 1.8 m. The channel section at the proposed crossing has been assessed as stable, and the clay till relatively non-erodible. Maximum scour depths due to the bridge and approach causeways are:

- maximum 1.4 m due to channel constriction;
- maximum 3.3 m in alluvium at piers;
- maximum 4.9 m in clay at piers (design to 2.0 m, with monitoring, recommended); and,
- maximum 3.0 m at abutments.

Ice Regime

The river is typically affected by ice from early November to early June. During spring breakup, ice jams at the downstream Providence Rapids increase the stage at the proposed crossing. Maximum water levels are experienced when ice from the upstream Beaver Lake meets this ice jam and backs up to the crossing (Trillium 2002).

In-situ ice at the proposed crossing has a 2-year return period thickness of 0.99 m and a 50-year return period thickness of 1.24 m; however, ice formed in Beaver Lake may lodge at the crossing and due to shoving and stacking of pans during freeze-up, this ice has a 2-year return period thickness of 1.54 m and a 50-year return period thickness of 1.83 m. The banks of the river channel are subject to ice shoving as ice floes drift down the channel during spring breakup (Trillium 2002).

4.1.2 General Fish Habitat Description

In general, the river within the 12 km study area can be characterized as predominantly a main channel type of habitat, characterized by high average velocities and depth. The main channel is bordered by low velocity, lake-like habitat (Figure 1.1). Within the study area, the widest part of the river was slightly over 2.5 km, and the narrowest part was just 0.8 km (at the downstream boundary of the study area). The nearshore area is characterized by a series of relatively shallow, protected backwaters (BW) (Figure 4.2). The substrate in these backwaters was comprised of silt and detritus, with abundant aquatic vegetation [pondweeds (*Potamogeton* spp.), rushes (*Scirpus* spp.), and cattails (*Typha* spp.)]. These backwaters were sheltered from the current by narrow fingers of land (peninsulas). The tips of these peninsulas (where they projected into the main channel) featured (gravel and cobble) substrate and formed riffle-run habitat complexes (RR).

At the ferry crossing, causeways extended from both the north and south shores. These causeways were characterized by a sheltered bank (SB) on the downstream side and an exposed bank (EB) on the upstream side. The nose (tip) of each causeway was characterized by moderate to high velocity, deep run (DR) habitat. Large boulders and cobble were common in the exposed bank and deep run habitats, while the substrate in the sheltered bank areas was primarily gravel and silt.

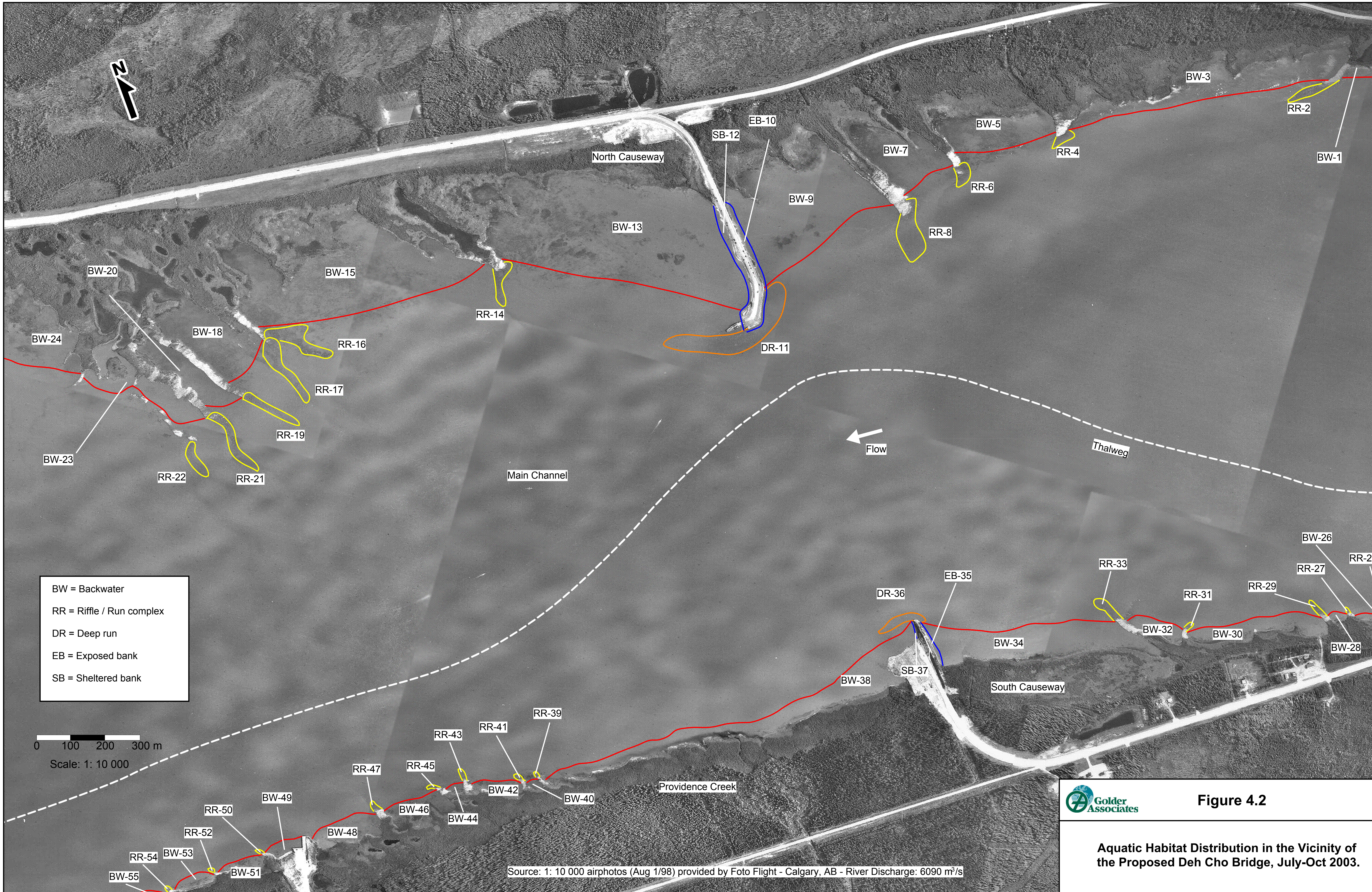


Figure 4.2

Aquatic Habitat Distribution in the Vicinity of the Proposed Deh Cho Bridge, July-Oct 2003.

Towards the downstream end of the study area, the river parted around Meridian Island (Figure 1.1); in this region, the banks were steep with some evidence of slumping. The water depths were shallow along the south shore at the mouth of the Big Snye. This part of the river was dotted with small islands and rocky reefs. The downstream portion of the north shoreline study area was relatively straight as compared with upstream sections; water velocities were swift and there were only a few backwaters.

Although habitat characteristics within the study area on both the north and south shores were similar, particularly in the vicinity of the ferry crossing, the size distribution of habitats differed considerably (Table 4.1). The mean surface area of backwater (BW) habitats on the north shore was 6.03 ha, compared to 1.25 ha on the south shore, and riffle-run complexes (RR) varied from 0.50 ha (north shore) to 0.06 ha (south shore).

In sheltered bays and backwaters, the dominant nearshore rooted macrophytes were bulrush and horsetail (*Equisetum* spp.). Broad-leafed and narrow-leafed pondweeds flourished in the deeper water of most backwaters. Water milfoil (*Myriophyllum* spp.) also occurred; however, it had a patchy distribution. Both banks of the river were vegetated by spruce (*Pinus* spp.), aspen (*Populus* spp.), and willow (*Salix* spp.). Some overhanging willows occurred on the peninsulas that separated the backwaters.

Table 4.1 Distribution of aquatic habitat in the vicinity of the proposed Deh Cho Bridge, July to October 2003.

Habitat Type[1]	Number of Habitats			Total of Surface Area (ha)			Mean Surface Area (ha)[2]		
	North	South	Combined	North	South	Combined	North	South	Combined
Backwater (BW)	11	15	26	66.29	18.77	85.07	6.03	1.25	3.27
Riffle-Run Complex (RR)	10	13	23	5.02	0.72	5.74	0.50	0.06	0.25
Exposed Bank (EB)	1	1	2	0.63	0.14	0.77	-	-	0.39
Sheltered Bank (SB)	1	1	2	0.62	0.03	0.65	-	-	0.33
Deep Run (DR)	1	1	2	2.36	0.36	2.72	-	-	1.36

[1] Mapped along a 4.2 km study reach; see Figure 4.2.
[2] Data is based on calculations from geo-referenced maps and air photographs.

4.2 Water and Bottom Sediment

4.2.1 Water Temperature

Water and air temperatures within the Deh Cho Bridge study area were continuously recorded between 1 July and 21 September 2003 (Figure 4.3; Appendix A, Tables A-3 to A-5). Mean daily air temperature ranged between 23.4°C (1 July) and 3.0°C (21 September). The mean daily water temperatures recorded during the corresponding periods were 22.8°C and 6.2°C, respectively. In general, water temperatures recorded at the north causeway site were slightly higher than at the south causeway site (e.g., averages of mean daily temperatures during August at the north and south sites were 16.7°C and 16.5°C, respectively). During August, mean daily water temperatures at the north site were higher than the south site on 22 of 31 days (71%). In September, the readings were higher at the north site on 19 of the 21 sampling days (91%). The maximum daily temperatures recorded during the survey at the north and south sites were 23.1°C and 21.4°C, respectively; both of these values were recorded on 1 July, the first day of recording.

The higher values recorded on the north side were likely due to the larger size, and greater isolation of the backwaters from the main river current (i.e., due to greater peninsula extension into the channel). Although only spot measurements of water temperature in the main channel were taken, it appears that nearshore habitats, regardless of their location (north or south shore), generally were warmer than the main channel (Appendix A, Table A-6). For example, on 1 August (late afternoon readings) water temperatures of 16.1°C and 16.8°C were recorded in the main channel off the south causeway. The minimum temperature reading on the continuous recorder (south site) on that date was 19.5°C, indicating that the main channel was at least 3°C cooler than the nearshore area on the south shore.

4.2.2 Water Quality

Field

Selected water quality constituents at sites upstream and downstream of each causeway, and within the main channel were measured (Appendix A, Table A-6). Dissolved oxygen concentrations (recorded only during summer survey) were generally high regardless of sampling location (8.6 to 11.9 mg/L). In general, turbidity levels were low in the study area (ranged between 8.0 and 13 NTU). Values appeared to be slightly higher along the south shore on most days. However, turbidity was considerably higher along the south shore during one of the fall sampling periods (values ranged between 25.3 and 71.0 NTU) relative to the north shore. It is assumed that the elevated turbidity on the south shore was due to the strong prevailing winds which re-suspended bottom sediments in Beaver Lake and in shallow, nearshore areas upstream. It is assumed that these areas accumulate substantial sediment delivered by tributaries entering the south shore of Great Slave Lake (i.e., Kakisa River, Buffalo River, Slave River). All pH values were slightly alkaline (7.2 to 8.7 pH units). Conductivity values were low, ranging between 159 and 225 μS/cm.

Laboratory

Comprehensive water quality samples were collected at four locations in the vicinity of the proposed Deh Cho Bridge. These data will provide background reference for the proposed development. The samples were collected upstream and downstream of each ferry landing causeway on 18 September 2003. Most of the water quality constituents had reported concentrations or values that were below the Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life (CCME 1999); many constituents were below laboratory analytical detection limits (Appendix A, Table A-1).

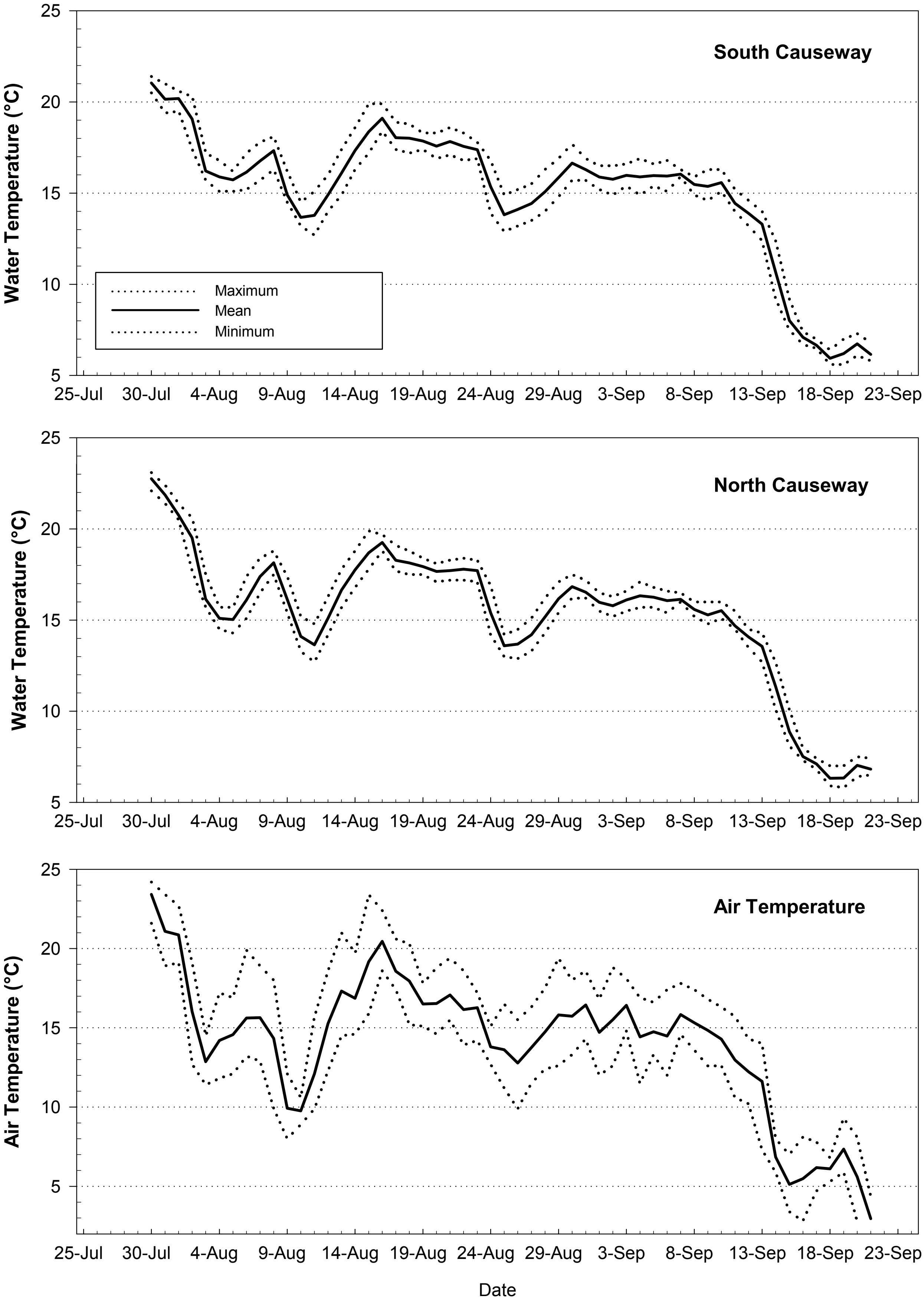


Figure 4.3 Water and air temperature recorded in the vicinity of the proposed Deh Cho Bridge, July - September 2003.

Constituents that were not compliant with CEQG included aluminum, copper, and iron (Table 4.2). Prior to sample collection, strong winds (generally greater than 50 km/h) persisted for several days. This disturbed sediments in shallow near shore areas and likely influenced the concentration of some water quality constituents. Ammonia, oil and grease, and total suspended solids (TSS) are water quality constituents of concern because they may be released during construction of the proposed bridge, as follows:

- ammonia occurs as a residue in blasted rock material;
- oil and grease is commonly encountered in transportation corridors, and is used to lubricate the wooden runners on the south ferry take-out area; and,
- elevated TSS concentrations generally occur during instream construction activities.

Table 4.2 Selected water quality constituents of the Mackenzie River in the vicinity of the Deh Cho Bridge, 18 September 2003.

Constituent [1]	Detection Limit	North Causeway		South Causeway		CEQG [4]
		u/s [2]	d/s [2]	u/s	d/s	
Aluminum	0.01	0.16	0.10	0.11	0.24	0.100
Copper	0.0006	0.0017	0.0017	0.0020	0.0035	0.002
Iron	0.005	0.379	0.240	0.531	2.12	0.300
Ammonia	0.05	<0.05	<0.05	<0.05	<0.05	1.04 [5]
Oil and Grease	1	<1	<1	<1	<1	na [6]
TSS	3	10 [3]	13 [3]	139	173	Background dependent [7]

[1] All concentrations reported as mg/L. TSS = total suspended solids.
[2] u/s = upstream; d/s = downstream.
[3] Collected on 20 September 2003.
[4] CEQG = Canadian Environmental Quality Guidelines for the protection of aquatic life (CCME 1999).
[5] Level for pH of 8.0 and water temperature of 10.0°C; ammonia guideline concentrations are pH and temperature dependent.
[6] na = not applicable/available.
[7] Total Suspended Sediment (TSS) guidelines
1) Clear flow conditions (TSS ≤ 25 mg/L)
- short-term exposure (≤ 24 h); levels not to exceed 25 mg/L above background.
- long-term exposure (24 h – 30 d); levels not to exceed 5 mg/L above background.
2) High flow conditions (TSS 25 – 250 mg/L)
- maximum allowable increase of 25 m/L above background.
3) Highflow conditions (TSS > 250 mg/L)
- maximum allowable increase of not more than 10% above background.

Concentrations of ammonia and oil and grease were below analytical detection limits. TSS concentrations at the north ferry landing causeway were low (collected on 20 September 2003), whereas the south ferry landing causeway exhibited high TSS concentrations (collected on 18 September 2003). This situation also was documented with field turbidity measurements (see Section 4.2.2).

4.2.3 Sediment Characteristics

Sediment samples were collected from four locations in the vicinity of the proposed Deh Cho Bridge (upstream and downstream of each causeway) on 18 September 2003. All of the sediment quality constituents had reported concentrations or values that were below the Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life (CCME 1999). Many constituents were below laboratory analytical detection limits (Appendix A, Table A-1). These data serve as background reference for the proposed development.

As described above for water quality (Section 4.2.2), ammonia and oil-gravimetric are sediment quality constituents of concern because they may be factors during construction activities. Ammonia concentrations were low at all sites. Oil and grease content was considerably higher (1200 mg/kg) in the sample collected downstream of the north ferry landing causeway, in comparison to the levels recorded in the samples from the remaining three sites (400 to 700 mg/kg). No explanation for this elevated reading is available; further testing would be required to extablish the relevance of the measurement. Median sediment particle size ranged from 6.892 to 9.437 µm; values tended to be slightly higher in the downstream samples at both ferry landings (Table 4.3; Appendix A, Table A-7).

Table 4.3 Selected sediment characteristics of the Mackenzie River in the vicinity of the Deh Cho Bridge, 18 September 2003.

Constituent [1]	Detection Limit	North Causeway		South Causeway		CEQG [3]
		u/s [2]	d/s [2]	u/s [2]	d/s [2]	
Ammonia	1	3	3	4	5	na[4]
Oil-Gravimetric	1	700	1200	600	400	Na
Median Particle Size (µm)	na	6.892	9.437	7.779	8.111	Na

[1] All concentrations reported as mg/km, unless stated otherwise.
[2] u/s = upstream; d/s = downstream.
[3] CEQG = Canadian Environmental Quality Guidelines for the protection of aquatic life (CCME 1999).
[4] na = not applicable/available.

4.3 Fish Resources

4.3.1 Local Fisheries Knowledge and Harvest

During the present investigation it was determined that, from a domestic value perspective, the key fish species are lake whitefish and northern pike. Species such as walleye and inconnu, although they are captured less frequently and on a more seasonal basis, are highly valued as well. Residents of Ft. Providence make considerable use of the various backwater habitats in the vicinity of the proposed bridge. In this regard, gill nets are set on a routine basis on both the north and south side of the river. The area upstream of the north ferry landing appears to be most heavily used. The results of the domestic fish harvest (1994 to 2001), were provided by DFO in Hay River (Table 4.4). As indicated, the catch year-over-year is comprised largely of lake whitefish and northern pike, followed by walleye and suckers. Arctic grayling, inconnu and burbot made only a minor contribution on an annual basis. The domination of the catch by lake whitefish and northern pike appears to persist throughout the open water season (Table 4.5). Sport fishing was not observed in the study area during the two survey periods; however, the upstream end of Providence Island is reported to be a favorite location for Arctic grayling. Providence Creek which historically has supported Arctic grayling spawning has been closed to angling for many years to protect the population. Angling for northern pike and walleye also occurs in the study area. Some local anglers indicated that the walleye catch has declined in recent years, particularly relative to the catch of northern pike.

Table 4.4 Summary of domestic fish harvest by residents of Ft. Providence, NT (1994 to 2001).

Fish Species	Mackenzie River Near Townsite		Horn River		Combined	
	Mean Catch/year	Range	Mean Catch/year	Range	Mean Catch/year	Range
Lake Whitefish	487	0-1190	1206	10-1777	1693	0-1777
Northern Pike	174	0-337	477	138-853	651	0-853
Walleye	32	0-59	79	28-240	110	0-240
Inconnu	5	0-21	5	0-15	10	0-21
Longnose/White Suckers	41	0-101	1477	59-607	225	0-607
Arctic Grayling	12	0-30	163	0-66	33	0-66
Burbot	1	0-5	33	0-21	7	0-21

Table 4.5 Seasonal fish harvest by residents of Ft. Providence, NT (1996 to 2001).

Harvest Intervals	Numbers of Fish Harvested													
	Lake Whitefish		Northern Pike		Walleye		Inconnu		Suckers		Arctic Grayling		Burbot	
	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River
Jun 1-15														
1996	0	106	0	97	0	30	0	8	0	348	0	0	0	0
1997	0	68	0	32	0	6	0	4	0	8	0	7	0	0
1998	50	36	31	22	1	2	8	1	8	119	7	5	0	0
1999	14	32	9	17	3	0	0	0	2	15	1	0	0	0
2000	0	100	0	55	0	12	0	2	0	42	0	18	0	0
2001	78	74	21	38	6	3	0	0	5	13	2	4	0	0
MEAN	**23.6**	**69.3**	**10.2**	**43.5**	**1.7**	**8.8**	**1.3**	**2.5**	**2.5**	**90.8**	**1.7**	**5.7**	**0.0**	**0.0**
Jun 16-30														
1996	5	46	4	117	1	35	0	0	0	165	0	0	0	0
1997	0	161	0	59	0	20	0	1	0	42	0	13	0	0
1998	69	51	35	24	5	6	1	0	12	17	4	5	1	0
1999	62	63	21	27	8	4	0	0	13	17	8	4	0	0
2000	0	59	0	55	0	22	0	0	0	23	0	19	0	0
2001	46	63	20	28	2	5	0	0	5	9	0	2	0	0
MEAN	**30.3**	**73.8**	**13.3**	**51.7**	**2.7**	**15.3**	**0.2**	**0.2**	**5.0**	**45.5**	**2.0**	**7.2**	**0.2**	**0.0**
Jul 1-15														
1996	6	38	7	64	2	40	0	0	1	11	0	0	0	0
1997	150	72	42	33	8	8	0	0	16	58	13	3	0	0
1998	77	70	42	34	3	11	0	0	9	9	1	3	0	0
1999	53	38	26	16	6	12	1	0	10	4	7	6	0	0
2000	35	76	17	51	5	10	0	2	6	8	6	19	0	0
2001	68	69	24	30	11	7	0	0	5	9	3	2	0	0
MEAN	**64.8**	**60.5**	**26.3**	**32.8**	**5.8**	**14.7**	**0.2**	**0.3**	**7.8**	**16.5**	**5.0**	**5.5**	**0.0**	**0.0**

…Continued

Table 4.5 Seasonal fish harvest by residents of Ft. Providence, NT (1996 to 2001), continued.

Harvest Interval	Numbers of Fish Harvested													
	Lake Whitefish		Northern Pike		Walleye		Inconnu		Suckers		Arctic Grayling		Burbot	
	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River
Jul 16-31														
1996	63	139	29	94	27	67	0	0	3	13	0	0	0	0
1997	139	79	56	36	15	9	0	0	17	34	9	10	0	0
1998	159	13	88	16	10	2	0	0	39	5	2	0	0	0
1999	0	112	0	46	0	22	0	0	0	16	0	7	0	0
2000	49	71	13	36	7	12	0	0	1	10	2	6	0	0
2001	44	40	16	24	4	6	2	0	6	4	0	0	3	0
MEAN	**75.7**	**75.7**	**33.7**	**42.0**	**10.5**	**19.7**	**0.3**	**0.0**	**11.0**	**13.7**	**2.1**	**3.8**	**0.5**	**0.0**
Aug 1-15														
1996	122	180	51	101	19	56	0	0	8	12	0	0	0	0
1997	78	66	39	35	9	9	0	0	4	13	8	0	0	0
1998	39	17	25	19	3	2	0	0	7	2	0	2	1	0
1999	36	103	18	46	2	11	0	0	8	14	4	8	0	0
2000	42	141	29	56	10	3	0	2	0	19	0	3	0	0
2001	38	72	10	48	2	12	0	0	6	17	1	1	0	0
MEAN	**59.2**	**96.5**	**28.7**	**50.8**	**7.5**	**15.5**	**0.0**	**0.3**	**5.5**	**12.8**	**2.2**	**2.3**	**0.2**	**0.0**
Aug 16-31														
1996	103	306	36	132	5	11	0	2	3	31	0	0	0	0
1997	37	74	16	35	6	4	0	0	0	10	0	0	0	0
1998	49	74	25	35	7	1	0	4	12	5	9	8	1	0
1999	62	148	47	76	1	5	0	0	8	16	3	1	0	0
2000	46	240	22	89	6	28	1	1	4	16	0	0	0	2
2001	85	165	36	72	5	1	0	0	14	18	0	0	0	0
MEAN	**63.7**	**167.8**	**30.3**	**73.2**	**5.0**	**8.3**	**0.2**	**1.2**	**6.8**	**16.0**	**2.0**	**1.5**	**0.2**	**0.3**

…Continued

Table 4.5 Seasonal fish harvest by residents of Ft. Providence, NT (1996 to 2001) concluded.

Harvest Interval	Numbers of Fish Harvested													
	Lake Whitefish		Northern Pike		Walleye		Inconnu		Suckers		Arctic Grayling		Burbot	
	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River	Townsite	Horn River
Sep 1-15														
1996	96	148	35	58	0	0	0	0	4	13	0	0	0	0
1997	74	176	18	44	0	7	0	0	6	8	0	0	0	0
1998	79	162	42	82	3	2	0	0	9	12	0	0	0	0
1999	16	161	9	91	0	0	0	0	2	8	0	0	0	0
2000	0	303	0	16	0	0	0	5	0	11	0	1	0	3
2001	54	123	9	43	0	1	0	0	0	7	0	0	0	0
MEAN	**53.2**	**178.8**	**18.8**	**55.7**	**0.5**	**1.7**	**0.0**	**0.8**	**3.5**	**9.8**	**0.0**	**0.2**	**0.0**	**0.5**
Sep 16-30														
1996	71	316	24	96	1	4	0	0	3	14	0	0	0	0
1997	0	214	0	63	0	0	0	0	0	6	0	0	0	0
1998	44	258	22	107	0	0	0	0	5	13	0	0	0	2
1999	0	491	0	134	0	0	0	0	0	28	0	0	0	0
2000	0	417	0	117	0	0	0	2	0	5	0	0	0	11
2001	72	184	15	61	0	0	0	0	4	0	0	0	0	0
MEAN	**31.2**	**313.3**	**10.2**	**96.3**	**0.2**	**0.7**	**0.0**	**0.2**	**2.0**	**11.0**	**0.0**	**0.0**	**0.0**	**2.2**
Oct 1-15														
1996	179	527	34	117	0	1	0	0	1	0	0	0	0	0
1997	0	413	0	85	0	4	0	0	0	6	0	0	0	0
1998	63	244	27	78	0	2	0	0	0	7	0	0	2	10
1999	0	254	0	40	0	0	0	0	0	4	0	0	0	0
2000	0	189	0	41	0	0	0	1	0	1	0	0	0	5
2001	26	59	14	19	0	0	0	1	0	0	0	0	0	0
MEAN	**44.7**	**331.0**	**12.5**	**63.3**	**0.0**	**1.2**	**0.0**	**0.3**	**0.2**	**3.0**	**0.0**	**0.0**	**0.3**	**2.5**

4.3.2 Species Occurrence (2003)

Twelve fish species, representing eight taxonomic families, were captured in the Mackenzie River within the Deh Cho Bridge study area in 2003 (Table 4.6). The combined catch from all sampling methods was 1044 fish (Table 4.7; Appendix C, Table C-1). Emerald shiners dominated the sample (i.e., contributed 62.8% to the total catch). Six sportfish species accounted for 21.0% of the total catch; these included northern pike (10.9%), lake whitefish (7.4%), walleye (0.9%), Arctic grayling (0.7%), round whitefish (0.6%), and burbot (0.6%). Other species frequently encountered were white sucker (1.8%), longnose sucker (0.4%), spottail shiner (11.3%), ninespine stickleback (1.4%), and trout-perch (1.2%).

Catch data for the same study area in 1977 (RRCS 1978) yielded a similar species composition. However, during the 1977 study, five species not recorded in the present study were encountered, including lake chub, longnose dace, spoonhead sculpin, slimy sculpin, and lake cisco. As was the case in 2003, the dominant sportfish species in 1977 were lake whitefish and northern pike.

Chum salmon (*Oncorhynchus keta (Walbaum)*) were not encountered during the present study, but are known to migrate upstream past the site (to Great Slave Lake and Slave River) during late fall, on a sporadic basis (McPhail and Lindsay, 1970).

Table 4.6 Fish species recorded in the vicinity of the proposed Deh Cho Bridge, July to Sept 2003.

Scientific Name	Common Name	South Slavey[1] Name	Code
Family Salmonidae			
Coregonus clupeaformis (Mitchill)	Lake whitefish	Luh	LKWH
Prosopium cylindraceum (Pallas)	Round whitefish	Luh	RNWH
Thymallus arcticus (Pallas)	Arctic grayling	Ts'a'iah	ARGR
Family Percidae			
Stizostedion vitreum vitreum (Mitchill)	Walleye	Ehch'ue	WALL
Family Escoidae			
Esox lucius Linnaeus	Northern pike	Udaa	NRPK
Family Gadidae			
Lota lota (Linnaeus)	Burbot	Nohtthie	BURB
Family Catostomidae			
Catostomus catostomus (Forster)	Longnose sucker	Dedeli	LNSC
C. commersoni (Lacepède)	White sucker	Dedeli	WHSC
Family Cyprinidae			
Notropis atherinoides Rafinesque	Emerald shiner		EMSH
N. hudsonius (Clinton)	Spottail shiner		SPSH
Family Percopsidae			
Percopsis omiscomaycus (Walbaum)	Trout-perch		TRPR
Family Gasterosteidae			
Pungitius pungitius (Linnaeus)	Ninespine stickleback		NNST

[1] South Slavey Topical Dictionary, Second Edition, 1993. Teaching and Learning Centre, Dehcho Divisional Board of Education, Ft. Simpson, NT 162 p.

4.3.3 Fyke Net Catches

The fyke net was installed perpendicular to shore in shallow water (less than 1.5 m) at two locations in the vicinity of the proposed Deh Cho bridge. During the July field sampling session the fyke net was installed downstream of the south ferry causeway. In September, it was installed upstream of the south ferry causeway. During the fall survey, the fyke net was equipped with two cod ends separated by a single 45 m lead to permit the separation of catches into upstream and downstream movements. Only one cod end was installed during the summer (due to river conditions); therefore, collection of directional data was not possible at this time.

Northern pike (75.5%) and burbot (10.2%) dominated the combined summer and fall catch (Table 4.7). Five other species (lake whitefish, white sucker, emerald shiner, spottail shiner, and trout-perch) made minor contributions to the catch (total of 14.2%).

The total fyke netting effort during the study was 136 hours, and the total catch was 49 fish (Table 4.8). The catch per unit effort (CPUE) for northern pike and burbot was 0.27 fish/h and 0.04 fish/h, respectively. The individual catch rates for the five remaining species were very low (CPUE values of 0.01 fish/h).

4.3.4 Gill Net Catches

Gill netting was conducted at 14 different locations in the study area; sets were made at one of these sites on two occasions (Figure 3.1). The combined catch was largely comprised of northern pike (41.9%) and lake whitefish (37.1%); other species recorded were white sucker (10.5%), walleye (7.3%), emerald shiner (2.4%), and longnose sucker (0.8%) (Table 4.7).

In total, 6.1 net-units (one net-unit equaled 100 m^2 of net set for 24 h) of gillnetting effort were expended; 124 fish were captured, providing a mean CPUE of 20.3 fish/net-unit (Table 4.9).The CPUE for the most frequently recorded species were: northern pike (8.5 fish/net-unit), lake whitefish (7.5 fish/net-unit), white sucker (2.1 fish/net-unit), and walleye (1.5 fish/net-unit). Emerald shiner (0.5 fish/net-unit) and longnose sucker (0.2 fish/net-unit) were encountered infrequently (Table 4.9).

In 1977, RRCS (1978) reported catches similar to those documented during the present study. As was the case in 2003, their gill net catch was made up primarily of northern pike (48%) and lake whitefish (35%). The percentage contribution of walleye to the catch also was similar between the two studies (7.3% in 2003 and 7.5% in 1977). The remainder of the catch in 1977 was comprised of longnose sucker (5%), round whitefish (3%), and white sucker (1.5%).

4.3.5 Beach Seine Catches

Beach seining was conducted at 10 representative sites located in shallow, nearshore habitat, upstream and downstream of the ferry crossing. Emerald shiner and spottail shiner were the dominant species recorded, contributing 81.9% and 14.7% respectively, to the total beach seine catch. Small numbers of ninespine stickleback (1.9%), trout-perch (1.4%), and northern pike (0.1%) also were collected (Tables 4.7 and 4.10).

Table 4.7 Summary of fish captured in the vicinity of the proposed Deh Cho Bridge, July to September 2003.

Species	Boat Electrofishing		Gill Nets		Fyke Nets		Beach Seines		Minnow Traps		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Northern pike	23	28.0	52	41.9	37	75.5	1	0.1	1.0	100.0	**114**	**10.9**
Walleye			9	7.3							**9**	**0.9**
Arctic grayling	7	8.5									**7**	**0.7**
Burbot	1	1.2			5	10.2					**6**	**0.6**
Lake whitefish	30	36.6	46	37.1	1	2.0					**77**	**7.4**
Round whitefish	6	7.3									**6**	**0.6**
White sucker	5	6.1	13	10.5	1	2.0					**19**	**1.8**
Longnose sucker	3	3.7	1	0.8							**4**	**0.4**
Emerald shiner	7	8.5	3	2.4	1	2.0	645	81.9			**656**	**62.8**
Spottail shiner					2	4.1	116	14.7			**118**	**11.3**
Trout-perch					2	4.1	11	1.4			**13**	**1.2**
Ninespine stickleback							15	1.9			**15**	**1.4**
Total	**82**	**100**	**124**	**100**	**49**	**100**	**788**	**100**	**1**	**100**	**1044**	**100**

Table 4.8 Number of fish captured and effort (CPUE) in the fyke net located in the vicinity of the proposed Deh Cho Bridge, July to September 2003.

Set No.[1]	Set Date	Check Date	Effort (h)	Number of Fish Captured[2]								CPUE (Number of Fish / h)							
				NRPK	LKWH	BURB	WHSC	EMSH	SPSH	TRPR	Total	NRPK	LKWH	BURB	WHSC	EMSH	SPSH	TRPR	Total
1	31-Jul	1-Aug	18.5	11			1				**12**	0.59			0.05				**0.65**
1	1-Aug	2-Aug	24.3	1							**1**	0.04							**0.04**
1	2-Aug	3-Aug	24.5	5							**5**	0.20							**0.20**
2	17-Sep	18-Sep	21.0	6	1	1			1		**9**	0.29	0.05	0.05			0.05		**0.43**
2	18-Sep	19-Sep	24.5	10		3			1		**14**	0.41		0.12			0.04		**0.57**
2	19-Sep	20-Sep	23.3	4		1		1		2	**8**	0.17		0.04		0.04		0.09	**0.34**
Total			**136.0**	**37**	**1**	**5**	**1**	**1**	**2**	**2**	**49**	**0.27**	**0.01**	**0.04**	**0.01**	**0.01**	**0.01**	**0.01**	**0.36**

[1] All fyke net sets were in the vicinity of the south ferry causeway. Set 1 = UTM (11V) NAD 27, 471548E 6791735N;
Set 2 = UTM (11V) NAD 27, 472651E 6791061N. Net sets were in backwater habitats, 1.0 to 1.5 m water depth, among silt/sand/boulder substrate.

[2] See Table 4.1 for explanation of fish species codes.

Table 4.9 Gillnet catches and CPUE in the vicinity of the proposed Deh Cho Bridge, July to September 2003.

Set No.	Site[1]	Location (UTM) (Datum NAD27)	Pull Date	Set Duration (h)	Net Units[2]	Water Temp (C°)	Substrate Type[3]	Number of Fish Captured/ *CPUE (fish/ 100 m^2/ 24 h)*												
								NRPK		LKWH		WALL		LNSC		WHSC		EMSH		**TOTAL**
GN1	NC	11V E471928 N6792782	30-Jul	4.5	0.21	22.6	Si/Sa	5	*23.9*											**5**
GN2	NC	11V E472044 N6792765	30-Jul	4.0	0.23	22.6	Si/Sa	4	*17.2*	3	*12.9*							3	*12.9*	**10**
GN3	NC	11V E471882 N6792789	1-Aug	40.8	0.47	22.6	Si/Sa													**0**
GN4	NC	11V E472012 N6792684	1-Aug	40.7	0.47	22.6	Si/Sa	1	*2.1*											**1**
GN5[4]	SC	11V E471548 N6791578	31-Jul	4.5	0.21	23.2	Si/Sa	2	*9.6*	3	*14.3*	1	*4.8*			3	*14.3*			**9**
GN6[5]	SC	11V E471822 N6791542	31-Jul	4.4	0.25	23.2	Si/Sa/Gr	1	*3.9*											**1**
GN7[5]	SC	11V E471822 N6791542	3-Aug	67.0	0.78	19.3	Si/Sa/Bo	10	*12.8*	4	*5.1*	2	*2.6*							**16**
GN8[4]	SC	11V E471548 N6791578	3-Aug	65.6	0.76	19.3	Si/Sa/Bo	6	*7.9*	2	*2.6*	5	*6.6*			5	*6.6*			**18**
GN9	PC	11V E474826 N6791702	1-Aug	5.5	0.32	19.0	Bo/Co													**0**
GN10	NS	11V E474826 N6791489	1-Aug	3.7	0.17	17.9	Si/Sa/Bo	9	*52.8*	4	*23.5*	1	*5.9*			5	*29.4*			**19**
GN11	SS	11V E467205 N6794479	2-Aug	4.2	0.24	17.9	Si/Sa	1	*4.1*	1	*4.1*			1	*4.1*					**3**
GN12	SC	11V E472742 N6790996	20-Sep	22.3	0.52	6.0	Bo/Co	3	*5.8*	13	*25.1*									**16**
GN13	SC	11V E471615 N6791560	20-Sep	22.3	0.52	6.0	Bo/Co	3	*5.8*	1	*1.9*									**4**
GN14	NC	11V E472630 N6792608	21-Sep	21.4	0.50	6.5	Bo/Co	5	*10.1*	2	*4.0*									**7**
GN15	NC	11V E471340 N6793165	21-Sep	20.4	0.47	6.5	Bo/Co	2	*4.2*	13	*27.4*									**15**
TOTAL				**331.2**	**6.13**			**52**	***8.5***	**46**	***7.5***	**9**	***1.5***	**1**	***0.2***	**13**	***2.1***	**3**	***0.5***	**124**

[1] NC = north ferry causeway; SC = south ferry causeway; PC = near Providence Creek; NS = north shore upstream near groyne area; SS = south shore downstream near island. Catches were at a water depth of 1.0 m to 3.0 m.
[2] 1 net unit = 100 m^2 of gill net set for an equivalent of 24 hours.
[3] Si = silt; sa = sand; gr = gravel; co = cobble; bo = boulder.
[4] Sets GN5 and GN8 at same location.
[5] Sets GN6 and GN7 at same location.

Table 4.10 Beach seine catches and CPUE in the vicinity of the proposed Deh Cho Bridge

Set No.	Site[1]	UTM (11V) NAD27		Date	Time	Effort (m^2)	Substrate[2]	Max. Depth (m)	Cover[3]	Number of Fish Captured[4]						CPUE (Number of Fish / 100 m^2)					
		Easting	Northing							NRPK	EMSH	NNST	SPSH	TRPR	Total	NRPK	EMSH	NNST	SPSH	TRPR	Total
BS-1	NC	471983	6792786	17-Sep	15:15	750	sa/gr/co/bo	1.1	Veg/Bo		89		8		**97**		11.9		1.1		**12.9**
BS-2	NC	471940	6792650	17-Sep	15:30	660	si/sa/gr	1.0	Veg		64		18	10	**92**		9.7		2.7	1.5	**13.9**
BS-3	NC	472016	6792805	17-Sep	16:50	280	si/sa/co/bo	1.0	Veg/Bo		21	1	1		**23**		7.5	0.4	0.4		**8.2**
BS-4	NC	472009	6792760	17-Sep	17:20	210	si/sa/bo	1.0	Veg/Bo		21				**21**		10.0				**10.0**
BS-5	SC	471746	6791548	19-Sep	14:15	280	si/sa/co/bo	0.7	Bo		25	1	4		**30**		8.9	0.4	1.4		**10.7**
BS-6	SC	471692	6791498	19-Sep	14:25	140	si/sa/co/bo	0.9	Bo		2	2			**4**		1.4	1.4			**2.9**
BS-7	SC	472165	6791291	19-Sep	16:30	320	si/sa/bo	0.7	Veg/Bo		11	1	5		**17**		3.4	0.3	1.6		**5.3**
BS-8	SC	472255	6791257	19-Sep	16:40	350	si/sa/bo	0.8	Veg/Bo			7			**7**			2.0			**2.0**
BS-9	SIR	475481	6787721	20-Sep	15:30	195	si/sa/gr	1.0	Veg		32	1	3		**36**		16.4	0.5	1.5		**18.5**
BS-10	SIR	475481	6787721	20-Sep	15:50	210	si/sa/gr	1.0	Veg	1	252		71		**324**	0.5	120.0		33.8		**154.3**
BS-11	NIR	477718	6788994	20-Sep	14:10	175	si/sa/gr/co	1.0	Veg		59		1		**60**		33.7		0.6		**34.3**
BS-12	NIR	477718	6788994	20-Sep	14:30	195	si/sa/gr/co	1.0	Veg		69	2	5	1	**77**		35.4	1.0	2.6	0.5	**39.5**
Total						**3765**				**1**	**645**	**15**	**116**	**11**	**788**	**0.03**	**17.1**	**0.4**	**3.1**	**0.3**	**20.9**

[1] NC = north causeway; NIR = north shore ice road crossing, SIR = south shore ice road causeway.
[2] Si = silt; sa = sand; gr = gravel; co = cobble; bo = boulder.
[3] Veg = aquatic vegetation; Bo = boulder.
[4] See Table 4.1 for explanation of fish species codes.

The total area sampled was approximately 3765 m^2 and the total catch was 788 fish (Table 4.10). The CPUE for emerald shiner and spottail shiner, the species which dominated the catch, were 17.1 fish/100 m^2 and 3.1 fish/100 m^2, respectively. Low catch rates were recorded for ninespine stickleback, trout-perch and northern pike (i.e., 0.4, 0.3, and 0.03 fish/100 m^2, respectively).

In contrast to the results obtained in 2003, RRCS (1978) captured few emerald shiners. In 1977, the catch was dominated by white and longnose sucker followed by spoonhead sculpin, spottail shiner, northern pike, slimy sculpin, lake chub, and longnose dace. Seine hauls in 1977 also included low numbers of Arctic grayling and burbot.

4.3.6 Minnow Trap Catches

Minnow traps were largely ineffective during the present study (Table 4.7). Thirty-five traps were set for a total effort of 957 hours, and only one northern pike (1.1 fish/24 h) was captured.

4.3.7 Boat Electrofishing

In total, 82 fish encompassing eight species were captured while boat electrofishing in the study area (Figure 3.1; Table 4.7). The electrofishing catch was comprised largely of lake whitefish (36.6%) and northern pike (28%). Arctic grayling and round whitefish made contributions to the catch of 8.5% and 7.3%, respectively. The two sucker species (longnose sucker and white sucker) together contributed 9.8% to the total catch. Other species recorded in the catch were emerald shiner (8.5%), and burbot (1.2%).

Catch-per-unit-effort (CPUE) values were calculated, based on time sampled (Table 4.11). The species combined CPUE was 3.25 fish/10 min. The CPUE values for lake whitefish and northern pike, the species that contributed most to the catch, were1.19 fish/10 min and 0.91 fish/10 min, respectively. Catch rates for Arctic grayling, round whitefish and burbot were considerably lower (ranging from 0.28 fish/10 min to 0.04 fish/10 min).

During the 1977 study (RRCS, 1978), boat electrofishing was conducted during spring and fall. Lake whitefish (57%) was the dominant species in the catch during the spring survey. Other species contributing to the spring catch included: longnose sucker (21%), northern pike (15%), and white sucker (7%). During the fall survey, lake whitefish and northern pike comprised the majority of the catch (55%) followed by Arctic grayling (14%), longnose dace (10%), round whitefish (7%), and burbot (4%). Longnose and white suckers contributed 10% to the fall 1977 catch.

Table 4.11 Boat electrofishing catches and CPUE in the vicinity of the proposed Deh Cho Bridge, July to September 2003.

Site	Location[1]	Start UTM (11V) NAD27		Stop UTM (11V) NAD27		Effort (s)	Number of Fish Captured[2]									CPUE (Number of Fish / 10 min)								
		Easting	Northing	Easting	Northing		NRPK	LKWH	ARGR	RNWH	BURB	LNSC	WHSC	EMSH	Total	NRPK	LKWH	ARGR	RNWH	BURB	LNSC	WHSC	EMSH	Total
ES-1	NS-upst	474716	6791585	469735	6793939	5244	12	7	6	6			1		**20**	1.37	0.80	0.69	0.69			0.11		**3.66**
ES-2	NS-dnst	469735	6793939	471967	6792794	4384	5	8					1		**9**	0.68	1.1					0.14		**1.92**
ES-3	SS-upst	474122	6790309	471648	6791498	3024	3	8	1			2	3	1	**15**	0.6	1.59	0.2			0.4	0.6	0.2	**3.57**
ES-4	SS-dnst	471648	6791498	469079	6792209	2488	3	7			1	1		6	**15**	0.72	1.69			0.24	0.24		1.45	**4.34**
Total						**15140**	**23**	**30**	**7**	**6**	**1**	**3**	**5**	**7**	**59**	**0.91**	**1.19**	**0.28**	**0.24**	**0.04**	**0.12**	**0.20**	**0.28**	**3.25**

[1] NS-upst = north shore usptream of north ferry causeway, NS-dnst = north shore downstream of north ferry causeway, SS-upst = south shore upstream of south ferry causeway,
SS-dnst = south shore downstream of south ferry causeway.
Substrate consisted of silt, sand, gravel, and cobble. Habitat type was a mixture of Runs and Backwaters with aquatic vegetative cover.

[2] See Table 4.1 for explanation of fish species codes.

4.3.8 Life History Data

Northern pike

Size Distribution

The size distribution of northern pike in the catch (*n*=114) was widespread (fork lengths ranged between 88 and 928 mm). The distribution exhibited several distinct modes, indicating the presence of a range of age classes in the sample (Figure 4.4). A considerable portion of the catch (21%) consisted of fish smaller than 160 mm in fork length (modal length of 125 mm). The capture of immature individuals confirms that the study area is providing rearing habitat for northern pike, and could indicate that spawning is occurring in the vicinity as well. Fish larger than 420 mm contributed 72% to the catch. The median length of the total measured sample was 520 mm.

Age

Sampled fish were not systematically aged during the present study (ageing structures archived for future reference). However, based on the size of northern pike captured, in comparison to aged samples reported by other investigators (RRCS, 1978; Roberge et al, 1985), northern pike captured in 2003 likely ranged in age from age-0 to age-15+. Several smaller specimens (100-125 mm, fork length) were aged using scales to confirm the presence of young-of-the-year pike in the study area; all were considered to be fish spawned in spring 2003.

Diet

Six of the 23 northern pike stomachs examined contained food items (Appendix C, Table C-1). The mean fullness index was low (23.9%). Northern pike diet consisted primarily of fish; identifiable fish species in the diet included northern pike, burbot, lake whitefish, and shiners. One individual had a whole mouse in the stomach, which accounted for 18.2% of the total food volume.

Stomach analysis conducted during 1977 (RRCS 1978) also determined that the diet was primarily composed of fish (lake cisco, round whitefish, sculpin, etc.). A small percentage (less than 1%) of the food content was comprised of invertebrates including beetle (Coleoptera) and dragonfly (Anisoptera) larvae.

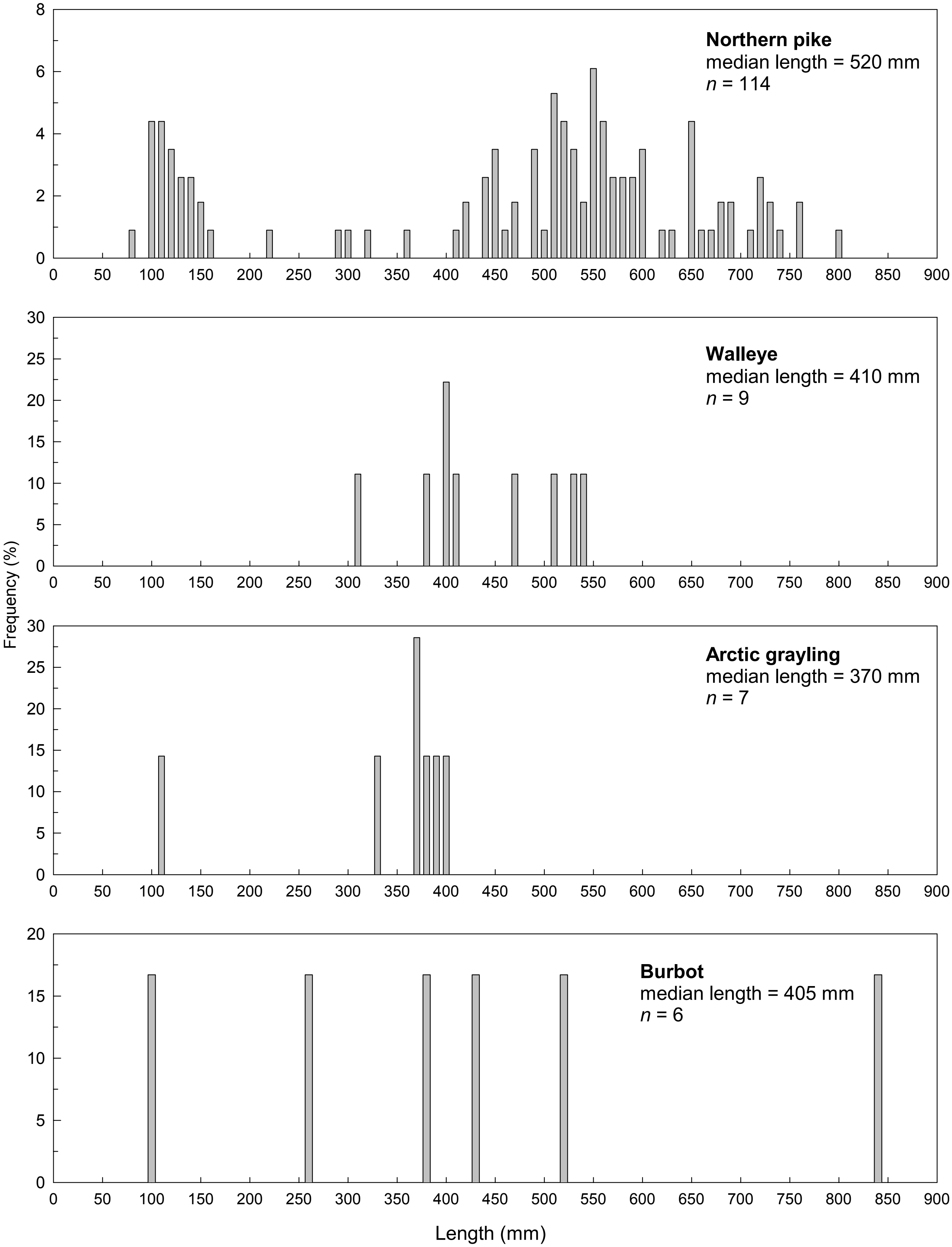


Figure 4.4 Length-frequency distribution of the fish catches in the vicinity of the proposed Deh Cho Bridge, July - September, 2003.

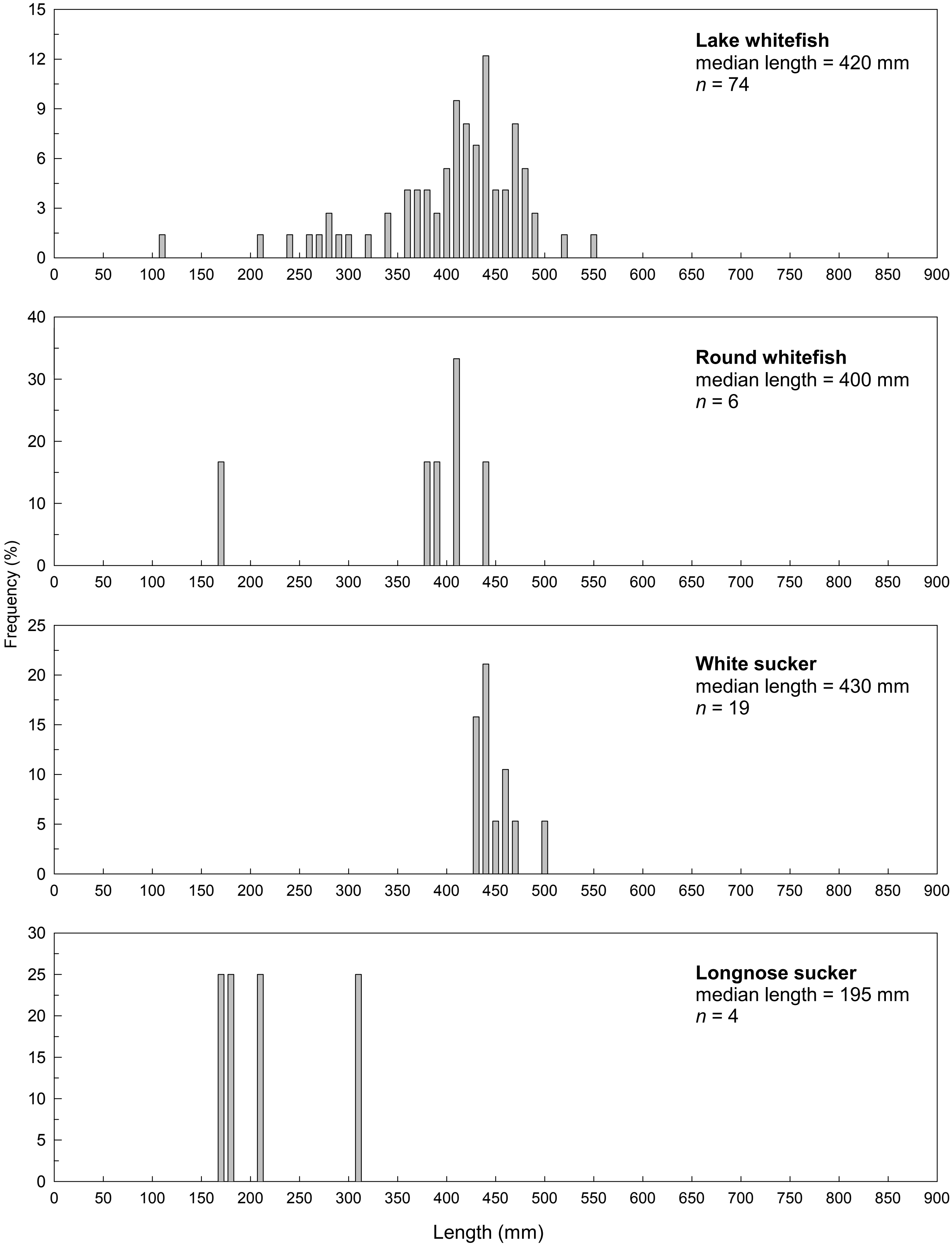


Figure 4.4 continued.

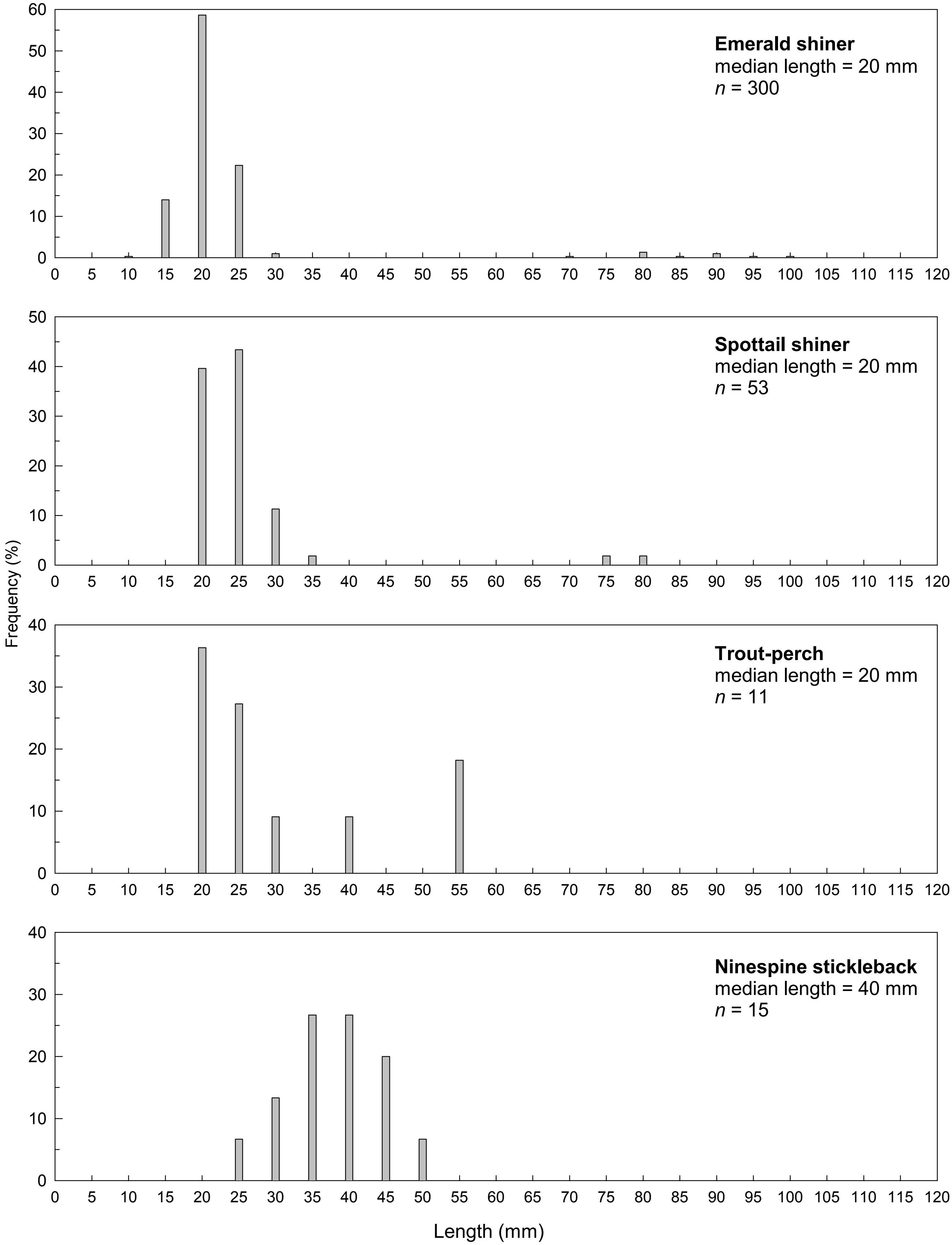


Figure 4.4   concluded.

Walleye

Size Distribution

The catch of walleye (*n*=9) ranged in fork length between 318 and 540 mm; the median length of the sample was 410 mm. Length-classes between 400 and 540 mm contributed 77.8% to the total catch. Individuals less than 380 mm were poorly represented, contributing only 22.2% to the total catch (Figure 4.4).

Age

Walleye sampled in 2003 were not aged although the ageing structures were archived for future use. Based on age-length data for walleye in nearby Kakisa Lake (Roberge et al. 1986), it is assumed that walleye captured in Deh Cho Bridge study area ranged in age from age-6 to age-15+.

Diet

Two of the seven walleye stomachs examined contained food items (Appendix C, Table C-1). The mean fullness index was 17.1%. The diet consisted entirely of fish; although most food items were unidentifiable to species, northern pike were present. Stomach analysis during the 1977 study (RRCS 1978) also determined that fish were the primary food source; identifiable fish in the diet included Arctic grayling, whitefish, and sculpin.

Arctic grayling

Size Distribution

The catch of Arctic grayling (*n*=7) ranged in fork length between 115 and 403 mm (Figure 4.4); the median length of the sample was 370 mm. Only one young-of-the-year individual was captured during the study (115 mm fork length individual recorded on 18 September).

Age

The age of Arctic grayling in the 2003 sample was estimated based on a comparison to aged samples reported by RRCS (1978), for the Mackenzie River near Ft. Providence and by Falk et al (1982), for Providence Creek. Based on these sources, the 2003 sample was comprised of individuals ranging in age from age-0 to age-7.

Diet

During the present study, Arctic grayling stomach contents were not examined internally (i.e., all fish released). However, in 1977 (RRCS 1978) 11 young-of-the-year Arctic grayling stomachs were analyzed. Diet consisted primarily of invertebrates, including midges (Chironomidae), blackflies (Simuliidae), caddisflies (Trichoptera), mayflies (Ephemeroptera), biting midges (Ceratopogonidae), and true bugs (Hemiptera).

Burbot

Size Distribution

The catch of burbot (*n*=6) ranged between 102 and 844 mm in total length, with a median length of 405 mm (Figure 4.4). Length-classes between 260 and 520 mm contributed 66.7% to the total catch. Only one young-of-the-year individual was captured during the study (102 mm total length individual recorded on September 18).

Age

Based on the size of burbot captured in 2003, in comparison to an aged sample from the west end of Great Slave Lake (Roberge et al. 1985), it is assumed that burbot encountered in the present study ranged in age from age-0 to age-17+.

Diet

Only one burbot stomach was examined during the present study; it contained one burbot and one lake whitefish (Appendix C, Table C-1). RRCS (1978) analyzed stomach contents from six young-of-the year burbot; they determined that the primary food source was invertebrates [mayflies, dragonflies, blackflies, water fleas (Cladocera), scuds (Amphipoda) and seed shrimp (Ostracoda)].

Lake whitefish

Size Distribution

The median fork length of lake whitefish in the catch (*n*=74) was 420 mm (range from 117 to 555 mm). A considerable proportion (36.5%) of the catch was composed of fish less than 400 mm in length. Individuals greater than 480 mm were poorly represented, contributing only 10.8% to the total catch (Figure 4.4).

Age

Based on the size of lake whitefish captured during the present study, in comparison to an aged sample from the west end of Great Slave Lake (Roberge et al., 1985), it is likely that fish in the sample ranged in age from age-0 to age-18+. Several adult lake whitefish (females and males) in pre-spawning condition were captured in the study area during the fall survey (18-21 September), indicating that spawning may occur in the area. Alternatively, these individuals may have been on route to spawning areas located elsewhere.

Diet

Only 18 of the 42 lake whitefish stomachs examined contained food items (Appendix C, Table C-1). The mean fullness index was 35.7%. Lake whitefish diet consisted primarily of invertebrates (94.3% of total food volume), including water boatmen (Corixidae), clams (Sphaeridae), back swimmers (Notonectidae), caddisflies, mayflies, scuds, snails (Gastropoda), and beetles. Aquatic vegetation was also recorded in lake whitefish stomachs, accounting for 5.7% of the total food volume. Stomach analysis during 1977 (RRCS 1978) produced similar results; the primary food source was invertebrates, with a small (1%) fish component (sculpins).

Round whitefish

Size Distribution

The catch of round whitefish (n=6) ranged in fork length from 173 to 445 mm; the median length of the sample was 400 mm (Figure 4.4). Only one round whitefish smaller than 350 mm was captured in the study (individual with a fork length of 173 mm, captured on September 17).

Age

Based on the size of round whitefish captured, in comparison to an aged sample from Great Slave Lake (Roberge et al. 1985), it is likely that the 2003 catch ranged in age from age-1 to age-18+. Two of the round whitefish captured were in pre-spawning condition (a male and female captured on 17 September), indicating that spawning may occur in the area.. Alternatively, these individuals may have been on route to spawning areas located elsewhere.

Diet

Round whitefish stomachs were not examined during the present study. However, RRCS (1978) analyzed the contents of two round whitefish stomachs; they determined that the primary food source was invertebrates (caddisflies and mayflies).

White sucker

Size Distribution

White suckers in the catch (*n*=19) ranged between 350 and 507 mm in fork length, with a median length of 430 mm (Figure 4.4). The length-frequency distribution was characterized by one distinct mode centered around 460 mm. Young-of-the-year and juvenile individuals were not encountered in the present study.

Diet

Two white sucker stomachs were examined for food contents during the present study; both were empty. RRSC (1978) examined the contents of white sucker stomach; they determined that it contained clams, caddisflies, mayflies, and midge larvae.

Longnose sucker

Size Distribution

Longnose suckers in the catch (*n*=4) ranged between 175 and 313 mm in fork length; the median length of the sample was 195 mm (Figure 4.4).

Diet

Longnose sucker stomachs were not examined for food contents during the present study. However, RRCS (1978) reported that the stomachs of three longnose suckers contained primarily filamentous green algae and caddisflies.

Minnow species

Size Distribution

Emerald shiners in the sample (*n*=300) varied between 12 and 100 mm in fork length (median length of 20 mm). Most (96.3%) of the catch was less than 30 mm in fork length. It is assumed that these individuals (which were all captured between 17-21 September) were young-of-the-year fish. Specimens greater than 70 mm also were encountered, but they contributed only 3.7% to the total catch (Figure 4.4). Although specimens were not aged, it is likely that the larger individuals were primarily age-1 with a smaller contribution of age-2 fish. The largest individuals would be age-3 during the coming spring/summer; three years of age is considered to be the maximum life expectancy for emerald shiners (Scott and Crossman, 1973).

The catch of spottail shiners (*n*=53) ranged between 21 and 80 mm in fork length; the median length of the sample was 20 mm. Most spottail shiners (96.2%) were less than 30 mm (Figure 4.4). As was the case for emerald shiners, it is assumed that the captured specimens were primarily age-0 (young-of-the-year), with a minor contribution of age-1 individuals.

The trout-perch catch (*n*=11) ranged between 21 mm and 56 mm in fork length; the median length of the sample was 20 mm (Figure 4.4). Most trout-perch (72.7%) were less than 30 mm; these individuals were assumed to be young produced during spring/ early summer of the current year.

Ninespine stickleback in the catch (*n*=15) ranged between 27 and 50 mm in fork length, with a median length of 40 mm (Figure 4.4)..

4.3.9 Important/Critical Fish Movements

The fish capture results (fyke net, gill nets, electrofishing) did not detect any distinct seasonal movements in the study area during the two survey periods. It is assumed that any movements in the area were localized and feeding-related rather than being specifically to and from important and critical habitats (i.e., spawning, overwintering areas). The inability to detect defined movements during the survey periods may have been influenced by the timing of the field sampling. In this regard, the late July sampling event occurred after the spring spawning related movement period, and the fall sampling event may have taken place prior to major fall spawning and overwintering related movements. However, based on the fish (species, life stage, maturity) captured, and known to inhabit the area according to traditional knowledge, defined movements past the proposed bridge site on an annual basis can be assumed.

During spring (mid-April through May), spawning-related movements by Arctic grayling can be expected due to the presence of known spawning areas in the lower reach of Providence Creek (Bishop 1971; Falk *et al* 1982). Fish tagged during the spawning run were later recaptured by anglers in the Mackenzie River near Ft. Providence and as far away as Brabant Island in Great Slave Lake, indicating that Arctic grayling from the Providence Creek spawning population contribute to the sport fishery over a wide area (Falk *et al* 1982). Movements of pre-spawning adult Arctic grayling directed towards Providence Creek can be expected to occur in early spring (late April to mid-May). Post-spawning adults are likely to depart Providence Creek in late May and disperse to summer feeding areas in the Ft. Providence area and Great Slave Lake. For adults that remain in the area, or move in from other spawning sites, the focus of feeding activity over the summer would be in the vicinity of the riffle-run complexes situated off the tips of peninsulas.

Northern pike are also known to spawn in Providence Creek during the spring (Bishop 1971; Falk et al 1982). Therefore, movements of adult pike towards Providence Creek can be expected in early to mid-May; post-spawning movements to summer feeding areas in the Mackenzie River can be anticipated in late May. Spawning by northern pike has not been confirmed in the mainstem Mackenzie River near Ft. Providence. However, the likelihood of it occurring is high based on the abundance of northern pike in the area and the presence of extensive potentially suitable spawning habitat in the nearshore zone along both the north and south banks.

Spawning movements by other spring spawning species inhabiting the area (walleye, longnose sucker, white sucker) are not well-understood. Walleye are captured in nearshore habitats in the vicinity of the proposed bridge, particularly along the south shore. The extent of use of the rocky areas off the tips of the various peninsulas which extend into the channel for spawning is unknown. Walleye were captured in small numbers during the late July/early August 2003 survey, but were not encountered during the fall sampling period (Table 4.9). The domestic harvest data (Table 4.5) indicates that the local catch of walleye is relatively low during the early part of the season (June 1-15) and increases to its maximum level in mid-summer (July 16-31). Thereafter, the catches decline and reach their minimum levels during fall. Based on the information available (i.e., low numbers of walleye in the late spring early summer domestic harvest) it appears that walleye spawning may not occur in the study area. This being the case, it follows that there is a post-spawning dispersal of walleye into the area beginning in early summer from spawning sites outside the study area, and an out-migration in late summer/early fall to overwintering sites. Walleye are known to spawn in the Kakisa River during late May and early June (Falk and Dahlke 1975). This spawning population may be the source of the walleye inhabiting the Ft. Providence study area during the summer months.

Spawning, feeding and overwintering-related movements by key fall spawning species in the study area (lake whitefish, round whitefish, inconnu) are not well-understood. However, based on trends apparent in the domestic harvest data (Table 4.5), previously collected data and the 2003 results, it is evident that lake whitefish movements in the area are likely to be extensive. The data suggests that there may be a dispersal into the area during the summer for feeding purposes, followed by an outmigration in the fall (perhaps to spawning areas located elsewhere). However, based on the capture of several pre-spawning adults in suitable spawning habitat, it is possible that lake whitefish spawn, and may be resident in the area.

Very little is known about the distribution, biology and movements of round whitefish in the upper Mackenzie River mainstem. However, round whitefish utilize the riffle/run complexes located at the offshore ends of peninsulas for feeding during the summer months, and may spawn there as well. Whether these individuals are year-round residents or move into the area from Great Slave Lake for part of their life-cycle is unknown.

Inconnu, although they are highly regarded by the residents of Ft. Providence, do not appear to make a large contribution to the domestic harvest near the townsite (Table 4.5).The few that are encountered on an annual basis are apparently captured in the early part of the season (June).These individuals are likely part of an overall movement towards spawning areas located outside the study area. Spawning areas for inconnu have been documented in several tributaries to Great Slave Lake, particularly the Buffalo River and the Slave River (Fuller 1955, McLeod *et al* 1985). Based on the low numbers of inconnu in the domestic harvest and their absence in the 2003 survey catch, it is assumed that this species is an occasional migrant past the site. Individuals encountered in the vicinity of Ft. Providence may be downstream migrants from Great Slave populations or perhaps strays form riverine-based populations in the Ft. Simpson/Liard River areas.

Burbot were captured during the fall 2003 survey in directional fyke nets, indicating that these individuals were moving through the nearshore zone along the south shore. The extensive backwater habitats in the study area are assumed to be highly suited to burbot feeding (i.e., based on large numbers and diversity of fish prey). While the riffle-run complexes, which feature coarse substrate, would appear to be suitable for spawning, the extent of use of these areas is unknown. Because burbot are mid-winter spawners (January – March) their spawning distribution and biology is not well understood.

5.0 IMPACT ASSESSMENT AND MITIGATION OPPORTUNITIES

5.1 Key Fish Species and Important / Critical Habitat Availability

Based on the Ft. Providence domestic harvest and the capture results obtained during the present study, it is apparent that the key fish species inhabiting the Mackenzie River in the vicinity of the proposed Deh Cho Bridge are northern pike and lake whitefish. These species accounted for the largest percentage of fish captured in the domestic fishery near the townsite (over 85 % of harvest between 1994 and 2001; Table 4.4), which extends throughout the open water season. Other highly valued species include Arctic grayling, walleye, burbot, and inconnu; however, they are captured on a more seasonal and site specific basis. Fish groups such as suckers (white and longnose) and minnows (emerald shiners, spottail shiners, etc.) are also important members of the fish community due to their importance as a food source for predatory fish species (e.g., northern pike, walleye, inconnu, and burbot).

The magnitude and significance of the proposed Deh Cho Bridge on the various species is dependent on the type and quality of the habitat available, and the project activities that are applied. Table 5.1 summarizes the suitability and use (when known) of habitat for the various life requisite activities (spawning, rearing, etc.). Following a review of this material it is apparent that the “high” suitability ratings are associated with the “backwater”, “riffle-run” and (to a lesser extent) “sheltered bank” habitats. These nearshore habitats, were developed, and are currently maintained, naturally (in association with the peninsulas that extend into the channel) and by man-made structures (i.e., ferry approaches).

With respect to spawning, backwater habitats are considered to be highly suitable for northern pike, and several minnow species (emerald shiner, spottail shiner, ninespine stickleback) that are very important to the overall food chain in the study area. These habitats provide ideal spawning conditions for these species due primarily to the extensive availability of areas with low velocity and aquatic vegetation. Backwater areas also provide ideal rearing conditions for a wide range of species including northern pike, lake whitefish, burbot, suckers and several types of minnows. These habitats are also used extensively for adult feeding during the open water season (northern pike, lake whitefish, suckers, burbot, minnows).

Riffle-run complexes, located at the offshore ends of peninsulas, provide highly suitable spawning habitat for species that require coarse bed material (gravel, cobble) situated in moderate velocity settings. This includes both spring spawning (Arctic grayling, white sucker, longnose sucker, and possibly walleye) and fall/winter spawning species (lake whitefish, round whitefish, burbot). The sheltered bank areas, which are formed on the leeward side of the north and south ferry landings, provide high quality rearing and adult feeding habitat for northern pike and a range of minnow species.

5.2 Short Term Effects (Construction)

The construction of the Deh Cho bridge may result in a number of impacts on the aquatic environment at, and within the downstream zone of influence. The extent and severity of the impacts will depend on the type and quality of the habitat affected, the timing of the construction activity and, of course, the nature of the instream construction and the effectiveness of the mitigation plan implemented.

The construction will result in an increase in boat/barge traffic at the site, with attendant increases in noise associated with the equipment. While this activity may deflect some fish from the immediate areas of the construction, these disturbances are expected to be short term and not harmful to the local fish populations. This conclusion is based on the large size of the river in relation to the availability of alternate habitats for rearing and feeding. However, this also assumes that construction scheduling is sensitive to timing issues with respect to spawning. For example, it would be prudent to avoid instream construction activity at, or immediately upstream of sites that are known (or suspected) to be spawning sites, during critical periods.

It is inevitable that suspended sediment will be introduced into the river during the bridge construction phase. The amount of sediment that will be released is difficult to predict. However, it is possible to adjust the intensity and timing of instream activity on a daily basis to regulate the amount of sediment released and ultimately the concentrations reached in the water column (feedback monitoring). Also, it may be possible to schedule some of construction activities during non-sensitive time periods for fish and other aquatic life. The background level of natural sediment in the river should also be taken into account. For example, it may be possible to conduct some instream activity during periods when suspended sediment levels are running at seasonally high levels. Guidelines for sediment release can also be set and monitored during construction to ensure that suspended sediment levels do not exceed accepted water quality guidelines (an example of a construction monitoring program is provided in Appendix D). During construction there will be an increased risk of a contaminant spill, primarily associated with the heavy equipment operating in the area. With proper planning and supervision this risk can be minimized.

Table 5.1 Aquatic Habitat Suitability[1] of the Mackenzie River for key fish species, in the vicinity of the proposed Deh Cho Bridge

Fish Species	Backwater (BW)				Riffle-Run (RR)				Deep Run (DR)				Sheltered Bank (SB)				Exposed Bank (EB)				Main Channel (MC)			
	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW
Northern Pike	H	H	H	M	N	L	L	N	N	N	L	N	N	H	H	N	N	L	M	N	N	N	L	L
Comments:	The amount of backwater habitat is higher on the north shore due to greater extension of peninsulas, but the suitability of the south shore on a unit-area basis was similar to the north shore.				Adults may hold and feed at bottom end of runs, or in adjacent backwater.				Some adult feeding potential but water velocities generally too high to support use.				Adult feeding use high due to abundance of minnows (several species available); y-o-y and juvenile pike rearing high due to presence of low velocity habitat with aquatic vegetation.				Some adult feeding (and limited rearing) in specific low velocity locations.				Limited adult feeding in lower velocity habitat along perimeter of backwaters; overwintering possible along low velocity margins.			
Walleye	N	L	M	M	M	L	M	N	N	N	M	N	N	L	M	N	N	L	M	N	N	N	L	L
Comments:	Apparent preference for the south shore, possibly due to elevated turbidity relative to north shore (i.e.sediment input from Kakisa River etc. during freshet, and subsequent wind-induced re-suspension).				Potentially suitable for spawning, but adults inhabiting area may be from other known spawning populations (ie. Kakisa River). Rearing suitability low due to generally high velocities.				Some adult feeding potential but velocities too high for overwintering.				Adult feeding based on abundance of minnows, but suitability reduced by high water clarity over much of year.				Adult feeding use during certain periods of year, based on availability of juvenile fish.				May overwinter in low velocity areas along perimeter.			
Arctic grayling	N	N	L	L	H	M	H	L	N	N	M	L	N	N	N	N	N	L	L	N	N	N	M	M
Comments:	Possible use for feeding and overwintering, but primary habitat focus on associated riffle-run complexes.				Potential for spawning and rearing, but grayling in area likely from known spawning population in Providence Creek; adult feeding use				Some adult feeding potential, but high velocities may limit overwintering use.				Water velocities generally too low, and presence of adult northern pike reduces suitability.				Rearing and adult feeding possible, but suitability reduced by low water velocities and presence of northern pike.				Adult feeding and overwintering may extend from riffle-run complexes into main channel margins.			
Lake whitefish	N	H	H	M	H	M	M	N	N	N	M	N	N	M	M	N	N	M	M	N	N	N	N	M
Comments:	High quality adult feeding and juvenile rearing habitat confirmed.				Good spawning conditions; capture of fish in pre-spawning condition indicates possible spawning use.				Some adult feeding potential but velocities may be excessive.				Potential for adult feeding and juvenile rearing.				Potential for adult feeding and juvenile rearing.				May overwinter in low velocity areas along perimeter of backwater.			
Round whitefish	N	L	L	L	H	M	H	N	N	N	M	L	N	L	L	N	N	L	L	N	N	N	L	L
Comments:	Some potential for rearing and adult feeding, but prefer higher velocity areas (riffle/run).				Good spawning conditions noted; fish in pre-spawning condition captured indicating possible spawning use.				Some adult feeding potential, but overwintering use may be restricted by high velocities.				Habitat largely unsuitable due to low water velocities.				Some adult feeding and rearing potential, but likely site-specific use depending on water velocities.				Adult feeding and overwintering may occur in margins between riffle/run complexes and main channel.			
Burbot	N	H	H	M	H	N	M	N	N	N	L	L	N	M	M	N	N	L	M	N	N	N	N	M
Comments:	High quality adult feeding and rearing habitat throughout.				Spawning possible at downstream end of runs where depths >2 m.				Some adult feeding and overwintering, but restricted by high water velocities.				Some adult feeding and possible rearing.				Some adult feeding (possible rearing), but site-specific according to velocities.				May overwinter in low velocity areas along channel margins.			

Table 5.1 Aquatic Habitat Suitability[1] of the Mackenzie River for key fish species, in the vicinity of the proposed Deh Cho Bridge

Fish Species	Backwater (BW)				Riffle-Run (RR)				Deep Run (DR)				Sheltered Bank (SB)				Exposed Bank (EB)				Main Channel (MC)			
	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW	S	R	AF	OW
White sucker	N	H	H	M	H	M	M	N	N	N	L	L	N	M	M	N	N	L	M	N	N	N	N	M
Comments:	High quality adult feeding and rearing habitat throughout.				Spawning possible in shallow, moderate velocity riffle/runs.				Some adult feeding and overwintering; will depend on water velocities.				Some adult feeding and possible rearing.				Adult feeding and possible rearing. Likely depends on water velocities.				May overwinter in low velocity areas along channel margins..			
Longnose sucker	N	H	H	M	H	M	M	N	N	N	L	M	N	M	M	N	N	L	M	N	N	N	N	M
Comments:	High quality feeding and rearing habitat throughout.				Spawning possible in shallow, moderate velocity rifle/runs.				Some adult feeding and overwintering; will depend on water velocities.				Some adult feeding and possible rearing.				Adult feeding and possible rearing. Likely depends on water velocities.				May overwinter in low velocity areas along channel margins.			
Emerald shiner	H	H	H	H	N	N	L	N	N	N	L	L	L	H	H	N	N	L	L	N	N	N	N	M
Comments:	Young-of-the year present in abundance, indicates probable spawning use.				Limited use of area due to generally high velocities and lack of preferred cover (depth and low velocity).				Limited use of area due to generally high velocities.				High quality feeding and rearing habitat due to presence of preferred cover (depth and low velocity).				Some adult feeding and rearing; likely depends on water velocities.				Some potential for overwintering.			
Spottail shiner	H	H	H	H	N	N	L	N	N	N	N	N	L	H	H	N	N	L	L	N	N	N	N	M
Comments:	Capture of young-of-the year indicates probable spawning use of area.				Limited use of area due to generally high velocities and lack of preferred cover (low velocity, depositional, aquatic vegetation).				Limited to nil use of area due to generally high velocities.				High quality feeding and rearing habitat due to presence of preferred cover (low velocity, depositional, aquatic vegetation).				Some adult feeding and rearing; likely depends on water velocities.				Limited use of main channel overall.			
Trout-perch	N	H	M	H	H	L	H	N	N	N	L	L	N	H	M	N	N	L	M	N	N	N	N	M
Comments:	High quality feeding and rearing habitat available.				Potential spawning and feeding use of bottom end of runs.				Some adult feeding and overwintering; will depend on water velocities.				High quality rearing habitat, with some adult feeding.				Adult feeding and possible rearing; likely depends on water velocities.				Limited use of main channel overall.			
Ninespine stickleback	H	H	H	H	N	N	N	N	N	N	N	N	N	H	H	N	N	L	L	N	N	N	N	M
Comments:	High quality feeding and rearing habitat throughout. Spawning likely occurs in aquatic vegetation.				Water velocities too high.				Water velocities too high.				High quality rearing and adult feeding habitat.				Adult feeding and rearing possible, but water velocities generally too high.				Limited use of main channel overall.			

[1]S = spawning; R = rearing; AF = adult feeding; OW = overwatering; N = nil; L = low; M = medium; H = high.

5.3 Operational Effects (Footprint)

Bridge projects have the potential to impact fish resources through direct loss, or alteration, of habitat associated with the physical footprint of the bridge, and through changes to surrounding (peripheral) habitat. Direct habitat losses generally occur when causeways and abutments are extended into the river, and at the locations where the bridge piers are installed. In certain situations, the bridge projects result in habitat gains associated with removal of existing structures. Because the footprint of bridges constructed in large river settings is quite small in comparison to the amount of habitat available, the resulting impacts are generally minimal. These impacts can be significant, however, if sensitive habitat (e.g., spawning areas) is present directly under the footprint of these structures, or immediately downstream. In some situations, design modifications to the structures can provide new, productive habitat, thereby compensating partially or wholly for the original losses. Alterations to habitat in peripheral areas can occur through changes to the river-hydraulic setting or water quality. These effects can also be mitigated through properly designing the bridge, protecting the channel and banks against erosion, and following best practices during construction and maintenance to prevent sediment release or spills.

During the operational period of the bridge, the bridge structure and footprint may provide more diverse habitat in the area of the bridge through the formation of scour holes and velocity breaks in association with the causeways, abutments and bridge piers (e.g., refugia for feeding or migrating fish).

The remainder of Section 5.3 below discusses these issues in greater detail.

5.3.1 North Approach Footprint and Peripheral Habitats

The nose of the north causeway will be reduced in length by 80 m and widened (Figure 5.1); fill will be removed from an area of approximately 4300 m^2 (Figure 5.1). Overall, habitats peripheral to the north causeway will be reduced in size (Table 5.2). Backwater BW-9, situated immediately upstream of the causeway, will be reduced in size by approximately 1800 m^2. The downstream-situated backwater would be reduced by 4900 m^2. The resultant changes to habitat areas, however, are small relative to the availability of habitat encountered in the study area (see Section 4.1.2).

Table 5.2 Projected changes in nearshore habitats due to modification of the north approach.

Habitat unit[1]	Pre-Construction (m^2)	Habitat Transfer Losses (m^2)	Permanent Loss (m^2)	Post-Construction (m^2)	Net Change (m^2)	Net Habitat Transfer[2]	
						From BW Habitat (m^2)	To MC Habitat (m^2)
BW9	102700	-1000	-800	100900	**-1800**	800	1000
EB10	6300	-2100	-	4200	**-2100**	-	2100
DR11	23600	-4200	-	19400	**-4200**	-	4200
SB12	6200	-1500	-	4700	**-1500**	-	1500
BW13	208300	-4100	-800	203400	**-4900**	800	4100
Totals	**347100**	**-12900**	**-1600**	**332600**	**-14500**		

[1] Refer to Figures 4.2 and 5.1 for locations. MC = main channel; BW = backwater; EB = exposed bank; DR = deep run; SB = sheltered bank. Areas calculated from geo-referenced maps and air photographs.

[2] Net Habitat Transfer: Shows breakdown leading to Net Change habitat numbers.

5.3.2 South Approach Footprint and Peripheral Habitats

The south causeway will be lengthened by 60 m and widened (Figure 5.2); the increase in area will be 5600 m^2. In general, habitats peripheral to the south causeway will be increased, primarily due to the removal of the ferry haul-out area (9500 m^2) (Table 5.3). The backwater area situated immediately upstream of the south causeway (BW-34) will be increased in area by 2550 m^2 and BW-38, situated immediately downstream would experience a gain of 12 650 m^2. The resultant changes to habitat areas, however, are small relative to the availability of habitat encountered in the study area (Section 4.1.2).

Table 5.3 Projected changes in nearshore habitats due to modification of the south approach.

Habitat unit[1]	Pre-Construction (m^2)	Habitat Transfer Gains (m^2)	Permanent Loss (m^2)	Post-Construction (m^2)	Net Change (m^2)	Net Habitat Transfer[2]		
						From MC Habitat (m^2)	To SB Habitat (m^2)	To BW Habitat (m^2)
BW34	55300	4900	-2350	57850	**+2550**	2550	-	-
EB35	1400	400	-	1800	**+400**	400	-	-
DR36	3600	-	-	3600	**-**	-	-	-
SB37	300	800	-	1100	**+800**	300	500	-
BW38	59900	15000	-2350	72550	**+12650**	5500	-	7150
Totals	**120500**	**21100**	**4700**	**136900**	**+16400**	**8750**	**500**	**7150**

[1]Refer to Figures 4.2 and 5.1 for locations. MC = main channel; BW = backwater; EB = exposed bank; DR = deep run; SB = sheltered bank. Areas calculated from geo-referenced maps and air photographs.

[2] Net Habitat Transfer: Shows breakdown leading to Net Change habitat numbers.

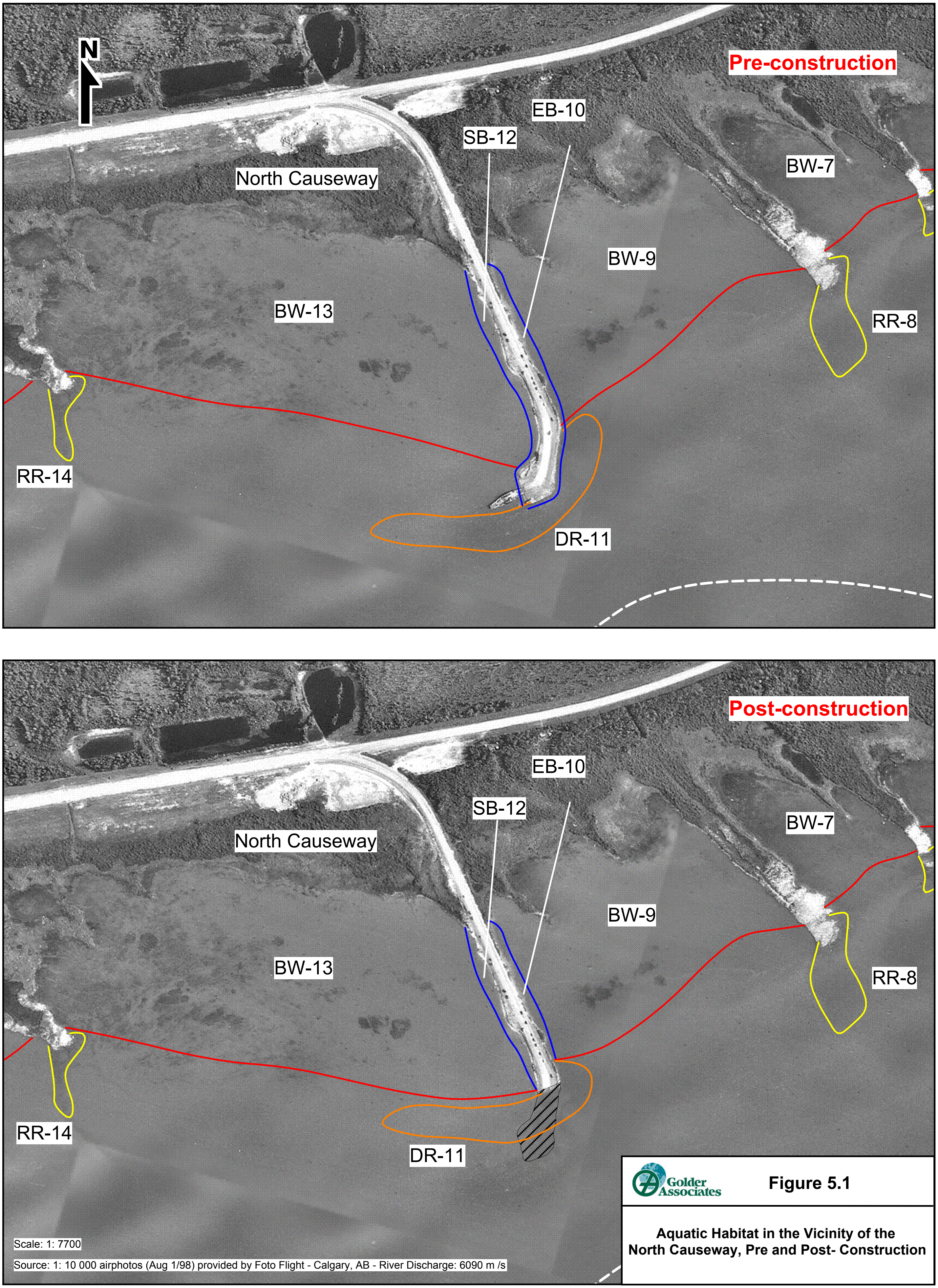


Figure 5.1

Aquatic Habitat in the Vicinity of the North Causeway, Pre and Post- Construction

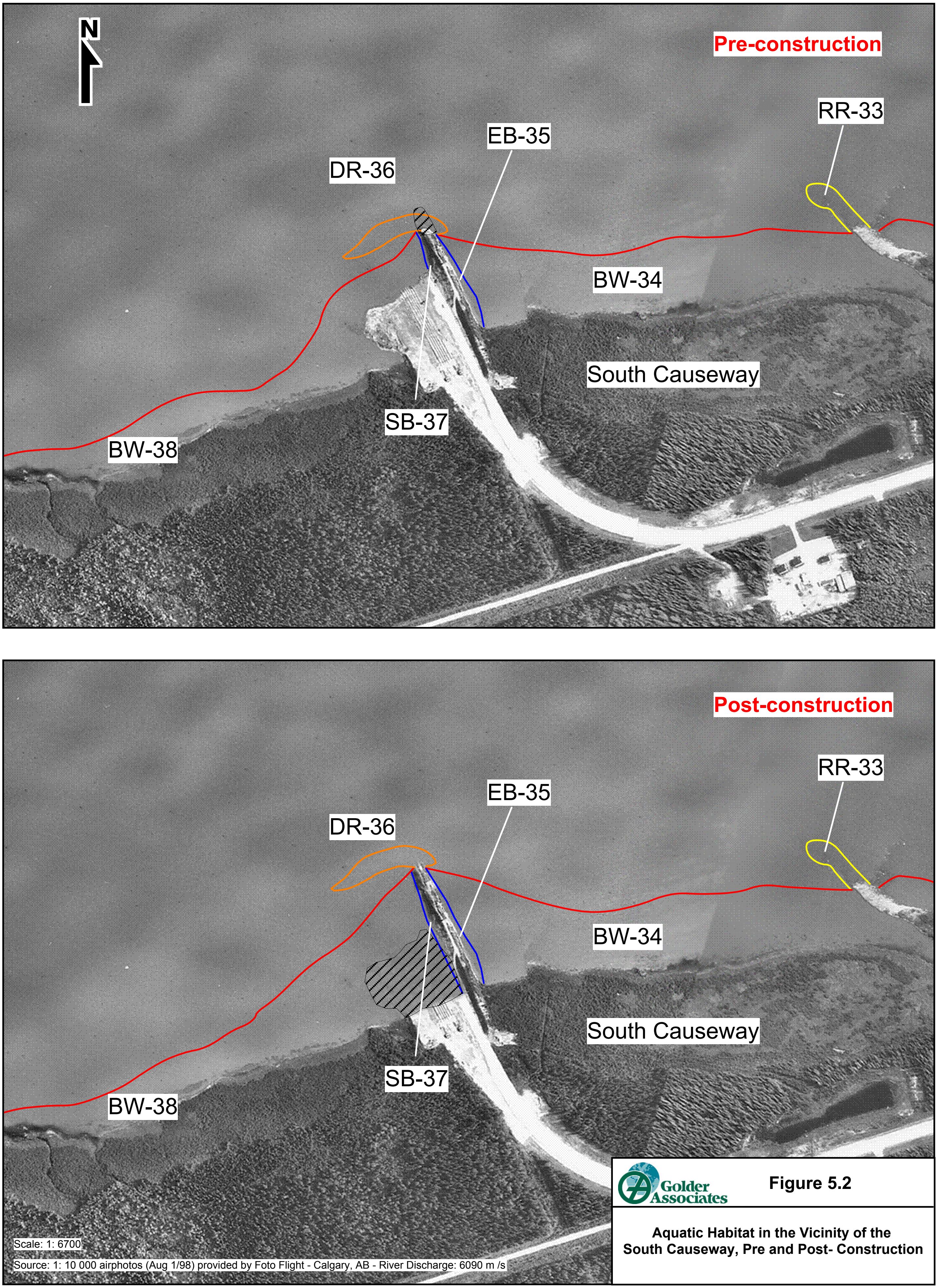


Figure 5.2

Aquatic Habitat in the Vicinity of the South Causeway, Pre and Post- Construction

5.3.3 Footprint of Instream Bridge Abutments and Piers

Instream structures such as bridge piers and abutments cause local flow velocity increases which result in local scour. The proposed bridge abutments will be constructed on the end of relatively long approach embankments. In this situation, a vertical wake vortex forms at the downstream end of the abutment, and a horizontal vortex forms along the toe of the abutment, as shown in Figure 5.3. The vortex action increases local velocities, and can remove bed material and create a scour hole.

In rivers with large seasonal fluctuations in water level, projections into the flow such as the proposed bridge approaches might form scour holes during flood events that have the potential to create/provide cover or overwintering habitat. However, a recent bathymetric survey (Trillium 2002) found only 1.0 m of possible scour against sheet piles at the north approach, and none at the south approach. This is in contrast to the 1 to 3 m of scour that are predicted by equations for alluvial material. This may be due to the cohesive bed material that underlies a relatively thin layer of alluvium. The relatively deep water and small seasonal variation in water level makes a shallow scour hole less important as habitat.

Zones of deep run habitat presently exist across the nose and downstream of each ferry approach, and given that the configuration of the bridge approaches are similar to the ferry approaches, it is reasonable to expect that the future conditions will be approximately equivalent to existing conditions.

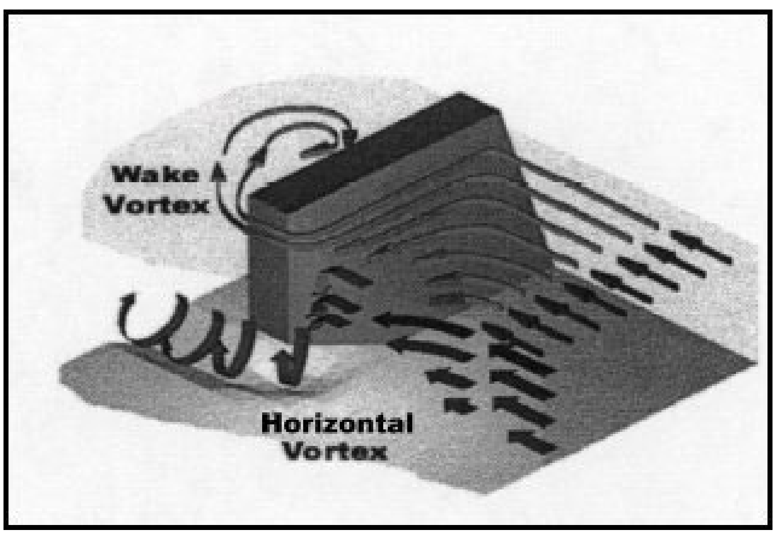


Figure 5.3 Schematic of typical flow configuration and scour hole location at bridge abutments (adapted from FHWA 2001).

The proposed bridge has eight instream piers. At each pier, the river flow will produce a horseshoe vortex, as shown in Figure 5.4. As for the abutments, the vortex action increases local velocities, and can remove bed material and create a scour hole which is deepest at the nose of the pier.

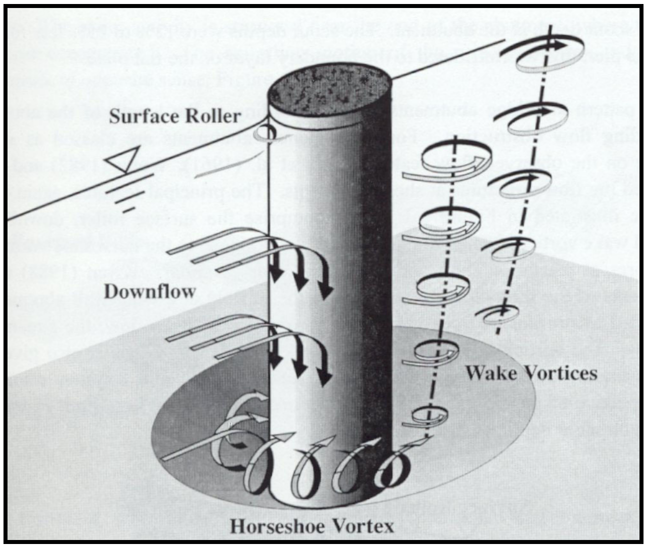


Figure 5.4 Schematic of typical flow configuration and scour hole location at bridge piers (adapted from Melville and Coleman 2000).

Again, in rivers with large seasonal fluctuations in water level, instream piers might form scour holes during flood events that have the potential to create/provide cover or overwintering habitat. The design pier scour depth for the bridge is 3.3 m in alluvium and 4.9 m in clay, though the bridge may be designed for a scour depth of 2 m, with monitoring and mitigation by rip rap placement if required (Trillium 2002). This is because scour in clay may occur slowly and is unlikely to occur due to a single flood event. To prevent scour adjacent to the footing an apron of blasted armour rock (300 mm diameter granite) will be placed; the apron will extend out 11 m (±) in all directions (Pier Design Clarification, 6 January 2004). As for abutments, the relatively deep water and small seasonal variation in water level makes a shallow scour hole less important as habitat.

The piers will marginally increase local flow velocities, but since they are generally located in deep, fast-flowing water, these increases are unlikely to have any significant effects on fish habitat.

5.4 Effects of Bridge Structures on Migrations and Movements

The construction and operation of a bridge has the potential to limit the migration or movements of fish in the river. During bridge construction, the river channel will be narrowed when cofferdams are placed around pier construction zones. However, fish passage will still be able to occur, as construction will only block off a small portion of the channel and considerable river velocity changes, that may impede fish, are not predicted (Section 5.3.3). The Deh Cho is too large a river to restrict flows to any great extent. There will still be an increase in boat/barge traffic during construction and noise associated with equipment. This activity may deter some fish from areas of the river where construction is occurring.

5.5 Discontinuing Ferry and Ice Road Operations

The following sections discuss issues related to existing ferry and ice road operations. The negative effects of these operations will cease or tend to be tempered greatly once the Deh Cho Bridge is in operation.

5.5.1 Present Ferry and Ice Road Impacts to Fish Habitat

Water Quality

A considerable amount of sand and gravel is used annually as part of maintaining the ferry landing areas at Ft. Providence. This material is regularly washed into the river and must be routinely replaced; discussed in detail below (Section 5.5.2). In addition, sand and gravel currently enter the river at the ice road crossing from traffic crossing the river and from maintenance of the crossing area. During the operation period for the bridge, the amount of sediment released annually to the river will likely be less than that released by the operation of the ferry/ice road infrastructure.

Recently, the GNWT, Department of Transportation commissioned an investigation on the effects of ferry operations on river water quality (GeoNorth 2003). Four ferry landing sites were monitored for TSS concentrations: Mackenzie River (at Tsiigehticchic and Inuvik), and Peel River [west bank (Yukon side) and McPherson]. The authors found that increases in suspended sediment concentration and turbidity between “at rest” (i.e., 5 min after ferry departure) and during ferry “departure” (i.e., propeller wash) was less than 15% and that natural variation in TSS and turbidity in the rivers overshadowed these results. They concluded that ferry landings and departures did not have a significant effect on turbidity levels in the river, and that water quality was not negatively altered.

In the present study, the TSS samples were collected in the vicinity of the south ferry causeway on 30 July 2003. One sample was collected immediately upstream of the causeway, whereas the second sample was collected approximately 10 m offshore (perpendicular) to the ferry docking spot and 30 seconds following ferry departure. TSS upstream of the causeway was 6 mg/L, whereas the propeller wash sample was 8 mg\L (Appendix A, Table A-6). These preliminary investigations indicate that present ferry operations at the location of the proposed Deh Cho Bridge negatively affect the water quality of the Mackenzie River, albeit at a minimum level.

Ferry operations are conducted during January and February, until ice road conditions can accommodate large, heavy trucks. During winter a backhoe is used to break ice and flows of the Mackenzie River often are very low, such that the ferry carries one truck at a time and periodically bottoms-out (field crew discussions with anonymous ferry operators). Ice-breaking activities and ferry bottom-out incidences undoubtedly disturb river bottom material, which negatively affects water quality through the introduction and re-settling of sediments.

The community has expressed concerns over the possibility of trucks going through the ice especially at the beginning and end of the season (Golder 2003). They feel that if a spill incident were to occur on the bridge, it might be easier to clean up than if it occurred on a ferry or on the ice road. The ferry has emergency spill response equipment and trained staff immediately available. However, until the equipment is employed, the material spilled would disperse in the river and could not be recovered. Spills on ice are easily cleaned up as long as the material does not enter moving water. Major spills on a bridge would present a clean-up challenge. However, the bridge design could incorporate features to facilitate spill containment and clean up.

Bridge installation would remove the possibility of a spill incident related to ferry and winter road operations. However, there would still be a possibility of contaminants entering the water, and the bridge would be subject to poor weather conditions. Provisions will be made to collect and treat contaminated run-off from the bridge deck to the extent possible; the approach will be outlined in a spill contingency plan which will be reviewed by the environmental consultants under contract to DCBC.

Fish Habitat / Populations

Sediment released from the existing ferry/ice road infrastructure may have an effect on fish habitat. Potential spawning and confirmed rearing habitat for northern pike has been identified immediately downstream of the ferry landings, particularly the south approach (Sections 4.3 and 5.1). However, the potential for a fisheries impact due to bridge construction would be of a similar scope. By avoiding sensitive time periods and following good construction techniques the potential to adversely affect fish is very small. The possibility for a fish mortality impact to occur during operations is smaller. The possibility of a spill during construction will be higher than current conditions but will be similar during operations and will be traffic dependent. In all cases, the possibility of a spill occurring can be reduced by good planning and preparation.

In general, the large size of the ferry boat has the potential to directly affect fish, particularly in nearshore areas. Fish in the immediate vicinity of the ferry boat may be affected by one or more of the following:

- noises may deter some fish from utilizing habitats of the river where ferry operations are occurring;
- sudden noises (e.g., engine revving, dropping of vehicle ramp) cause fish to bolt for cover;
- direct contact of boats or propellers may be a source of mortality for certain fish species, such as minnow species and immature northern pike;
- boat movement can affect individual fish directly by disturbing normal activities such as spawning or feeding;
- increased turbidity from boats may interfere with sight based feeding or success of eggs or fish spawning; and,
- on a population level, boats may affect fish through habitat alteration caused by waves or propeller damage.

5.5.2 Impacts of Gravel Fill Placement

The existing ferry landings at the Ft. Providence crossing require the placement of approximately 1000 m^3 of silty gravel each year to build up the river bed at the two ferry landings. It is assumed that since this quantity of gravel is placed each year, the same quantity is transported downstream over the course of the year. The method for estimating annual sediment deposition follows:

- samples of silty gravel fill were collected from the north and south ferry stockpiles and a grain size analysis was undertaken;
- flow data and bathymetry were examined to characterize river depths and velocities in the area subject to deposition;
- a sediment transport calculation tool was used to calculate particle settling times. This was combined with flow depths and velocities to estimate particle settling distances; and,
- estimated widths of settling zones were combined with settling distances and gravel placement quantities to estimate annual sediment deposition depths.

Grain Size Analysis of Fill Material

One sample of silty gravel fill was collected from each of the north and south stockpiles, during the summer field sampling session of 2003. Material from the surface of each stockpile, that may have been affected by wind and rain, was removed and samples were collected from the freshly exposed area. These samples were transported to the Golder materials laboratory and sieved to determine their particle size distribution.

The results of the analysis of the two samples are fairly consistent (Table 5.4; Appendix E, Figures E1 and E2). A mean of the two samples was calculated and used as input to the subsequent analyses.

Table 5.4 Grain size analyses of gravel fill material from the Highway #3 Ferry operations on the Mackenzie River, 30 July 2003.

Sieve Diameter (mm)	North Ferry Percent Passing	South Ferry Percent Passing	Mean Percent Passing
150	100.0	100.0	100.0
75.0	100.0	100.0	100.0
37.5	97.9	95.7	96.8
20.0	75.6	82.0	78.8
10.0	57.4	66.9	62.2
5.00	43.2	48.6	45.9
2.00	29.0	33.2	31.1
0.850	19.5	22.4	20.9
0.425	11.8	14.3	13.0
0.150	6.4	7.5	7.0
0.075	4.7	5.5	5.1

Flow Data and Bathymetry

Physical characteristics of the study reach of the Mackenzie river were described in Section 4.1 of the present report. Both of the ferry landings are located in the lee of the approach causeways. Based on sediment plume observations from the upstream confluence with the Kakisa River, it was assumed that sediment deposited in at the ferry landings and transported downstream would be deposited in the relatively shallow, slower-flowing zones along the banks of the Mackenzie River.

Bathymetry and extent of the bank zones was measured from the Government of Canada Navigation Chart 6453 (Mackenzie River Kilometre 58-90). The south left downstream bank zone is approximately 200 m wide, with a mean flow depth of 2.0 m, and the north right downstream bank zone has a mean flow depth of 1.5 m, and the depositional area is approximately 600 m wide. For the calculation of sediment deposition depths on the RDB, a 200 m wide bank zone was used to account for the influence of natural spurs that project into the river. Based on flow velocities measured during the fisheries field investigation and those calculated by Trillium (2002), a mean flow velocity in the bank zone was estimated to be 0.9 m/s.

It must be noted that values of flow depth, depositional zone width and flow velocity used in this analysis are approximate, and the results of the analysis should be treated only as coarsely representative of actual conditions.

Sediment Transport

The sediment deposition zone of influence is the estimated extent of settling particles downstream of the ferry landing. The exact nature of deposition depends on microhabitat, sediment particle sizes, flow velocity, water depth, and flow turbulence. The zone of influence was estimated by settling velocity calculations according to Rubey (1933). The zone of influence calculation includes an additional turbulence adjustment factor, which increases the downstream travel distance over that which would apply to quiescent conditions.

The results of the analysis show that the gravel and cobble components of the fill are expected to settle within 50 to 60 m of the ferry landing (Table 5.5). Medium to coarse sands would typically be deposited within 100 to 500 m of the ferry landing, and fine sands and silts could persist for several kilometres. Calculated differences between the left and right banks are due to different mean flow depths (1.5 m on the RDB and 2.0 m on the LDB).

Table 5.5 Expected downstream sediment transport distances, Highway #3 ferry operations on the Mackenzie River near Ft. Providence.

Particle Description	Particle Size Range	Maximum Downstream Sedimentation Distance	
		Left Bank Zone	Right Bank Zone
Silt/Clay	< 0.02 mm	remains in suspension[1]	remains in suspension[1]
Coarse Silt	0.02 – 0.06 mm	38,000 m	28,000 m
Fine Sand	0.06 – 0.2 mm	4,200 m	3,200 m
Medium Sand	0.2 – 0.6 mm	460 m	350 m
Coarse Sand	0.6 – 2 mm	140 m	100 m
Fine Gravel	2 – 6 mm	63 m	47 m
Gravel	6 – 60 mm	36 m	27 m
Cobble	> 60 mm	8 m	6 m

[1] Particles that remain in suspension will be dispersed and diffused in both the lateral and longitudal direction, but will eventually settle in local depositional areas.

Sediment Deposition

The mean annual sediment deposition depth with distance was estimated for each bank zone, based on the calculated sedimentation distances and the estimated width of the bank zone. These quantities were based on an estimate of 500 m^3 of fill placed per year per ferry landing, and are based on loose gravel density estimates of 1.44 t/m^3 dry and 1.46 t/m^3 wet (Holtz and Kovacs 1981).

The results of the analysis indicate that the effects of sedimentation due to fill placement at the existing ferry landings are essentially limited to 500 m downstream, with deposition rates greater than 1 mm/a limited to 100-150 m downstream of the crossing (Table 5.6). The present analysis is coarse and subject to the stated assumptions, but is physically-based and incorporates project-specific material and river characteristics, and should thus be representative of actual conditions.

Table 5.6 Expected downstream sediment deposition distances, Highway #3 ferry operations on the Mackenzie River.

Distance Downstream of Ferry Landing	Derived Annual Sediment Deposition Depth	
	Left Bank Zone	Right Bank Zone
0 - 20 m	46 mm	61 mm
20 - 30 m	46 mm	45 mm
30 - 40 m	30 mm	14 mm
40 - 50 m	10 mm	11 mm
50 – 75 m	6.9 mm	4.2 mm
75 – 100 m	3.2 mm	4.2 mm
100 – 150 m	2.4 mm	0.7 mm
150 – 200 m	0.5 mm	0.6 mm
200 – 300 m	0.5 mm	0.6 mm
300 – 500 m	0.4 mm	0.2 mm
500 – 1000 m	<0.1 mm	<0.1 mm

5.6 Availability of Alternate Habitats in Vicinity of Bridge Crossing

A wide range of information was reviewed in the present study (bathymetry data, habitat mapping results, fisheries data, information obtained during community consultation process, etc.). Based on this information, it is apparent that nearshore habitat similar to that in the immediate vicinity of the proposed bridge occurs extensively along both the north and south shores, upstream and downstream of the site. Indeed, the present ferry causeways were constructed on natural peninsulas (Jivko Jivkov, Jivko Engineering, Yellowknife, NT, personal communication). Field surveys indicated that similar nearshore habitats extend approximately 6.0 km upstream and downstream of the proposed bridge site. These habitats include extensive backwater, riffle-run complexes, exposed and sheltered banks focused around natural peninsulas. Within this 12 km reach, there are 14 natural peninsulas on the north shore and 13 on the south shore.

5.7 Summary of Impacts / Mitigation Opportunities

Tables 5.7 to 5.11 summarize the major impacts due to construction and operation of the proposed Deh Cho bridge on aquatic resources; mitigation opportunities that may be available for implementation are also identified.

Table 5.7 Potential fisheries impacts on the Mackenzie River due to the proposed Deh Cho Bridge – Construction Phase.

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
1) Modification of North Approach								
a) Removal of outermost section of causeway (80 m) (i.e., reduced perpendicular extension into channel by 108.5 m (Attachment 8A)	Increased suspended sediment/deposition	N	L-M	S	M	M-H	Probable spawning (confirmed rearing use of habitat unit (BW-13) immediately downstream; sediment travel into and subsequent deposition in). BW-13 may be minimal (i.e., majority of sediment expected to enter main channel (i.e., bypass nearshore habitats). Potential impact on BW-13 on two occasions; removal expected to generate more sediment.	Avoidance of instream activity during northern pike spawning/ incubation/ early rearing period (May, June). Sediment monitoring with construction feedback objective.
b) Addition of blasted rock into channel on downstream perimeter of causeway for detour road; removal of same following completion of bridge construction.	Increased suspended sediment/deposition	N	M	S	M-H	M-H	Potential impact on BW-13 on two occasions; removal expected to generate more sediment.	Avoidance of May/ June period (northern pike spawning/ incubation/ early rearing). Feedback monitoring.
c) Widening of the bridge approach; involving placement of clean blasted rock into the channel	Increased suspended sediment/deposition	N	L	S	L	H	Material added will have low sediment content; one time only event.	Avoidance of spring spawning/ incubation/ early rearing period for northern pike. Feedback monitoring.
2) Modification of South Approach								
a) Linear extension of causeway by 30 m and widening of causeway. Involving placement of clean limestone into the channel. Total area of displacement: 5600 m^2.	Increased suspended sediment/deposition	N	L	S	L	H	Probable spawning and confirmed rearing by northern pike in backwater habitat unit downstream (BW-38). This unit encompasses the confluence area of Providence Creek, which supports spawning run of northern pike and Arctic grayling. However, the rock material added will have low sediment content. The placement is a one time only event and the majority of the fines will likely settle out within 500 m of the construction site.	Avoidance of construction during spring spawning and early rearing period for northern pike and Arctic grayling (May to June).
b) Removal of 11,000 m^3 of granular backfill and 90 m^3 of structural timber from the ferry haul out area. Material to be removed from an area of 9500 m^2, situated primarily in backwater habitat unit BW-38.	Increased suspended sediment/deposition	N	M-H	S	M-H	H	Removal of this volume of material will release a considerable volume of sediment, much of which is expected to accumulate in the nearshore zone. This area is potentially used for northern pike spawning; rearing has been confirmed. The confluence area of Providence Creek is situated approximately 600 m downstream ; this system supports a known spawning run of Arctic grayling and northern pike. Any disturbance that affects access or movement timing delays during the spring spawning period would be particularly significant.	Avoidance of construction during pre-spawning movement period for Arctic grayling and northern pike into Providence Creek and spawning/early rearing period for northern pike in downstream nearshore habitats (e.g., BW-38). (i.e., May to June).
3) Installation of Instream Piers (8)								
a) Cofferdams (sheet piling driven into riverbed) will be installed at each pier site. The sheet piling will be extracted after the footings are completed, using vibrating equipment.	Increased suspended sediment/deposition	N	N-L	S	N-L	H	The amount of sediment released at each of the pier sites is anticipated to be very small, and will be rapidly entrained and diluted due to the large flow volume and high average velocity. It is expected that very little sediment generated at the pier construction sites will settle in important/critical habitats located in the nearshore zone. There may be a slightly higher risk of sediment generated at the two inner pier sites (i.e., 90 m off both the north and south approaches) depositing in nearshore habitats. Sediment will be generated on two occasions (i.e., during installation and removal).	Selection and use of equipment during installation and extraction that will minimize the amount of sediment generated and the duration of the sediment event. Consideration could be given to avoiding construction/extraction of the two outside piers during the spring spawning period (May to June). If construction at these sites is scheduled to occur during the critical spring period, feedback monitoring should be in place.
b) After the cofferdams are installed, the bed material will be augered and removed. Dewatering (pumping to river) will then be carried out; this water will contain significant amounts of suspended sediment.	Increased suspended sediment/deposition	N	N-L	S	N-L	H	The method of disposal of excavated spoil and sediment-laden water will depend on the timing of construction. If in winter, the spoil will be disposed of in a nearby gravel pit and water will be pumped into a confined area on the ice. After freezing the frozen material will be removed and disposed of in a nearby gravel pit. In summer, the spoil will be loaded into a barge and disposed of in the designated gravel pit; the water will be pumped into the river. In either case, the intent will be to minimize sediment input into the river and maintain input at levels not considered to be harmful to aquatic life.	If the disposal of the excavated spoil material in areas adjacent to the river was considered to have higher environmental risk than returning it to the river (i.e., out of concern for birds or other wildlife) it may be possible to schedule a controlled release of the material into the river. A scheduled, controlled release would take into account the location, and timing of use, of important nearshore habits. It would also incorporate a feedback monitoring component (i.e., rate of release dependent upon results of strategic water sampling).

Continued

Table 5.7 Potential fisheries impacts on the Mackenzie River due to the proposed Deh Cho Bridge – Construction Phase (concluded).

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
3) Installation of Instream Piers (8) (cont.)								
c) The riverbed will be excavated to a depth of not less than 2.5 m below the natural level in order to construct the footings. Between 750 and 800 m^3 of material will be excavated at each pier site (i.e., piers 4 and 5 require 800 m^3 and remaining six piers require 750 m^3). Rock aprons (300 mm granite rip rap) will be placed around the perimeter of the footings (±11 m radius) to prevent scour (total volume placed: 4790 m^3).	Increased suspended sediment/deposition	N	N-L	S	N-L	H	In winter, the excavated material will be stockpiled on the ice until frozen; it will then be scraped from the ice surface, and trucked to a nearby gravel pit for disposal. In summer, the material will be placed in a barge and then hauled to the gravel pit disposal site. In either case, the intent will be to minimize sediment input into the river (i.e., attempt to maintain at levels not considered harmful to aquatic life).	The benefits and associated adverse effects of placing the material in a land disposal site would have to be weighed against the same for a river material disposal (possible wildlife effects versus fisheries concerns). If it was considered to be most appropriate to return the material to the river, this could likely be accomplished with very little negative effects (i.e., through scheduled, controlled release). Given the discharge and velocities in the main channel it is anticipated that the material will be assimilated by the river within a short period of time.
4) Placement of blasted rock in river.								
a) Blasted rock, with possible ammonia residue and uncertain regulated metal content, will be used in the construction of several of the bridge-related structures within the wetted channel. These include the North Approach detour road (6000 m^3), which will be removed following completion of the bridge, the South Approach extension and the widening of both approaches (22,000 m^3), and the protective aprons around the 8 instream piers (4790 m^3).	Altered water quality (ammonia, regulated metals)	N	N-L	S-L	N-L	M-H	The ammonia content of the blasted rock to be used at the site is unknown. Ammonia has a high chronic toxicity to aquatic organisms (e.g., fish and invertebrates). However, it is unlikely to be problematic in the current setting due to the large dilutional capacity at the site (high, sustained hand flows), generally high dissolved oxygen levels (which result in a rapid decline in ammonia levels), relatively cold water temperatures throughout the summer months and the presence neutral to basic pH (which reduce the toxicity). Ammonia toxicity is generally observed in southern latitudes and in situations where there is a constant input of ammonia into a low flow-through setting (e.g., drainage from rock dumps at mining facilities, releases from sewage treatment facilities). The proponent submitted three samples of limestone/bedrock from local quarries to determine geochemistry. It was determined that none of the regulated parameters (arsenic, cadmium, chromium, copper, lead, zinc) exceeded the applicable guidelines (EBA, Dec. 2003).	The proponent has developed a specific strategy to monitor ammonia levels at the site during and following the placement of blasted rock. Representative samples of blasted rock will be tested to determine ammonia residue content prior to placement in the channel. If significant ammonia residue is detected a water quality monitoring program will be put into place. Particular attention will be paid to tracking ammonia levels in the backwater habitats immediately adjacent to the north and south causeways (habitat units BW-9, BW-13, BW-34, BW-38). The monitoring plan is outlined in Appendix D. With respect to regulated metal content, it appears that limestone rip rap/fill material should not pose a concern to aquatic life.
5) Placement of concrete in the channel								
a) Cast in-place concrete flat footings will be installed inside the cofferdams at the 8 instream piers (approx. 3600 m^3 of concrete). Concrete pedestals will be constructed on top of the footings (approx. 2700 m^3 of concrete). During construction, it will likely be necessary to de-water the contained site. Water that has been in contact with fresh concrete (which is typically alkaline) may have exhibit elevated pH levels (relative to river background levels).	Altered water quality (pH)	N	N-L	S	N-L	H	Water with elevated pH levels can be harmful to aquatic and terrestrial life. The contained water will be treated prior to returning to the river (e.g., efforts applied to neutralize the pH).	Prior to releasing the affected water, it will be tested and treated as necessary to balance the pH.

[1] N = negative; P = positive
[2] N = nil; L = low; M = medium; H = high
[3] S = short-term; L = long-term

Table 5.8 Potential fisheries impacts to the footprint of the Proposed Deh Cho Bridge – Operational Phase

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
1) Modification of North Approach								
a) Shortening of causeway, resulting in increase of 4300 m^2 of natural river channel.	Footprint	P	M	L	M-H	M-H	The removal of the ferry landing (including associated sheet-piling and concrete pad) will restore a portion of main channel habitat that was lost when the causeway was initially constructed. The deep-run habitat that was available along the outer perimeter of the causeway will be reformed off the tip of the new bridge abutment. However, the size of the habitat unit (DR-11) may be reduced slightly because the causeway will not extend as for into the main channel. The backwater habitat unit (BW-13) immediately downstream will be reduced in areas slightly (i.e., approx. 2% reduction, occurring on outer perimeter). Northern pike spawning potential and use not likely to be effected (i.e., spawning likely occurs along inside perimeter of habitat unit. Significant reduction in both exposed bank and sheltered bank habitat units along causeway perimeter (i.e., 33% reduction in area of EB-10 and 24% reduction in SB-12).	Ensure that the restored portion of channel is shaped and formed to a condition resembling the natural channel. The rip rap bank protection that will be employed on the outer perimeter of the abatement should be designed and placed to maximize its value as fish feeding habitat.
b) Widening of the bridge approach; involving placement of clean blasted rock into the channel	Increased footprint	N	L	L	L	H	The widening will result in minor losses of backwater habitat in units BW-9 (upstream) and BW-13 (downstream).	No mitigation opportunities available (i.e., involves permanent loss of stream channel).
2) Modification of South Approach								
a) Lengthening of the causeway by approximately 60 m and widening of the causeway will result in the loss of 5600 m^2 of riverine habitat. The majority of the loss of habitat will be at the expense of deep, main channel habitat, although a small portion of adjacent backwater habitat (BW-34 and BW-38) will be affected directly by the new footprint. Additional backwater habitat in both units will be formed as a result of the increased outward extension of the south approach. The lengthening of the approach will increase the availability of exposed (EB-35) and sheltered (SB-37) banks. The deep run habitat off the tip of the causeway will be reformed further offshore; the size of the habitat unit (DR-36) will increase slightly due to the increased penetration of the approach into the main channel.	Footprint	N	L	L	L	M-H	The overall effects of the lengthening and widening of the approach is expected to be negative, but of low magnitude and significance. The direct footprint losses will occur to main channel type habitat which is considered to be less important and sensitive to key fish species. These physical losses will be partially offset by the gain of higher quality backwater and exposed/sheltered bank habitat.	Ensure that extended section (sides and outside portion of abutment) is designed and built with fisheries objectives in mind.
b) Removal of the ferry landing and haul-out area (includes associated concrete pad and timber). This action will result in the gain of 9500 m^2 of backwater habitat downstream of the south causeway. This represents a 16% increase in the area of habitat unit BW-38, and a return to habitat conditions that prevailed before the ferry service was initiated.	Footprint	P	M-H	L	M-H	M-H	The increased availability of nearshore, backwater habitat will benefit northern pike (spawning, rearing, adult feeding) additional adult feeding habitat for other key fish species (such as lake whitefish and walleye) will also be available.	The morphometry of the restored area should be adjusted to resemble the conditions in the adjacent backwater.
The bed material contained in the ferry haul out area may harbor harmful concentrations of hydrocarbons or other contaminants (e.g., creosote).	Water Quality	N	M	S	M-H	L	The magnitude and severity of this concern will be investigated by the NT government, the current operator of the facility.	The NT government will carry out rehabilitation of the site as required.
3) Installation of Instream Bridge Piers								
The superstructure of the bridge will be supported on eight piers located in the active channel. The footings for the piers will cover a surface area of 630 m^2. The nearshore piers will be placed 90 m off the north and south approaches. Thereafter, they will be placed at 112.5 m intervals, with the exception of the main span which will feature a 190 m pier spacing (navigation channel for large tug-barge configurations). The protective rip rap aprons will alter an additional 5800 m^2 of main channel habitat.	Footprint	N	L	L	N-L	H	It is extremely difficult to assess the use of main channel habitat in large rivers (i.e., due to deep water and high velocities). However, based on previous experience and fish distribution data for nearshore habitats in the area, we assume that the major use of the main channel is for fish migration and movements (upstream/downstream or bank to bank). As such, the footprint of the piers will have no significant adverse impact on spawning, rearing, adult feeding or overwintering for the range of fish species inhabiting the river in the vicinity of the proposed bridge. The instream piers and associated rip rap aprons may provide some useable adult feeding/holding habitat for fish (e.g., walleye, lake whitefish, burbot, etc.). However,the associated velocities and turbulence may limit their usefulness. These habitats are unlikely to be suitable for overwintering due to the relatively high velocities in place.	No mitigation opportunities or requirements. Any loss of habitat due to footprint or habitat alteration due to the rip rap aprons will be adequately replaced by new holding/feeding habitat created.

[1] N = negative; P = positive
[2] N = nil; L = low; M = medium; H = high
[3] S = short-term; L = long-term

Table 5.9 Potential fisheries impacts on the Mackenzie River due to the proposed Deh Cho Bridge – De-commissioning of Ferry and Ice Crossing.

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
1) De-commissioning of Ferry/Ice Crossing								
a) Discontinued placement of gravel fill (with significant fines content) on an annual basis, to upgrade and maintain the north and south ferry landings.	Decreased suspended sediment/deposition	P	L	L	L-M	M-H	Approximately 1000 m^3 of silty gravel material is placed in the channel at the ferry landings each year (500 m^3 per approach assumed). The finer grained materials (such as silt/clay, coarse silt and fine sand) are expected to move considerable distance downstream (i.e., in excess of 4.2 km on the south bank and 3.2 km on the north bank). However, in terms of sediment deposition the majority of the sediment is predicted to deposit within a short distance (100 to 150 m) of the ferry landings. The habitats most affected by the entrained and deposited sediment are the backwaters located immediately downstream of the causeways (BW-13 on the north and BW-38 on the south). These habitats are potentially important for spawning by northern pike, and are known to be use for rearing and feeding by this species. A wide range of other species (including walleye, lake whitefish, and several types of minnows) are known to inhabit these areas on a seasonal basis.	None required; discontinuing the input of silty gravel on an annual basis is considered to be beneficial to the aquatic environment in the area.
b) Discontinuing the use of the Ice Crossing, resulting in: reduced contamination of ice with silt and oil imported by traveling vehicles, and ending of risks associated with the accidental sinking of vehicles and attendant risks for a major fuel spill.	Altered water quality	P	L-H	S	L-H	L	The type and extent of input of sediment and petroleum products at the Ice Crossing is unknown. However, it is assumed that the amounts added are relatively small. While the likelihood of a major fuel-spill occurring as the result of a vehicle capsized at the crossing is difficult to assess, the potential for serious environmental damage is extremely high. The section of river downstream of the Ice Crossing, on both banks, is characterized by high habitat diversity and supports a complex fish species assemblage. Particularly susceptible are the numerous protected, backwater habitats in the nearshore zone which are heavily used by fish and for fishing by Ft. Providence residents.	None required; discontinuing the use of the Ice Crossing and eliminating the risk of a major fuel-spill in the future is considered to be a major benefit of the project.

[1] N = negative; P = positive
[2] N = nil; L = low; M = medium; H = high
[3] S = short-term; L = long-term

Table 5.10 Potential fisheries impacts on the Mackenzie River due to the proposed Deh Cho Bridge – Availability of Near-shore Habitats.

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
1) Availability of Alternate Habitats								
a) Construction of the proposed Deh Cho Bridge will modify the type and availability of nearshore habitat on a localized basis. This will be reflected by site-specific gains and losses, but the overall integrity and make-up of the site will remain largely unchanged. The impact of the bridge can also be assessed by investigating the availability of habitats of similar type and quality upstream and downstream of the bridge site.	Effect on nearshore habitat availability in the reach	P	M-H	L	M-H	M-H	High quality nearshore habitats focused around peninsula-like landforms that extend into the river channel (comprised of riffle/run complexes of the tips of the peninsulas and extensive backwaters in the protected lee of the peninsulas) are a common, yet highly productive feature of the reach surrounding the proposed bridge. Within the section 6 km upstream and 6 km downstream of the bridge (12 km in total) there are a total of 27 habitat complexes (14 on the north bank and 13 on the south bank). Apart from the differences that exist between the north and south habitats (peninsulas longer and backwaters more extensive on the north side and turbidity somewhat higher on the south side due o the influence of the Kakisa River), there appears to be little difference between the individual habitat units. The backwater habitats formed behind the causeways are somewhat more extensive due to the greater length of the extension into the main channel. However, this aspect will remain relatively unchanged.	None required; the original causeways were built on existing peninsulas. Overall, the changes in the availability nearshore habitat will serve to restore the conditions that existed prior to the construction of the ferry operation.

[1] N = negative; P = positive
[2] N = nil; L = low; M = medium; H = high
[3] S = short-term; L = long-term

Table 5.11 Potential fisheries impacts on the Mackenzie River due to the proposed Deh Cho Bridge – Fish Movements/Migrations.

Project Action	Type of Impact	Potential Effects on Fish (Non-Mitigated Case)					Rationale/Comments	Mitigation Techniques/Opportunities
		Direction[1]	Magnitude[2]	Duration[3]	Significance[2]	Confidence[2]		
1) Causeway Modifications/Instream Piers								
a) Instream construction activities will result in short term increases in suspended sediment levels.	Increased suspended sediment	N	L	S	L	M-H	Fish migrating upstream or downstream in the Mackenzie River may encounter increased suspended sediment. Elevated levels are expected to be short term in duration and fish will have the opportunity to avoid the sediment plume due to the size of the river.	Avoidance of major instream construction during active movement periods for the key fish species; this would include late April/May for spring spawners and mid Sept/October for fall spawners. This would apply mainly to work along the perimeter of the channel. An alternative would be carry out feedback monitoring during active movement periods.
b) Changes to the extension of the approaches and placement of 8 instream piers will alter the present situation with respect to migrating fish.	Movement deflection/delays	N/P	N-L	L	N-L	H	Due to the size and complexity of the channel, it is unlikely that migrations or movements will be significantly affected (negatively or positively). Protected areas behind the bridge piers may provide some temporary holding habitat. of the channel	None required or available.

[1] N = negative; P = positive
[2] N = nil; L = low; M = medium; H = high
[3] S = short-term; L = long-term

6.0 "NO NET LOSS" ACCOUNTING AND STRATEGY

The construction phase of the proposed Deh Cho Bridge will result in the disturbance and alteration of aquatic habitat, particularly in nearshore habitats located in close proximity to the construction activity (Table. 5.7). With effective scheduling instream (e.g., avoidance of major instream activity during the critical spring spawning period) and mitigation techniques (e.g., feedback monitoring to maintain satisfactory water quality) it is anticipated that these effects will be of short term duration (i.e., hours to days in length), of low magnitude and significance. However, because of the footprint of the bridge, and the permanent loss or alteration of habitat associated with the development, the development will be required to meet the requirements of DFO's NNL policy. Strategically, the "no net loss" strategy employed by the Deh Cho Bridge Corporation should identify and account for the beneficial and adverse effects associated with the physical footprint and the related operational aspects which are more difficult to quantify (benefits of reduced risk of fuel spill at the present ice crossing).

6.1 Footprint

The proposed Deh Cho Bridge will result in a net gain of 5970 m^2 of aquatic habitat (Table 6.1). This overall gain will be accomplished largely through the shortening of the causeway on the North Approach, and the removal of the ferry haul-out area immediately downstream of the South Approach. Other project actions (lengthening of the south causeway, widening of the north and south causeways, installation of instream piers) will remove aquatic habitat. However, these losses are considerably smaller than the associated gains. The net gain of habitat (5970 m^2) would be achieved through contributions on both approaches (north side: increased by 2700 m^2, and south side: increased by 3900 m^2). The footprint of the eight instream piers will result in a combined loss of 630 m^2 of aquatic habitat. The protective rip rap aprons located around the instream piers, will alter an additional 5800 m^2 of main channel habitat. However, it is assumed that the new habitat will adequately replace the original habitat. As such, this area was not included in the "no net loss" calculations.

Although the availability of aquatic habitat would increase following bridge construction, a re-distribution of habitat between nearshore and main channel types would occur (Table 6.2). Nearshore habitats adjacent to the north approach (two backwaters; one exposed bank, one sheltered bank, and one deep run) would be reduced by 14 500 m^2 due to the hydraulic changes associated with the reduced penetration of the causeway into the main channel. Of this total, 6700 m^2 will be a loss of backwater habitat, which is considered to be of higher value than other habitat types. A portion of the 14 500 m^2 (i.e., 12 900 m^2) of habitat would, in effect, be transferred to the main channel habitat type rather than being lost to the system. Main channel habitat is considered to be less important in terms of providing spawning, rearing and feeding habitat, although it may be important for other life-requisite activities (movements, overwintering). The habitat alteration at the north approach can be viewed as a partial return to conditions that existed prior to development of the north causeway.

In contrast to the situation that would develop at the north approach, nearshore habitats adjacent to the south approach will experience a substantial gain (Table 6.2). This gain (16 400 m^2) would be due primarily to the removal of the ferry haul out area and the extension of the causeway. The reclaimed area would be applied to the backwater habitat unit immediately downstream of the causeway. The total increase in backwater habitat associated with the bridge modifications around the south approach would be 15 200 m^2 .

The net result of the habitat modifications at the proposed bridge crossing, in terms of backwater habitat would be a gain of 8500 m^2 (i.e., 15 200 m^2 gain at south approach and 6700 m^2 loss at north approach) (Table 6.2).

Table 6.1 Summary of aquatic habitat gains and losses at the site of the proposed Deh Cho Bridge[1].

Location	Gains (m²)	Losses (m²)	Net Change (m²)
North Approach	4300[2]	-1600[3]	+2700
South Approach	9500[4]	-5600[5]	+3900
Instream Piers	NA	-630[6]	-630
Combined	**13800**	**-7830**	**+5970**

[1] Gains and losses irrespective of habitat type (i.e., backwaters, riffle-run complexes, main channel, sheltered bank, exposed bank).

[2] Gain due to removal of outer end of causeway.

[3] Loss due to widening of causeway (800 m^2 loss to BW-9 and 800 m^2 to BW-13)

[4] Gain due to removal of ferry haul out area.

[5] Loss due to extension and widening of causeway.

[6] Loss due to footprint of instream piers (2 x 90 m^2 and 6 x 75 m^2).

The bridge development would result in a net gain of 5970 m^2 of habitat overall (i.e., irrespective of habitat type) (Table 6.1). As such, the “no net loss of productive fish habitat” objective appears to have been met, when evaluated on the basis of square meters of habitat lost and gained.

6.2 Operational Habitat Gains (Non-Footprint)

Proceeding with the proposed Deh Cho Bridge would result in a number of benefits apart from the footprint gains. These benefits, which are not really quantifiable, but appear to be legitimate, include the following:

1) Decommissioning of the current ferry operation will result in discontinuing the practice of placing approximately 1000 m^3 of silt-laden gravel annually in the Mackenzie River. Much of

this sediment is likely being deposited within the backwater habitats immediately downstream of the north and south approaches.

2) Decommissioning the Ice Crossing will result in reduced contamination of the ice with silt and oil deposited by traveling vehicles, although the extent of this problem is unknown. More importantly, perhaps is the reduced risk of a major fuel spill at the crossing that will result from the construction of a bridge.

Table 6.2 Pre and post-construction habitat distribution according to habitat type, proposed Deh Cho Bridge.

Location	Total Nearshore Habitat (m^2)								Backwater Habitat (m^2)					
	Pre-Con.	Post-Con.	Net (m^2)	Net Habitat Transfer[1]					Pre-Con.	Post-Con.	Net (m^2)	Net Habitat Transfer[1]		
				Permanent Loss (m^2)	To MC Habitat (m^2)	To EB Habitat (m^2)	To SB Habitat (m^2)	To BW Habitat (m^2)				Permanent Loss (m^2)	To MC Habitat (m^2)	To BW Habitat (m^2)
North Approach	347100	332600	**-14500**	1600	12900	-	-	-	311000	304300	**-6700**	1600	5100	-
South Approach	120500	136900	**16400**	-	-	400	800	15200	115200	130400	**15200**	-	-	15200
Combined Nearshore	**467600**	**469500**	**1900**	**1600**	**1600**				**426200**	**434700**	**8500**			**8500**

[1]MC = main channel; BW = backwater; EB = exposed bank; SB = sheltered bank. Areas calculated from geo-referenced maps and air photographs.

7.0 COMPENSATION REQUIREMENTS / OPTIONS

Based on the fisheries assessment data currently available, it appears that the "no net loss of productive fish habitat" requirements will be met by the project. This assumes that an effective mitigation strategy is employed during the construction phase (strategic scheduling, feedback monitoring, etc.) and that the footprint of the project develops as outlined. However, if the regulatory agencies require additional compensation we would recommend the following:

1) Because of the large size and flow characteristics of the Mackenzie River (which might make it very difficult and costly to achieve a lasting and meaningful habitat gain), and the already high habitat diversity in the area, consideration should be given to directing habitat improvement efforts at Providence Creek. Prior to proceeding with this initiative it would be necessary to seek the approval of the community of Ft. Providence. The stream, which is located immediately downstream of the south bridge approach, is known to have supported an Arctic grayling (and northern pike) spawning run in previous years. Upstream spawning runs, numbering approximately 1000 fish in 1966 (Bishop 1967) and between 601 and 805 in 1979 (Falk et. al., 1982), were recorded near the confluence during May. Although the stream has been protected by special regulations for many years, and there are reports that Arctic grayling continue to use the system for spawning, there are indications that the size of the spawning population has declined. During the present study, we investigated and photographed the lower reach of Providence Creek and determined that riffle/run habitat suitable for spawning and rearing was largely absent, having been flooded out by numerous beaver dams. The stream should be investigated during the spring to confirm the physical availability of suitable spawning habitat, to assess the accessibility of the stream to upstream migrants (i.e., due to numerous beaver dams), and to determine the current status of the spawning population. Depending on the results of this site visit, consideration could be given to carrying out a habitat rehabilitation project (selective beaver dam removal, spawning area development, etc.). A project of this nature close to the community would be advantageous from a cost-benefit point of view and would favor inclusion of Ft. Providence residents in the project (during the initial phases and for future follow-up).

2) If a project on Providence Creek is not considered feasible, or doesn't meet the approval of the community, an option would be to approach the regulatory agencies to identify a small stream/river in the area that would benefit from a targeted habitat improvement/rehabilitation project (bank stabilization, spawning area development, improved fish passage at culvert crossing, etc.).

8.0 CLOSURE

This report was prepared by Golder Associates Ltd. (Golder) for Jivko Engineering. The material in it reflects Golder's best judgment in light of information available to it at the time of preparation. Any use which a third party makes of this report or any reliance on or decisions to be made based on it, are the responsibility of such third party. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decision made or action based on this report.

We trust the information contained in this report is sufficient for your present needs. Should you have any questions regarding the project, please do not hesitate to contact the undersigned.

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PHOTOGRAPHIC PLATES

Plate 1 *30 July 2003*. Exposed bank (EB-10) and backwater (BW-9) habitat, upstream of the north causeway (Section 4, Figure 4.2).

Plate 2 *30 July 2003*. Sheltered bank (SB-12) and backwater (BW-13) habitat downstream, of the north causeway.

Plate 3 *30 July 2003*. View of main channel and steel plate armouring on nose of north causeway.

Plate 4 *30 July 2003.* View of backwater (BW-13) habitat and ferry docking area downstream of the north causeway.

Plate 5 *1 August 2003*. View of the south causeway from ferry. Note: amour plating on causeway nose and ferry haul-out area on right.

Plate 6 *30 July 2003*. Backwater (BW-34) and riffle-run (RR-33, see arrow) habitat on the upstream side of the south causeway.

Plate 7 *30 July 2003*. View of ferry haul-out area and stockpile material used for maintaining ferry docking approach.

Plate 8 *30 July 2003.* View of ferry docking area and backwater (BW-38) habitat on the downstream side of the south causeway.

Plate 9 *19 September 2003*. Adult northern pike captured in the fyke net. This specimen was 928 mm in fork length and weighed 5.48 kg.

Plate 10 *19 September 2003*. Louie Lacorne holding an adult burbot (loche) captured in the fyke net (fork length = 844 mm, weight = 3.08 kg).

Plate 11 *18 September 2003*. Children from Fort Providence departing for an outdoor adventure on the Mackenzie River.

Plate 12 *30 July 2003.* Checking gill net set in large backwater (BW-9) upstream of the north causeway.

Plate 13 *21 September 2003*. View of extensive backwater (BW-24) habitat downstream of the north causeway (Section 4, Figure 4.2).

Plate 14 *21 September 2003*. Backwater area popular for gill netting by locals, approximately four kilometres upstream of ferry crossing.

Plate 15 *21 September 2003*. Downstream section of backwater (BW-15), approximately 1.2 km west of the north causeway.

Plate 16 *30 July 2003.* Upstream view of Providence Creek from bridge, note the large beaver dam (~2.0 m high) in center of photo.

Plate 17 *20 September 2003*. Edwin Sabourin beach seining in backwater habitat at the south ice road causeways.

Plate 18 *1 August 2003*. North ice road causeways (downstream view), about 7 km upstream of the ferry crossing. Note children swimming.

Plate 19 *19 September 2003*. Fyke net set in backwater (BW-30) habitat, approximately one kilometre upstream of south ferry causeway.

Plate 20 *20 September 2003.* View of riffle-run (RR-17) habitat approximately 1.4 km downstream of the north causeway.

APPENDIX A

WATER AND SEDIMENT

Table A-1

Enviro-Test Chemical Analysis Report

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-1 SITE NE								
Sample Date: 18-SEP-03 14:20								
Matrix: WATER								
BTEX, F1 (C6-C10) and F2 (>C10-C16)								
F2 (>C10-C16)	<0.05		0.05	mg/L	25-SEP-03	26-SEP-03	AAT	R145752
BTEX and F1 (C6-C10)								
Benzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
Toluene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
EthylBenzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
Xylenes	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
F1(C6-C10)	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
F1-BTEX	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
Extractable Metals								
Extractable Trace Metals (Low Level)								
Silver (Ag)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Aluminum (Al)	0.16		0.01	mg/L		23-SEP-03	JY	R145050
Arsenic (As)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Boron (B)	0.013		0.002	mg/L		23-SEP-03	JY	R145050
Barium (Ba)	0.0463		0.0001	mg/L		23-SEP-03	JY	R145050
Beryllium (Be)	<0.0005		0.0005	mg/L		23-SEP-03	JY	R145050
Bismuth (Bi)	0.00018		0.00005	mg/L		23-SEP-03	JY	R145050
Cadmium (Cd)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Cobalt (Co)	0.0003		0.0001	mg/L		23-SEP-03	JY	R145050
Chromium (Cr)	0.0015		0.0004	mg/L		23-SEP-03	JY	R145050
Copper (Cu)	0.0017		0.0006	mg/L		23-SEP-03	JY	R145050
Molybdenum (Mo)	0.0008		0.0001	mg/L		23-SEP-03	JY	R145050
Nickel (Ni)	0.0013		0.0001	mg/L		23-SEP-03	JY	R145050
Lead (Pb)	0.0004		0.0001	mg/L		23-SEP-03	JY	R145050
Antimony (Sb)	0.0008		0.0004	mg/L		23-SEP-03	JY	R145050
Selenium (Se)	0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Tin (Sn)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Strontium (Sr)	0.150		0.0001	mg/L		23-SEP-03	JY	R145050
Titanium (Ti)	0.0047		0.0003	mg/L		23-SEP-03	JY	R145050
Thallium (Tl)	0.00014		0.00005	mg/L		23-SEP-03	JY	R145050
Uranium (U)	0.0004		0.0001	mg/L		23-SEP-03	JY	R145050
Vanadium (V)	0.0008		0.0001	mg/L		23-SEP-03	JY	R145050
Zinc (Zn)	0.010		0.002	mg/L		23-SEP-03	JY	R145050
Extractable Major Metals								
Calcium (Ca)	30.3		0.5	mg/L		24-SEP-03	HAS	R145296
Potassium (K)	1.1		0.1	mg/L		24-SEP-03	HAS	R145296
Magnesium (Mg)	6.68		0.01	mg/L		24-SEP-03	HAS	R145296
Sodium (Na)	8.0		0.5	mg/L		24-SEP-03	HAS	R145296
Iron (Fe)	0.379		0.005	mg/L		24-SEP-03	HAS	R145296
Manganese (Mn)	0.018		0.001	mg/L		24-SEP-03	HAS	R145296
Mercury (Hg)-Extractable	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Silicon (Si)-Extractable	1.6		0.1	mg/L		24-SEP-03	HAS	R145296
Cyanide, Total	<0.002		0.002	mg/L		24-SEP-03	SEN	R145625
Phosphorus, Total	0.04		0.02	mg/L		24-SEP-03	JTV	R145154
Ammonia-N	<0.05		0.05	mg/L		23-SEP-03	TL	R144913
Oil and Grease	<1		1	mg/L		25-SEP-03	ZOW	R145358
Phenols (4AAP)	0.011		0.001	mg/L		26-SEP-03	STW	R145683
Total Kjeldahl Nitrogen	<0.2		0.2	mg/L		24-SEP-03	TL	R145102
Total Organic Carbon	4		1	mg/L		26-SEP-03	STW	R145696

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-1	SITE NE								
Sample Date: 18-SEP-03 14:20									
Matrix: WATER									
CCME PAHs									
	Naphthalene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Quinoline	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Acenaphthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Fluorene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Phenanthrene	<0.00001	RAMB	0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Acridine	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Chrysene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	72		50-112	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	68		53-98	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	91		70-118	%	23-SEP-03	24-SEP-03	FWC	R144969
Routine Water Analysis									
	Chloride (Cl)	9		1	mg/L		24-SEP-03	SHC	R145187
	Nitrate+Nitrite-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrate-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrite-N	<0.05		0.05	mg/L		23-SEP-03	JTV	R144881
pH, Conductivity and Total Alkalinity									
	pH	8.2		0.1	pH		23-SEP-03	PTT	R144945
	Conductivity (EC)	236		0.2	uS/cm		23-SEP-03	PTT	R144945
	Bicarbonate (HCO3)	103		5	mg/L		23-SEP-03	PTT	R144945
	Carbonate (CO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Hydroxide (OH)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Alkalinity, Total (as CaCO3)	84		5	mg/L		23-SEP-03	PTT	R144945
Ion Balance Calculation									
	Ion Balance	100			%		25-SEP-03		
	TDS (Calculated)	129			mg/L		25-SEP-03		
	Hardness (as CaCO3)	103			mg/L		25-SEP-03		
ICP metals and SO4 for routine water									
	Calcium (Ca)	29.9		0.5	mg/L		23-SEP-03	DES	R144764
	Potassium (K)	1.2		0.1	mg/L		23-SEP-03	DES	R144764
	Magnesium (Mg)	6.8		0.1	mg/L		23-SEP-03	DES	R144764
	Sodium (Na)	8		1	mg/L		23-SEP-03	DES	R144764
	Sulfate (SO4)	23.4		0.5	mg/L		23-SEP-03	DES	R144764
L131493-2	SITE NW								
Sample Date: 18-SEP-03 15:00									
Matrix: WATER									
BTEX, F1 (C6-C10) and F2 (>C10-C16)									
	F2 (>C10-C16)	<0.05		0.05	mg/L	25-SEP-03	26-SEP-03	AAT	R145752
BTEX and F1 (C6-C10)									
	Benzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Toluene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-2 SITE NW								
Sample Date: 18-SEP-03 15:00								
Matrix: WATER								
BTEX, F1 (C6-C10) and F2 (>C10-C16)								
BTEX and F1 (C6-C10)								
EthylBenzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
Xylenes	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
F1(C6-C10)	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
F1-BTEX	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
Extractable Metals								
Extractable Trace Metals (Low Level)								
Silver (Ag)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Aluminum (Al)	0.10		0.01	mg/L		23-SEP-03	JY	R145050
Arsenic (As)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Boron (B)	0.012		0.002	mg/L		23-SEP-03	JY	R145050
Barium (Ba)	0.0444		0.0001	mg/L		23-SEP-03	JY	R145050
Beryllium (Be)	<0.0005		0.0005	mg/L		23-SEP-03	JY	R145050
Bismuth (Bi)	0.00020		0.00005	mg/L		23-SEP-03	JY	R145050
Cadmium (Cd)	0.0003		0.0001	mg/L		23-SEP-03	JY	R145050
Cobalt (Co)	0.0002		0.0001	mg/L		23-SEP-03	JY	R145050
Chromium (Cr)	0.0011		0.0004	mg/L		23-SEP-03	JY	R145050
Copper (Cu)	0.0017		0.0006	mg/L		23-SEP-03	JY	R145050
Molybdenum (Mo)	0.0008		0.0001	mg/L		23-SEP-03	JY	R145050
Nickel (Ni)	0.0011		0.0001	mg/L		23-SEP-03	JY	R145050
Lead (Pb)	0.0003		0.0001	mg/L		23-SEP-03	JY	R145050
Antimony (Sb)	0.0007		0.0004	mg/L		23-SEP-03	JY	R145050
Selenium (Se)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Tin (Sn)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Strontium (Sr)	0.144		0.0001	mg/L		23-SEP-03	JY	R145050
Titanium (Ti)	0.0025		0.0003	mg/L		23-SEP-03	JY	R145050
Thallium (Tl)	0.00015		0.00005	mg/L		23-SEP-03	JY	R145050
Uranium (U)	0.0004		0.0001	mg/L		23-SEP-03	JY	R145050
Vanadium (V)	0.0006		0.0001	mg/L		23-SEP-03	JY	R145050
Zinc (Zn)	0.011		0.002	mg/L		23-SEP-03	JY	R145050
Extractable Major Metals								
Calcium (Ca)	28.4		0.5	mg/L		24-SEP-03	HAS	R145296
Potassium (K)	1.0		0.1	mg/L		24-SEP-03	HAS	R145296
Magnesium (Mg)	6.31		0.01	mg/L		24-SEP-03	HAS	R145296
Sodium (Na)	7.9		0.5	mg/L		24-SEP-03	HAS	R145296
Iron (Fe)	0.240		0.005	mg/L		24-SEP-03	HAS	R145296
Manganese (Mn)	0.013		0.001	mg/L		24-SEP-03	HAS	R145296
Mercury (Hg)-Extractable	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Silicon (Si)-Extractable	1.4		0.1	mg/L		24-SEP-03	HAS	R145296
Cyanide, Total	<0.002		0.002	mg/L		24-SEP-03	SEN	R145625
Phosphorus, Total	0.04		0.02	mg/L		24-SEP-03	JTV	R145154
Ammonia-N	<0.05		0.05	mg/L		23-SEP-03	TL	R144913
Oil and Grease	<1		1	mg/L		25-SEP-03	ZOW	R145358
Phenols (4AAP)	0.010		0.001	mg/L		26-SEP-03	STW	R145683
Total Kjeldahl Nitrogen	0.3		0.2	mg/L		24-SEP-03	TL	R145102
Total Organic Carbon	4		1	mg/L		26-SEP-03	STW	R145696
CCME PAHs								
Naphthalene	0.00002		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Quinoline	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-2	SITE NW								
Sample Date:	18-SEP-03 15:00								
Matrix:	WATER								
CCME PAHs									
	Acenaphthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Fluorene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Phenanthrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Acridine	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Chrysene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	55		50-112	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	53	H	53-98	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	85		70-118	%	23-SEP-03	24-SEP-03	FWC	R144969
Routine Water Analysis									
	Chloride (Cl)	9		1	mg/L		24-SEP-03	SHC	R145187
	Nitrate+Nitrite-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrate-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrite-N	<0.05		0.05	mg/L		23-SEP-03	JTV	R144881
pH, Conductivity and Total Alkalinity									
	pH	8.2		0.1	pH		23-SEP-03	PTT	R144945
	Conductivity (EC)	232		0.2	uS/cm		23-SEP-03	PTT	R144945
	Bicarbonate (HCO3)	100		5	mg/L		23-SEP-03	PTT	R144945
	Carbonate (CO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Hydroxide (OH)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Alkalinity, Total (as CaCO3)	82		5	mg/L		23-SEP-03	PTT	R144945
Ion Balance Calculation									
	Ion Balance	99.9			%		25-SEP-03		
	TDS (Calculated)	127			mg/L		25-SEP-03		
	Hardness (as CaCO3)	100			mg/L		25-SEP-03		
ICP metals and SO4 for routine water									
	Calcium (Ca)	29.1		0.5	mg/L		23-SEP-03	DES	R144764
	Potassium (K)	1.1		0.1	mg/L		23-SEP-03	DES	R144764
	Magnesium (Mg)	6.7		0.1	mg/L		23-SEP-03	DES	R144764
	Sodium (Na)	8		1	mg/L		23-SEP-03	DES	R144764
	Sulfate (SO4)	23.5		0.5	mg/L		23-SEP-03	DES	R144764
L131493-3	SITE SE								
Sample Date:	18-SEP-03 15:50								
Matrix:	WATER								
BTEX, F1 (C6-C10) and F2 (>C10-C16)									
	F2 (>C10-C16)	<0.05		0.05	mg/L	25-SEP-03	26-SEP-03	AAT	R145752
BTEX and F1 (C6-C10)									
	Benzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Toluene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	EthylBenzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Xylenes	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-3 SITE SE								
Sample Date: 18-SEP-03 15:50								
Matrix: WATER								
BTEX, F1 (C6-C10) and F2 (>C10-C16)								
BTEX and F1 (C6-C10)								
F1(C6-C10)	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
F1-BTEX	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
Extractable Metals								
Extractable Trace Metals (Low Level)								
Silver (Ag)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Aluminum (Al)	0.11		0.01	mg/L		23-SEP-03	JY	R145050
Arsenic (As)	0.0005		0.0004	mg/L		23-SEP-03	JY	R145050
Boron (B)	0.009		0.002	mg/L		23-SEP-03	JY	R145050
Barium (Ba)	0.0398		0.0001	mg/L		23-SEP-03	JY	R145050
Beryllium (Be)	<0.0005		0.0005	mg/L		23-SEP-03	JY	R145050
Bismuth (Bi)	0.00019		0.00005	mg/L		23-SEP-03	JY	R145050
Cadmium (Cd)	0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Cobalt (Co)	0.0003		0.0001	mg/L		23-SEP-03	JY	R145050
Chromium (Cr)	0.0012		0.0004	mg/L		23-SEP-03	JY	R145050
Copper (Cu)	0.0020		0.0006	mg/L		23-SEP-03	JY	R145050
Molybdenum (Mo)	0.0005		0.0001	mg/L		23-SEP-03	JY	R145050
Nickel (Ni)	0.0014		0.0001	mg/L		23-SEP-03	JY	R145050
Lead (Pb)	0.0005		0.0001	mg/L		23-SEP-03	JY	R145050
Antimony (Sb)	0.0007		0.0004	mg/L		23-SEP-03	JY	R145050
Selenium (Se)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Tin (Sn)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Strontium (Sr)	0.0932		0.0001	mg/L		23-SEP-03	JY	R145050
Titanium (Ti)	0.0024		0.0003	mg/L		23-SEP-03	JY	R145050
Thallium (Tl)	0.00015		0.00005	mg/L		23-SEP-03	JY	R145050
Uranium (U)	0.0003		0.0001	mg/L		23-SEP-03	JY	R145050
Vanadium (V)	0.0006		0.0001	mg/L		23-SEP-03	JY	R145050
Zinc (Zn)	0.013		0.002	mg/L		23-SEP-03	JY	R145050
Extractable Major Metals								
Calcium (Ca)	31.8		0.5	mg/L		24-SEP-03	HAS	R145296
Potassium (K)	1.0		0.1	mg/L		24-SEP-03	HAS	R145296
Magnesium (Mg)	6.35		0.01	mg/L		24-SEP-03	HAS	R145296
Sodium (Na)	4.3		0.5	mg/L		24-SEP-03	HAS	R145296
Iron (Fe)	0.531		0.005	mg/L		24-SEP-03	HAS	R145296
Manganese (Mn)	0.033		0.001	mg/L		24-SEP-03	HAS	R145296
Mercury (Hg)-Extractable	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Silicon (Si)-Extractable	1.9		0.1	mg/L		24-SEP-03	HAS	R145296
Cyanide, Total	<0.002		0.002	mg/L		24-SEP-03	SEN	R145625
Phosphorus, Total	0.06		0.02	mg/L		24-SEP-03	JTV	R145154
Ammonia-N	<0.05		0.05	mg/L		23-SEP-03	TL	R144913
Oil and Grease	<1		1	mg/L		25-SEP-03	ZOW	R145358
Phenols (4AAP)	0.011		0.001	mg/L		26-SEP-03	STW	R145683
Total Kjeldahl Nitrogen	0.3		0.2	mg/L		24-SEP-03	TL	R145102
Total Organic Carbon	8		1	mg/L		26-SEP-03	STW	R145696
CCME PAHs								
Naphthalene	<0.00001	RAMB	0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Quinoline	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Acenaphthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Fluorene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-3 SITE SE									
Sample Date: 18-SEP-03 15:50									
Matrix: WATER									
CCME PAHs									
	Phenanthrene	<0.00001	RAMB	0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Acridine	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Chrysene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	61		50-112	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	61		53-98	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	98		70-118	%	23-SEP-03	24-SEP-03	FWC	R144969
Routine Water Analysis									
	Chloride (Cl)	3		1	mg/L		24-SEP-03	SHC	R145187
	Nitrate+Nitrite-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrate-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrite-N	<0.05		0.05	mg/L		23-SEP-03	JTV	R144881
pH, Conductivity and Total Alkalinity									
	pH	8.2		0.1	pH		23-SEP-03	PTT	R144945
	Conductivity (EC)	215		0.2	uS/cm		23-SEP-03	PTT	R144945
	Bicarbonate (HCO3)	114		5	mg/L		23-SEP-03	PTT	R144945
	Carbonate (CO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Hydroxide (OH)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Alkalinity, Total (as CaCO3)	93		5	mg/L		23-SEP-03	PTT	R144945
Ion Balance Calculation									
	Ion Balance	104			%		25-SEP-03		
	TDS (Calculated)	121			mg/L		25-SEP-03		
	Hardness (as CaCO3)	108			mg/L		25-SEP-03		
ICP metals and SO4 for routine water									
	Calcium (Ca)	32.2		0.5	mg/L		23-SEP-03	DES	R144764
	Potassium (K)	1.2		0.1	mg/L		23-SEP-03	DES	R144764
	Magnesium (Mg)	6.7		0.1	mg/L		23-SEP-03	DES	R144764
	Sodium (Na)	5		1	mg/L		23-SEP-03	DES	R144764
	Sulfate (SO4)	17.1		0.5	mg/L		23-SEP-03	DES	R144764
L131493-4 SITE SW									
Sample Date: 18-SEP-03 16:20									
Matrix: WATER									
BTEX, F1 (C6-C10) and F2 (>C10-C16)									
	F2 (>C10-C16)	<0.05		0.05	mg/L	25-SEP-03	26-SEP-03	AAT	R145752
BTEX and F1 (C6-C10)									
	Benzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Toluene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	EthylBenzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Xylenes	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	F1(C6-C10)	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
	F1-BTEX	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-4 SITE SW								
Sample Date: 18-SEP-03 16:20								
Matrix: WATER								
Extractable Metals								
Extractable Trace Metals (Low Level)								
Silver (Ag)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Aluminum (Al)	0.24		0.01	mg/L		23-SEP-03	JY	R145050
Arsenic (As)	0.0011		0.0004	mg/L		23-SEP-03	JY	R145050
Boron (B)	0.010		0.002	mg/L		23-SEP-03	JY	R145050
Barium (Ba)	0.0535		0.0001	mg/L		23-SEP-03	JY	R145050
Beryllium (Be)	<0.0005		0.0005	mg/L		23-SEP-03	JY	R145050
Bismuth (Bi)	0.00019		0.00005	mg/L		23-SEP-03	JY	R145050
Cadmium (Cd)	0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Cobalt (Co)	0.0010		0.0001	mg/L		23-SEP-03	JY	R145050
Chromium (Cr)	0.0012		0.0004	mg/L		23-SEP-03	JY	R145050
Copper (Cu)	0.0035		0.0006	mg/L		23-SEP-03	JY	R145050
Molybdenum (Mo)	0.0005		0.0001	mg/L		23-SEP-03	JY	R145050
Nickel (Ni)	0.0025		0.0001	mg/L		23-SEP-03	JY	R145050
Lead (Pb)	0.0017		0.0001	mg/L		23-SEP-03	JY	R145050
Antimony (Sb)	0.0006		0.0004	mg/L		23-SEP-03	JY	R145050
Selenium (Se)	0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Tin (Sn)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Strontium (Sr)	0.123		0.0001	mg/L		23-SEP-03	JY	R145050
Titanium (Ti)	0.0072		0.0003	mg/L		23-SEP-03	JY	R145050
Thallium (Tl)	0.00016		0.00005	mg/L		23-SEP-03	JY	R145050
Uranium (U)	0.0004		0.0001	mg/L		23-SEP-03	JY	R145050
Vanadium (V)	0.0014		0.0001	mg/L		23-SEP-03	JY	R145050
Zinc (Zn)	0.016		0.002	mg/L		23-SEP-03	JY	R145050
Extractable Major Metals								
Calcium (Ca)	38.4		0.5	mg/L		24-SEP-03	HAS	R145296
Potassium (K)	1.1		0.1	mg/L		24-SEP-03	HAS	R145296
Magnesium (Mg)	7.54		0.01	mg/L		24-SEP-03	HAS	R145296
Sodium (Na)	5.0		0.5	mg/L		24-SEP-03	HAS	R145296
Iron (Fe)	2.12		0.005	mg/L		24-SEP-03	HAS	R145296
Manganese (Mn)	0.183		0.001	mg/L		24-SEP-03	HAS	R145296
Mercury (Hg)-Extractable	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Silicon (Si)-Extractable	2.2		0.1	mg/L		24-SEP-03	HAS	R145296
Cyanide, Total	<0.002		0.002	mg/L		24-SEP-03	SEN	R145625
Phosphorus, Total	0.13		0.02	mg/L		24-SEP-03	JTV	R145154
Ammonia-N	<0.05		0.05	mg/L		23-SEP-03	TL	R144913
Oil and Grease	<1		1	mg/L		25-SEP-03	ZOW	R145358
Phenols (4AAP)	0.012		0.001	mg/L		26-SEP-03	STW	R145683
Total Kjeldahl Nitrogen	0.7		0.2	mg/L		24-SEP-03	TL	R145102
Total Organic Carbon	8		1	mg/L		26-SEP-03	STW	R145696
CCME PAHs								
Naphthalene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Quinoline	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Acenaphthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Fluorene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Phenanthrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Acridine	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-4	SITE SW								
Sample Date: 18-SEP-03 16:20									
Matrix: WATER									
CCME PAHs									
	Pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Chrysene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	66		50-112	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	63		53-98	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	92		70-118	%	23-SEP-03	24-SEP-03	FWC	R144969
Routine Water Analysis									
	Chloride (Cl)	4		1	mg/L		24-SEP-03	SHC	R145187
	Nitrate+Nitrite-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrate-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrite-N	<0.05		0.05	mg/L		23-SEP-03	JTV	R144881
pH, Conductivity and Total Alkalinity									
	pH	8.2		0.1	pH		23-SEP-03	PTT	R144945
	Conductivity (EC)	217		0.2	uS/cm		23-SEP-03	PTT	R144945
	Bicarbonate (HCO3)	110		5	mg/L		23-SEP-03	PTT	R144945
	Carbonate (CO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Hydroxide (OH)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Alkalinity, Total (as CaCO3)	90		5	mg/L		23-SEP-03	PTT	R144945
Ion Balance Calculation									
	Ion Balance	105			%		25-SEP-03		
	TDS (Calculated)	122			mg/L		25-SEP-03		
	Hardness (as CaCO3)	106			mg/L		25-SEP-03		
ICP metals and SO4 for routine water									
	Calcium (Ca)	31.6		0.5	mg/L		23-SEP-03	DES	R144764
	Potassium (K)	1.2		0.1	mg/L		23-SEP-03	DES	R144764
	Magnesium (Mg)	6.7		0.1	mg/L		23-SEP-03	DES	R144764
	Sodium (Na)	6		1	mg/L		23-SEP-03	DES	R144764
	Sulfate (SO4)	18.6		0.5	mg/L		23-SEP-03	DES	R144764
L131493-5	TRIP BLANK								
Sample Date: 18-SEP-03 17:20									
Matrix: WATER									
BTEX, F1 (C6-C10) and F2 (>C10-C16)									
	F2 (>C10-C16)	<0.05		0.05	mg/L	25-SEP-03	26-SEP-03	AAT	R145752
BTEX and F1 (C6-C10)									
	Benzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Toluene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	EthylBenzene	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	Xylenes	<0.0005		0.0005	mg/L		27-SEP-03	FWA	R145747
	F1(C6-C10)	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
	F1-BTEX	<0.1		0.1	mg/L		27-SEP-03	FWA	R145747
Extractable Metals									
Extractable Trace Metals (Low Level)									
	Silver (Ag)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
	Aluminum (Al)	<0.01		0.01	mg/L		23-SEP-03	JY	R145050

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-5 TRIP BLANK								
Sample Date: 18-SEP-03 17:20								
Matrix: WATER								
Extractable Metals								
Extractable Trace Metals (Low Level)								
Arsenic (As)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Boron (B)	<0.002		0.002	mg/L		23-SEP-03	JY	R145050
Barium (Ba)	0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Beryllium (Be)	<0.0005		0.0005	mg/L		23-SEP-03	JY	R145050
Bismuth (Bi)	0.00017		0.00005	mg/L		23-SEP-03	JY	R145050
Cadmium (Cd)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Cobalt (Co)	0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Chromium (Cr)	0.0010		0.0004	mg/L		23-SEP-03	JY	R145050
Copper (Cu)	<0.0006		0.0006	mg/L		23-SEP-03	JY	R145050
Molybdenum (Mo)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Nickel (Ni)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Lead (Pb)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Antimony (Sb)	0.0009		0.0004	mg/L		23-SEP-03	JY	R145050
Selenium (Se)	<0.0004		0.0004	mg/L		23-SEP-03	JY	R145050
Tin (Sn)	<0.0002		0.0002	mg/L		23-SEP-03	JY	R145050
Strontium (Sr)	0.0002		0.0001	mg/L		23-SEP-03	JY	R145050
Titanium (Ti)	<0.0003		0.0003	mg/L		23-SEP-03	JY	R145050
Thallium (Tl)	0.00015		0.00005	mg/L		23-SEP-03	JY	R145050
Uranium (U)	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Vanadium (V)	0.0002		0.0001	mg/L		23-SEP-03	JY	R145050
Zinc (Zn)	0.010		0.002	mg/L		23-SEP-03	JY	R145050
Extractable Major Metals								
Calcium (Ca)	<0.5		0.5	mg/L		24-SEP-03	HAS	R145296
Potassium (K)	<0.1		0.1	mg/L		24-SEP-03	HAS	R145296
Magnesium (Mg)	<0.01		0.01	mg/L		24-SEP-03	HAS	R145296
Sodium (Na)	<0.5		0.5	mg/L		24-SEP-03	HAS	R145296
Iron (Fe)	<0.005		0.005	mg/L		24-SEP-03	HAS	R145296
Manganese (Mn)	<0.001		0.001	mg/L		24-SEP-03	HAS	R145296
Mercury (Hg)-Extractable	<0.0001		0.0001	mg/L		23-SEP-03	JY	R145050
Silicon (Si)-Extractable	<0.1		0.1	mg/L		24-SEP-03	HAS	R145296
Cyanide, Total	<0.002		0.002	mg/L		24-SEP-03	SEN	R145625
Phosphorus, Total	<0.02		0.02	mg/L		24-SEP-03	JTV	R145154
Ammonia-N	<0.05		0.05	mg/L		23-SEP-03	TL	R144913
Oil and Grease	<1		1	mg/L		25-SEP-03	ZOW	R145358
Phenols (4AAP)	0.002		0.001	mg/L		26-SEP-03	STW	R145683
Total Kjeldahl Nitrogen	<0.2		0.2	mg/L		24-SEP-03	TL	R145102
Total Organic Carbon	3		1	mg/L		26-SEP-03	STW	R145696
CCME PAHs								
Naphthalene	<0.00001	RAMB	0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Quinoline	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Acenaphthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Fluorene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Phenanthrene	<0.00001	RAMB	0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Acridine	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Benzo(a)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-5	TRIP BLANK								
Sample Date:	18-SEP-03 17:20								
Matrix:	WATER								
CCME PAHs									
	Chrysene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.00001		0.00001	mg/L	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	66		50-112	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	61		53-98	%	23-SEP-03	24-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	88		70-118	%	23-SEP-03	24-SEP-03	FWC	R144969
Routine Water Analysis									
	Chloride (Cl)	<1		1	mg/L		24-SEP-03	SHC	R145187
	Nitrate+Nitrite-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrate-N	<0.1		0.1	mg/L		23-SEP-03	JTV	R144881
	Nitrite-N	<0.05		0.05	mg/L		23-SEP-03	JTV	R144881
pH, Conductivity and Total Alkalinity									
	pH	5.9		0.1	pH		23-SEP-03	PTT	R144945
	Conductivity (EC)	0.7		0.2	uS/cm		23-SEP-03	PTT	R144945
	Bicarbonate (HCO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Carbonate (CO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Hydroxide (OH)	<5		5	mg/L		23-SEP-03	PTT	R144945
	Alkalinity, Total (as CaCO3)	<5		5	mg/L		23-SEP-03	PTT	R144945
Ion Balance Calculation									
	Ion Balance	Low TDS			%		25-SEP-03		
	TDS (Calculated)	<1			mg/L		25-SEP-03		
	Hardness (as CaCO3)	<1			mg/L		25-SEP-03		
ICP metals and SO4 for routine water									
	Calcium (Ca)	<0.5		0.5	mg/L		23-SEP-03	DES	R144764
	Potassium (K)	<0.1		0.1	mg/L		23-SEP-03	DES	R144764
	Magnesium (Mg)	<0.1		0.1	mg/L		23-SEP-03	DES	R144764
	Sodium (Na)	<1		1	mg/L		23-SEP-03	DES	R144764
	Sulfate (SO4)	<0.5		0.5	mg/L		23-SEP-03	DES	R144764
L131493-6	SITE NE								
Sample Date:	18-SEP-03 15:00								
Matrix:	SEDIMENT								
CCME TVHs and TEHs									
CCME Total Hydrocarbons									
	F1 (C6-C10)	<5		5	mg/kg		29-SEP-03		
	F1-BTEX	<5		5	mg/kg		29-SEP-03		
	F2 (C10-C16)	19		5	mg/kg		29-SEP-03		
	F2-Naphth	19		5	mg/kg		29-SEP-03		
	F3 (C16-C34)	90		5	mg/kg		29-SEP-03		
	F3-PAH	90		5	mg/kg		29-SEP-03		
	F4 (C34-C50)	6		5	mg/kg		29-SEP-03		
	Total Hydrocarbons (C6-C50)	120		5	mg/kg		29-SEP-03		
	Chromatogram to baseline at nC50	NO					29-SEP-03		
CCME Total Extractable Hydrocarbons									
	Prep/Analysis Dates					25-SEP-03	26-SEP-03	CTL	R145615
CCME BTEX									
	Benzene	0.02		0.04	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
	Toluene	0.04		0.04	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-6 SITE NE								
Sample Date: 18-SEP-03 15:00								
Matrix: SEDIMENT								
CCME TVHs and TEHs								
CCME BTEX								
Ethylbenzene	<0.01		0.04	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
Xylenes	0.07		0.04	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
Note: raise DL due to moisture content								
Cyanide, Total	0.56		0.1	ug/g		30-SEP-03	SEN	R146339
% Moisture	62		0.1	%		23-SEP-03	BDH	R144772
Ammonia-N	3		1	mg/kg		25-SEP-03	TL	R145389
Mercury (Hg)	<0.05		0.05	mg/kg		25-SEP-03	MX	R145372
Oil-Gravimetric	700		100	mg/kg		26-SEP-03	JME	R145555
Phenols (4AAP)	0.09		0.03	mg/kg		26-SEP-03	STW	R145683
Silicon (Si)	900		50	mg/kg		29-SEP-03	HAS	R146001
Total Kjeldahl Nitrogen	0.23		0.02	%	25-SEP-03	25-SEP-03	HSL	R145463
Phosphorus, Total	530		90	mg/kg	26-SEP-03	26-SEP-03	BEM	R145568
Total Organic Carbon								
Organic Carbon	2.4		0.1	%	25-SEP-03	25-SEP-03	HSL	R145638
Organic Matter	4.2		0.2	%	25-SEP-03	25-SEP-03	HSL	R145638
Metals (ICP/MS)								
Silver (Ag)	<0.2		0.2	mg/kg		25-SEP-03	MX	R145372
Aluminum (Al)	11700		50	mg/kg		25-SEP-03	MX	R145372
Arsenic (As)	4.0		0.1	mg/kg		25-SEP-03	MX	R145372
Boron (B)	9		2	mg/kg		25-SEP-03	MX	R145372
Barium (Ba)	139		0.5	mg/kg		25-SEP-03	MX	R145372
Beryllium (Be)	0.8		0.2	mg/kg		25-SEP-03	MX	R145372
Bismuth (Bi)	<0.5		0.5	mg/kg		25-SEP-03	MX	R145372
Calcium (Ca)	33000		100	mg/kg		25-SEP-03	MX	R145372
Cadmium (Cd)	0.4		0.1	mg/kg		25-SEP-03	MX	R145372
Cobalt (Co)	12.9		0.1	mg/kg		25-SEP-03	MX	R145372
Chromium (Cr)	28.2		0.2	mg/kg		25-SEP-03	MX	R145372
Copper (Cu)	30.3		0.5	mg/kg		25-SEP-03	MX	R145372
Iron (Fe)	24100		200	mg/kg		25-SEP-03	MX	R145372
Potassium (K)	2760		50	mg/kg		25-SEP-03	MX	R145372
Magnesium (Mg)	14500		20	mg/kg		25-SEP-03	MX	R145372
Manganese (Mn)	341		1	mg/kg		25-SEP-03	MX	R145372
Molybdenum (Mo)	1.9		0.1	mg/kg		25-SEP-03	MX	R145372
Sodium (Na)	200		100	mg/kg		25-SEP-03	MX	R145372
Nickel (Ni)	41.2		0.5	mg/kg		25-SEP-03	MX	R145372
Lead (Pb)	12.4		0.5	mg/kg		25-SEP-03	MX	R145372
Selenium (Se)	0.5		0.2	mg/kg		25-SEP-03	MX	R145372
Tin (Sn)	<2		2	mg/kg		25-SEP-03	MX	R145372
Strontium (Sr)	60		1	mg/kg		25-SEP-03	MX	R145372
Titanium (Ti)	150		1	mg/kg		25-SEP-03	MX	R145372
Thallium (Tl)	0.24		0.05	mg/kg		25-SEP-03	MX	R145372
Uranium (U)	0.97		0.05	mg/kg		25-SEP-03	MX	R145372
Vanadium (V)	30.2		0.2	mg/kg		25-SEP-03	MX	R145372
Zinc (Zn)	87		5	mg/kg		25-SEP-03	MX	R145372
CCME PAHs								
Naphthalene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Quinoline	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Phenanthrene	0.02		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-6 SITE NE									
Sample Date: 18-SEP-03 15:00									
Matrix: SEDIMENT									
CCME PAHs									
	Pyrene	<0.01	RAMB	0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(a)anthracene	0.02		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	68		55-108	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	80		51-100	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	97		72-117	%	23-SEP-03	25-SEP-03	FWC	R144969
Detailed Salinity									
	Chloride (Cl)	9		1	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
	Sulphate (SO4)	35.7		0.5	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
pH and EC (Saturated Paste)									
	% Saturation	826		0.1	%		26-SEP-03	JZ	R145651
	pH in Saturated Paste	6.9		0.1	pH		26-SEP-03	JZ	R145651
	Conductivity Sat. Paste	0.34		0.03	dS m-1		26-SEP-03	JZ	R145651
SAR									
	Calcium (Ca)	40.7		0.5	mg/L		26-SEP-03	SIW	R145572
	Potassium (K)	2.3		0.1	mg/L		26-SEP-03	SIW	R145572
	Magnesium (Mg)	7.1		0.1	mg/L		26-SEP-03	SIW	R145572
	Sodium (Na)	16		1	mg/L		26-SEP-03	SIW	R145572
	SAR	0.6			SAR		26-SEP-03	SIW	R145572
L131493-7 SITE NW									
Sample Date: 18-SEP-03 14:20									
Matrix: SEDIMENT									
CCME TVHs and TEHs									
CCME Total Hydrocarbons									
	F1 (C6-C10)	<5		5	mg/kg		29-SEP-03		
	F1-BTEX	<5		5	mg/kg		29-SEP-03		
	F2 (C10-C16)	26		5	mg/kg		29-SEP-03		
	F2-Naphth	26		5	mg/kg		29-SEP-03		
	F3 (C16-C34)	130		5	mg/kg		29-SEP-03		
	F3-PAH	130		5	mg/kg		29-SEP-03		
	F4 (C34-C50)	25		5	mg/kg		29-SEP-03		
	Total Hydrocarbons (C6-C50)	180		5	mg/kg		29-SEP-03		
	Chromatogram to baseline at nC50	NO					29-SEP-03		
CCME Total Extractable Hydrocarbons									
	Prep/Analysis Dates					25-SEP-03	26-SEP-03	CTL	R145615
CCME BTEX									
	Benzene	<0.01		0.03	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
	Toluene	<0.01		0.03	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
	Ethylbenzene	<0.01		0.03	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
	Xylenes	0.03		0.03	mg/kg	28-SEP-03	29-SEP-03	TKP	R145900
Note: raise DL due to moisture content									
	Cyanide, Total	0.92		0.1	ug/g		30-SEP-03	SEN	R146339
	% Moisture	61		0.1	%		23-SEP-03	BDH	R144772
	Ammonia-N	3		1	mg/kg		25-SEP-03	TL	R145389

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-7 SITE NW								
Sample Date: 18-SEP-03 14:20								
Matrix: SEDIMENT								
Mercury (Hg)	<0.05		0.05	mg/kg		25-SEP-03	MX	R145372
Oil-Gravimetric	1200		100	mg/kg		10-OCT-03	JME	R145555
Phenols (4AAP)	0.21		0.03	mg/kg		26-SEP-03	STW	R145683
Silicon (Si)	1930		50	mg/kg		29-SEP-03	HAS	R146001
Total Kjeldahl Nitrogen	0.23		0.02	%	25-SEP-03	25-SEP-03	HSL	R145463
Phosphorus, Total	490		90	mg/kg	26-SEP-03	26-SEP-03	BEM	R145568
Total Organic Carbon								
Organic Carbon	2.7		0.1	%	25-SEP-03	25-SEP-03	HSL	R145638
Organic Matter	4.6		0.2	%	25-SEP-03	25-SEP-03	HSL	R145638
Metals (ICP/MS)								
Silver (Ag)	<0.2		0.2	mg/kg		25-SEP-03	MX	R145372
Aluminum (Al)	11600		50	mg/kg		25-SEP-03	MX	R145372
Arsenic (As)	5.1		0.1	mg/kg		25-SEP-03	MX	R145372
Boron (B)	10		2	mg/kg		25-SEP-03	MX	R145372
Barium (Ba)	152		0.5	mg/kg		25-SEP-03	MX	R145372
Beryllium (Be)	0.8		0.2	mg/kg		25-SEP-03	MX	R145372
Bismuth (Bi)	<0.5		0.5	mg/kg		25-SEP-03	MX	R145372
Calcium (Ca)	47600		100	mg/kg		25-SEP-03	MX	R145372
Cadmium (Cd)	0.4		0.1	mg/kg		25-SEP-03	MX	R145372
Cobalt (Co)	12.2		0.1	mg/kg		25-SEP-03	MX	R145372
Chromium (Cr)	27.7		0.2	mg/kg		25-SEP-03	MX	R145372
Copper (Cu)	33.5		0.5	mg/kg		25-SEP-03	MX	R145372
Iron (Fe)	24500		200	mg/kg		25-SEP-03	MX	R145372
Potassium (K)	2770		50	mg/kg		25-SEP-03	MX	R145372
Magnesium (Mg)	15400		20	mg/kg		25-SEP-03	MX	R145372
Manganese (Mn)	353		1	mg/kg		25-SEP-03	MX	R145372
Molybdenum (Mo)	1.7		0.1	mg/kg		25-SEP-03	MX	R145372
Sodium (Na)	200		100	mg/kg		25-SEP-03	MX	R145372
Nickel (Ni)	39.3		0.5	mg/kg		25-SEP-03	MX	R145372
Lead (Pb)	13.1		0.5	mg/kg		25-SEP-03	MX	R145372
Selenium (Se)	0.4		0.2	mg/kg		25-SEP-03	MX	R145372
Tin (Sn)	<2		2	mg/kg		25-SEP-03	MX	R145372
Strontium (Sr)	90		1	mg/kg		25-SEP-03	MX	R145372
Titanium (Ti)	160		1	mg/kg		25-SEP-03	MX	R145372
Thallium (Tl)	0.25		0.05	mg/kg		25-SEP-03	MX	R145372
Uranium (U)	0.97		0.05	mg/kg		25-SEP-03	MX	R145372
Vanadium (V)	29.1		0.2	mg/kg		25-SEP-03	MX	R145372
Zinc (Zn)	86		5	mg/kg		25-SEP-03	MX	R145372
CCME PAHs								
Naphthalene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Quinoline	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Phenanthrene	0.02		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(a)anthracene	0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(b)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(k)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(a)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Indeno(1,2,3-cd)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Dibenzo(a,h)anthracene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Surr: Nitrobenzene d5	66		55-108	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr: 2-Fluorobiphenyl	66		51-100	%	23-SEP-03	25-SEP-03	FWC	R144969

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-7	SITE NW								
Sample Date:	18-SEP-03 14:20								
Matrix:	SEDIMENT								
CCME PAHs									
Surr:	p-Terphenyl d14	106		72-117	%	23-SEP-03	25-SEP-03	FWC	R144969
Detailed Salinity									
	Chloride (Cl)	13		1	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
	Sulphate (SO4)	53.6		0.5	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
pH and EC (Saturated Paste)									
	% Saturation	979		0.1	%		26-SEP-03	JZ	R145651
	pH in Saturated Paste	6.9		0.1	pH		26-SEP-03	JZ	R145651
	Conductivity Sat. Paste	0.41		0.03	dS m-1		26-SEP-03	JZ	R145651
SAR									
	Calcium (Ca)	53.4		0.5	mg/L		26-SEP-03	SIW	R145572
	Potassium (K)	3.6		0.1	mg/L		26-SEP-03	SIW	R145572
	Magnesium (Mg)	6.2		0.1	mg/L		26-SEP-03	SIW	R145572
	Sodium (Na)	19		1	mg/L		26-SEP-03	SIW	R145572
	SAR	0.7			SAR		26-SEP-03	SIW	R145572
L131493-8	SITE SE								
Sample Date:	18-SEP-03 15:50								
Matrix:	SEDIMENT								
CCME TVHs and TEHs									
CCME Total Hydrocarbons									
	F1 (C6-C10)	<5		5	mg/kg		29-SEP-03		
	F1-BTEX	<5		5	mg/kg		29-SEP-03		
	F2 (C10-C16)	19		5	mg/kg		29-SEP-03		
	F2-Naphth	19		5	mg/kg		29-SEP-03		
	F3 (C16-C34)	98		5	mg/kg		29-SEP-03		
	F3-PAH	98		5	mg/kg		29-SEP-03		
	F4 (C34-C50)	22		5	mg/kg		29-SEP-03		
	Total Hydrocarbons (C6-C50)	140		5	mg/kg		29-SEP-03		
	Chromatogram to baseline at nC50	NO					29-SEP-03		
CCME Total Extractable Hydrocarbons									
	Prep/Analysis Dates					25-SEP-03	26-SEP-03	CTL	R145615
CCME BTEX									
	Benzene	<0.03		0.03	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
	Toluene	0.05		0.03	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
	Ethylbenzene	<0.03		0.03	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
	Xylenes	<0.03		0.03	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
Note: DL RAISED DUE TO HIGH MOISTURE CONTENT									
	Cyanide, Total	0.61		0.1	ug/g		30-SEP-03	SEN	R146339
	% Moisture	53		0.1	%		23-SEP-03	BDH	R144772
	Ammonia-N	4		1	mg/kg		25-SEP-03	TL	R145389
	Mercury (Hg)	<0.05		0.05	mg/kg		25-SEP-03	MX	R145372
	Oil-Gravimetric	600		100	mg/kg		26-SEP-03	JME	R145555
	Phenols (4AAP)	0.07		0.03	mg/kg		26-SEP-03	STW	R145683
	Silicon (Si)	1180		50	mg/kg		29-SEP-03	HAS	R146001
	Total Kjeldahl Nitrogen	0.18		0.02	%	25-SEP-03	25-SEP-03	HSL	R145463
	Phosphorus, Total	600		90	mg/kg	26-SEP-03	26-SEP-03	BEM	R145568
Total Organic Carbon									
	Organic Carbon	2.4		0.1	%	25-SEP-03	25-SEP-03	HSL	R145638

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-8 SITE SE									
Sample Date: 18-SEP-03 15:50									
Matrix: SEDIMENT									
Total Organic Carbon									
	Organic Matter	4.1		0.2	%	25-SEP-03	25-SEP-03	HSL	R145638
Metals (ICP/MS)									
	Silver (Ag)	<0.2		0.2	mg/kg		25-SEP-03	MX	R145372
	Aluminum (Al)	7140		50	mg/kg		25-SEP-03	MX	R145372
	Arsenic (As)	4.8		0.1	mg/kg		25-SEP-03	MX	R145372
	Boron (B)	8		2	mg/kg		25-SEP-03	MX	R145372
	Barium (Ba)	123		0.5	mg/kg		25-SEP-03	MX	R145372
	Beryllium (Be)	0.5		0.2	mg/kg		25-SEP-03	MX	R145372
	Bismuth (Bi)	<0.5		0.5	mg/kg		25-SEP-03	MX	R145372
	Calcium (Ca)	93900		100	mg/kg		25-SEP-03	MX	R145372
	Cadmium (Cd)	0.4		0.1	mg/kg		25-SEP-03	MX	R145372
	Cobalt (Co)	9.0		0.1	mg/kg		25-SEP-03	MX	R145372
	Chromium (Cr)	16.0		0.2	mg/kg		25-SEP-03	MX	R145372
	Copper (Cu)	18.6		0.5	mg/kg		25-SEP-03	MX	R145372
	Iron (Fe)	17600		200	mg/kg		25-SEP-03	MX	R145372
	Potassium (K)	1730		50	mg/kg		25-SEP-03	MX	R145372
	Magnesium (Mg)	15500		20	mg/kg		25-SEP-03	MX	R145372
	Manganese (Mn)	372		1	mg/kg		25-SEP-03	MX	R145372
	Molybdenum (Mo)	1.9		0.1	mg/kg		25-SEP-03	MX	R145372
	Sodium (Na)	300		100	mg/kg		25-SEP-03	MX	R145372
	Nickel (Ni)	26.5		0.5	mg/kg		25-SEP-03	MX	R145372
	Lead (Pb)	9.7		0.5	mg/kg		25-SEP-03	MX	R145372
	Selenium (Se)	0.4		0.2	mg/kg		25-SEP-03	MX	R145372
	Tin (Sn)	<2		2	mg/kg		25-SEP-03	MX	R145372
	Strontium (Sr)	166		1	mg/kg		25-SEP-03	MX	R145372
	Titanium (Ti)	59		1	mg/kg		25-SEP-03	MX	R145372
	Thallium (Tl)	0.25		0.05	mg/kg		25-SEP-03	MX	R145372
	Uranium (U)	1.37		0.05	mg/kg		25-SEP-03	MX	R145372
	Vanadium (V)	23.2		0.2	mg/kg		25-SEP-03	MX	R145372
	Zinc (Zn)	75		5	mg/kg		25-SEP-03	MX	R145372
CCME PAHs									
	Naphthalene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Quinoline	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Phenanthrene	0.02		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(a)anthracene	<0.01	RAMB	0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(b)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(k)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Benzo(a)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Indeno(1,2,3-cd)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
	Dibenzo(a,h)anthracene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	Nitrobenzene d5	77		55-108	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	2-Fluorobiphenyl	74		51-100	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr:	p-Terphenyl d14	102		72-117	%	23-SEP-03	25-SEP-03	FWC	R144969
Detailed Salinity									
	Chloride (Cl)	11		1	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
	Sulphate (SO4)	60.5		0.5	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
pH and EC (Saturated Paste)									
	% Saturation	553		0.1	%		26-SEP-03	JZ	R145651
	pH in Saturated Paste	7.0		0.1	pH		26-SEP-03	JZ	R145651

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-8 SITE SE								
Sample Date: 18-SEP-03 15:50								
Matrix: SEDIMENT								
Detailed Salinity								
pH and EC (Saturated Paste)								
Conductivity Sat. Paste	0.39		0.03	dS m-1		26-SEP-03	JZ	R145651
SAR								
Calcium (Ca)	47.9		0.5	mg/L		26-SEP-03	SIW	R145572
Potassium (K)	2.9		0.1	mg/L		26-SEP-03	SIW	R145572
Magnesium (Mg)	7.4		0.1	mg/L		26-SEP-03	SIW	R145572
Sodium (Na)	21		1	mg/L		26-SEP-03	SIW	R145572
SAR	0.8			SAR		26-SEP-03	SIW	R145572
L131493-9 SITE SW								
Sample Date: 18-SEP-03 16:20								
Matrix: SEDIMENT								
CCME TVHs and TEHs								
CCME Total Hydrocarbons								
F1 (C6-C10)	<5		5	mg/kg		29-SEP-03		
F1-BTEX	<5		5	mg/kg		29-SEP-03		
F2 (C10-C16)	17		5	mg/kg		29-SEP-03		
F2-Naphth	17		5	mg/kg		29-SEP-03		
F3 (C16-C34)	87		5	mg/kg		29-SEP-03		
F3-PAH	87		5	mg/kg		29-SEP-03		
F4 (C34-C50)	19		5	mg/kg		29-SEP-03		
Total Hydrocarbons (C6-C50)	120		5	mg/kg		29-SEP-03		
Chromatogram to baseline at nC50	YES					29-SEP-03		
CCME Total Extractable Hydrocarbons								
Prep/Analysis Dates					25-SEP-03	26-SEP-03	CTL	R145615
CCME BTEX								
Benzene	<0.01		0.02	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
Toluene	0.04		0.02	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
Ethylbenzene	<0.01		0.02	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
Xylenes	0.03		0.02	mg/kg	26-SEP-03	29-SEP-03	EMP	R145894
Note: raise DL due to moisture content								
Cyanide, Total	0.68		0.1	ug/g		30-SEP-03	SEN	R146339
% Moisture	48		0.1	%		23-SEP-03	BDH	R144772
Ammonia-N	5		1	mg/kg		25-SEP-03	TL	R145389
Mercury (Hg)	<0.05		0.05	mg/kg		25-SEP-03	MX	R145372
Oil-Gravimetric	400		100	mg/kg		10-OCT-03	JME	R145555
Phenols (4AAP)	0.17		0.03	mg/kg		26-SEP-03	STW	R145683
Silicon (Si)	1210		50	mg/kg		29-SEP-03	HAS	R146001
Total Kjeldahl Nitrogen	0.14		0.02	%	25-SEP-03	25-SEP-03	HSL	R145463
Phosphorus, Total	450		90	mg/kg	26-SEP-03	26-SEP-03	BEM	R145568
Total Organic Carbon								
Organic Carbon	1.5		0.1	%	25-SEP-03	25-SEP-03	HSL	R145638
Organic Matter	2.6		0.2	%	25-SEP-03	25-SEP-03	HSL	R145638
Metals (ICP/MS)								
Silver (Ag)	<0.2		0.2	mg/kg		25-SEP-03	MX	R145372
Aluminum (Al)	6890		50	mg/kg		25-SEP-03	MX	R145372
Arsenic (As)	4.8		0.1	mg/kg		25-SEP-03	MX	R145372
Boron (B)	8		2	mg/kg		25-SEP-03	MX	R145372
Barium (Ba)	122		0.5	mg/kg		25-SEP-03	MX	R145372
Beryllium (Be)	0.5		0.2	mg/kg		25-SEP-03	MX	R145372

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L131493-9 SITE SW								
Sample Date: 18-SEP-03 16:20								
Matrix: SEDIMENT								
Metals (ICP/MS)								
Bismuth (Bi)	<0.5		0.5	mg/kg		25-SEP-03	MX	R145372
Calcium (Ca)	75000		100	mg/kg		25-SEP-03	MX	R145372
Cadmium (Cd)	0.3		0.1	mg/kg		25-SEP-03	MX	R145372
Cobalt (Co)	8.8		0.1	mg/kg		25-SEP-03	MX	R145372
Chromium (Cr)	15.8		0.2	mg/kg		25-SEP-03	MX	R145372
Copper (Cu)	20.1		0.5	mg/kg		25-SEP-03	MX	R145372
Iron (Fe)	18000		200	mg/kg		25-SEP-03	MX	R145372
Potassium (K)	1590		50	mg/kg		25-SEP-03	MX	R145372
Magnesium (Mg)	13300		20	mg/kg		25-SEP-03	MX	R145372
Manganese (Mn)	371		1	mg/kg		25-SEP-03	MX	R145372
Molybdenum (Mo)	0.9		0.1	mg/kg		25-SEP-03	MX	R145372
Sodium (Na)	200		100	mg/kg		25-SEP-03	MX	R145372
Nickel (Ni)	23.5		0.5	mg/kg		25-SEP-03	MX	R145372
Lead (Pb)	9.6		0.5	mg/kg		25-SEP-03	MX	R145372
Selenium (Se)	0.3		0.2	mg/kg		25-SEP-03	MX	R145372
Tin (Sn)	<2		2	mg/kg		25-SEP-03	MX	R145372
Strontium (Sr)	148		1	mg/kg		25-SEP-03	MX	R145372
Titanium (Ti)	79		1	mg/kg		25-SEP-03	MX	R145372
Thallium (Tl)	0.21		0.05	mg/kg		25-SEP-03	MX	R145372
Uranium (U)	0.91		0.05	mg/kg		25-SEP-03	MX	R145372
Vanadium (V)	20.9		0.2	mg/kg		25-SEP-03	MX	R145372
Zinc (Zn)	93		5	mg/kg		25-SEP-03	MX	R145372
CCME PAHs								
Naphthalene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Quinoline	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Phenanthrene	0.02		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Pyrene	<0.01	RAMB	0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(a)anthracene	0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(b)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(k)fluoranthene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Benzo(a)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Indeno(1,2,3-cd)pyrene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Dibenzo(a,h)anthracene	<0.01		0.01	mg/kg	23-SEP-03	25-SEP-03	FWC	R144969
Surr: Nitrobenzene d5	67		55-108	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr: 2-Fluorobiphenyl	65		51-100	%	23-SEP-03	25-SEP-03	FWC	R144969
Surr: p-Terphenyl d14	102		72-117	%	23-SEP-03	25-SEP-03	FWC	R144969
Detailed Salinity								
Chloride (Cl)	3		1	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
Sulphate (SO4)	36.7		0.5	mg/L	26-SEP-03	26-SEP-03	DDN	R145681
pH and EC (Saturated Paste)								
% Saturation	955		0.1	%		26-SEP-03	JZ	R145651
pH in Saturated Paste	7.0		0.1	pH		26-SEP-03	JZ	R145651
Conductivity Sat. Paste	0.28		0.03	dS m-1		26-SEP-03	JZ	R145651
SAR								
Calcium (Ca)	38.3		0.5	mg/L		26-SEP-03	SIW	R145572
Potassium (K)	2.1		0.1	mg/L		26-SEP-03	SIW	R145572
Magnesium (Mg)	5.9		0.1	mg/L		26-SEP-03	SIW	R145572
Sodium (Na)	6		1	mg/L		26-SEP-03	SIW	R145572
SAR	0.2			SAR		26-SEP-03	SIW	R145572

ENVIRO-TEST ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
Refer to Referenced Information for Qualifiers (if any) and Methodology.								

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
H	Result falls within the 99% Confidence Interval (Laboratory Control Limits)
RAMB	Result Adjusted For Method Blank

Methods Listed (if applicable):

ETL Test Code	Matrix	Test Description	Preparation Method Reference(Based On)	Analytical Method Reference(Based On)
BTX,F1-ED	Water	BTEX and F1 (C6-C10)	EPA 5030	EPA 5030/8015&8260-P&T GC-MS & FID
C-TOT-ORG-CL	Water	Total Organic Carbon		APHA 5310 B-Instrumental
C-TOT-ORG-WB-SK	Soil	Total Organic Carbon		CSSS (1993) p. 190-191
Tiessen, H. and Moir, J.O. 1993. Total and Organic Carbon (Wet Oxidation-Redox Titration Method). p. 190-191. In: M.R. Carter (ed.). Soil Sampling and Methods of Analysis, Canadian Society of Soil Science. Lewis Publishers Anne Arbor, MI.				
CL-ED	Water	Chloride (Cl)		APHA 4500 Cl E-Colorimetry
CL-SAR-CL	Soil	Chloride (Cl) (Saturated Paste)		APHA 4110 B-Ion Chromatography
CN-TOT-WT	Water	Cyanide, Total		EPA 9012(mod)
CN-TOT-WT	Soil	Cyanide, Total		EPA 9012(mod)
ETL-BTX,TVH-CCME-ED	Soil	CCME BTEX	EPA 5030	CCME CWS-PHC Dec-2000 - Pub# 1310
ETL-ROUTINE-ICP-ED	Water	ICP metals and SO4 for routine water		APHA 3120 B-ICP-OES
ETL-TEH-CCME-ED	Soil	CCME Total Extractable Hydrocarbons		CCME CWS-PHC Dec-2000 - Pub# 1310
F2-ED	Water	F2 (>C10-C16)		EPA 3510/8000-GC-FID
HG-EXT-LOW-ED	Water	Mercury (Hg)-Extractable		EPA 6020
HG-LOW-ED	Soil	Mercury (Hg)	EPA 3050	EPA 6020
MET1-EXT-LOW-ED	Water	Extractable Trace Metals (Low Level)		EPA 6020
MET2-EXT-ED	Water	Extractable Major Metals		EPA 200.7
METAL-LOW-EXD-ED	Soil	Metals (ICP/MS)	EPA 3050	EPA 6020
N-TOTKJ-ED	Water	Total Kjeldahl Nitrogen		APHA 4500N-C -Dig.-Auto-Colorimetry
N-TOTKJ-SK	Soil	Total Kjeldahl Nitrogen (Organic N)		CSSS 22.2-Titration
N2N3-ED	Water	Nitrate+Nitrite-N		APHA 4500 NO3H-Colorimetry
NH4-ED	Water	Ammonia-N		APHA4500NH3F Colorimetry
NH4-ED	Soil	Ammonia-N		APHA 4500 NH3F-Colorimetry
NO2-ED	Water	Nitrite-N		APHA 4500 NO2B-Colorimetry
NO3-ED	Water	Nitrate-N		APHA 4500 NO3H-Colorimetry
OGG-ED	Water	Oil and Grease-Gravimetric		APHA 5520 B Hexane MTBE ext. Gravime
OGG-ED	Soil	Oil and Grease-Gravimetric		APHA 5520 D-Soxhlet Extr. Gravimetri
P-TOT-SK	Soil	Total Phosphorus - HNO3/HClO4 digestion	ICP	SSSA (1996) p. 870-872
Kuo, S. 1996. Total Phosphorous, Digestion with Perchloric Acid. p. 870-872. In: J.M. Bartels et al. (ed.) Methods of Soil Analysis: Part 3 Chemical Methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5				
P-TOTAL-ED	Water	Phosphorus, Total		APHA4500-PBE Auto-Colorimetry
PAH-CCME-ED	Water	CCME PAHs	GC/MS	EPA 3510/8270-GC/MS
PAH-CCME-ED	Soil	CCME PAHs	GC/MS	EPA 3540/8270-GC/MS

Reference Information

PH/EC/ALK-ED	Water	pH, Conductivity and Total Alkalinity		APHA 4500-H, 2510, 2320
PHENOLS-CL	Water	Phenols (4AAP)		EPA 9066-Colorimetric
PHENOLS-CL	Soil	Phenols (4AAP)		EPA MAY813355-Colorimteric
PREP-MOISTURE-ED	Soil	% Moisture		Oven dry 105C-Gravimetric
SAR-CALC-CL	Soil	SAR		CSSS 18.4-Calculation
SAT/PH/EC-CL	Soil	pH and EC (Saturated Paste)		CSSS, Chp. 18 - Saturation Extract
SI-ED	Soil	Silicon (Si)	EPA 3050	EPA 200.7
SI-EXT-ED	Water	Silicon (Si)-Extractable		EPA 200.7
SO4-SAR-CL	Soil	Sulfate (SO4)		APHA 4110 B-Ion Chromatography

** Laboratory Methods employed follow in-house procedures, which are generally based on nationally or internationally accepted methodologies.

Chain of Custody numbers:

60885

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
CL	Enviro-Test Laboratories - Calgary, Alberta, Canada	ED	Enviro-Test Laboratories - Edmonton, Alberta, Canada
SK	Enviro-Test Laboratories - Saskatoon, Saskatchewan, Canada	WT	Enviro-Test Laboratories - Waterloo (Sentinel), Ontario, Can

GLOSSARY OF REPORT TERMS
Surr - A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior but not normally detected in enviromental samples. Prior to sample processing, samples are fortified with one or more surrogate compounds.
The reported surrogate recovery value provides a measure of method efficiency. The Laboratory warning units are determined under column heading D.L.
mg/kg (units) - unit of concentration based on mass, parts per million
mg/L (units) - unit of concentration based on volume, parts per million
< - Less than
D.L. - Detection Limit
N/A - Result not available. Refer to qualifier code and definition for explanation

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
UNLESS OTHERWISE STATED, SAMPLES ARE NOT CORRECTED FOR CLIENT FIELD BLANKS.
Although test results are generated under strict QA/QC protocols, any unsigned test reports, faxes, or emails are considered preliminary.

Enviro-Test Laboratories has an extensive QA/QC program where all analytical data reported is analyzed using approved referenced procedures followed by checks and reviews by senior managers and quality assurance personnel. However, since the results are obtained from chemical measurements and thus cannot be guaranteed, Enviro-Test Laboratories assumes no liability for the use or interpretation of the results.

Table A-2

Enviro-Test QC Report

Enviro·Test LABORATORIES

ENVIRO-TEST QC REPORT

Workorder: L131493

Client: GOLDER ASSOCIATES LTD
17312 106 AVE
EDMONTON AB T5S 1H9

Contact: JIM CAMPBELL / M. DUNNIGAN

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BTX,F1-ED	**Water**							
Batch R145747								
WG141280-5 DUP		**L131493-5**						
Benzene		<0.0005	<0.0005	RPD-NA	mg/L	N/A	25	27-SEP-03
EthylBenzene		<0.0005	<0.0005	RPD-NA	mg/L	N/A	10	27-SEP-03
Toluene		<0.0005	<0.0005	RPD-NA	mg/L	N/A	21	27-SEP-03
F1(C6-C10)		<0.1	<0.1	RPD-NA	mg/L	N/A	23	27-SEP-03
Xylenes		<0.0005	<0.0005	RPD-NA	mg/L	N/A	22	27-SEP-03
WG141524-2 LCS								
Benzene			97		%		71-125	27-SEP-03
EthylBenzene			106		%		72-115	27-SEP-03
Toluene			103		%		68-130	27-SEP-03
F1(C6-C10)			113		%		61-134	27-SEP-03
Xylenes			104		%		76-123	27-SEP-03
WG141524-1 MB								
Benzene			<0.0005		mg/L		0.0005	27-SEP-03
EthylBenzene			<0.0005		mg/L		0.0005	27-SEP-03
Toluene			<0.0005		mg/L		0.0005	27-SEP-03
F1(C6-C10)			<0.1		mg/L		0.1	27-SEP-03
Xylenes			<0.0005		mg/L		0.0005	27-SEP-03
C-TOT-ORG-CL	**Water**							
Batch R145696								
WG141670-5 DUP		**L131493-4**						
Total Organic Carbon		8	7	J	mg/L	1	3.1	26-SEP-03
WG141670-1 LCS								
Total Organic Carbon			97		%		86-106	26-SEP-03
WG141670-2 MB								
Total Organic Carbon			<1		mg/L		1	26-SEP-03
WG141670-6 MS		**L131493-4**						
Total Organic Carbon			99		%		87-109	26-SEP-03
CL-ED	**Water**							
Batch R145187								
WG141077-5 DUP		**L130553-1**						
Chloride (Cl)		27	25		mg/L	4.1	5	24-SEP-03
WG141077-7 DUP		**L131128-4**						
Chloride (Cl)		16	16		mg/L	3.5	5	24-SEP-03
WG141077-9 DUP		**L131621-4**						

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-ED	**Water**							
Batch R145187								
WG141077-9 DUP		**L131621-4**						
Chloride (Cl)		17	17		mg/L	0.35	5	24-SEP-03
WG141077-2 LCS								
Chloride (Cl)			96		%		75-125	24-SEP-03
WG141077-3 LCS								
Chloride (Cl)			99		%		75-125	24-SEP-03
WG141077-1 MB								
Chloride (Cl)			<1		mg/L		1	24-SEP-03
WG141077-10 MS		**L131621-4**						
Chloride (Cl)			94	H	%		94-113	24-SEP-03
WG141077-6 MS		**L130553-1**						
Chloride (Cl)			92	H	%		94-113	24-SEP-03
WG141077-8 MS		**L131128-4**						
Chloride (Cl)			94	H	%		94-113	24-SEP-03
ETL-ROUTINE-ICP-ED	**Water**							
Batch R144764								
WG140662-3 CRM								
Calcium (Ca)			97		%		91-104	23-SEP-03
Magnesium (Mg)			98		%		92-105	23-SEP-03
Potassium (K)			107		%		89-111	23-SEP-03
Sodium (Na)			100		%		91-104	23-SEP-03
Sulfate (SO4)			100		%		90-103	23-SEP-03
WG140662-13 DUP		**L130944-16**						
Calcium (Ca)		3320	3290		mg/L	0.85	15	23-SEP-03
Magnesium (Mg)		85.5	82.0		mg/L	4.2	15	23-SEP-03
Potassium (K)		42.4	52.5	H	mg/L	21	18	23-SEP-03
Sodium (Na)		1730	1660		mg/L	4.3	15	23-SEP-03
Sulfate (SO4)		1440	1410		mg/L	1.8	15	23-SEP-03
WG140662-15 DUP		**L131080-12**						
Calcium (Ca)		377	377		mg/L	0.00095	15	23-SEP-03
Magnesium (Mg)		361	358		mg/L	0.80	15	23-SEP-03
Potassium (K)		13.9	13.6		mg/L	1.9	18	23-SEP-03
Sodium (Na)		1950	1940		mg/L	0.40	15	23-SEP-03
Sulfate (SO4)		4880	4830		mg/L	1.2	15	23-SEP-03
WG140662-17 DUP		**L131094-1**						
Calcium (Ca)		231	228		mg/L	1.4	15	23-SEP-03
Magnesium (Mg)		133	132		mg/L	0.98	15	23-SEP-03
Potassium (K)		26.9	26.5		mg/L	1.4	18	23-SEP-03
Sodium (Na)		624	610		mg/L	2.2	15	23-SEP-03
Sulfate (SO4)		1280	1210		mg/L	5.2	15	23-SEP-03

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ETL-ROUTINE-ICP-ED	**Water**							
Batch R144764								
WG140662-1 MB								
Calcium (Ca)			<0.5		mg/L		2.5	23-SEP-03
Magnesium (Mg)			<0.1		mg/L		0.5	23-SEP-03
Potassium (K)			<0.1		mg/L		0.5	23-SEP-03
Sodium (Na)			<1		mg/L		5	23-SEP-03
Sulfate (SO4)			<0.5		mg/L		2.5	23-SEP-03
WG140662-14 MS		**L130944-16**						
Calcium (Ca)			108		%		82-114	23-SEP-03
Magnesium (Mg)			102		%		88-111	23-SEP-03
Potassium (K)			103		%		87-122	23-SEP-03
Sodium (Na)			104		%		85-116	23-SEP-03
Sulfate (SO4)			97		%		81-114	23-SEP-03
WG140662-16 MS		**L131080-12**						
Calcium (Ca)			100		%		82-114	23-SEP-03
Magnesium (Mg)			102		%		88-111	23-SEP-03
Potassium (K)			102		%		87-122	23-SEP-03
Sodium (Na)			116	H	%		85-116	23-SEP-03
Sulfate (SO4)			137	E	%		81-114	23-SEP-03
WG140662-18 MS		**L131094-1**						
Calcium (Ca)			94		%		82-114	23-SEP-03
Magnesium (Mg)			97		%		88-111	23-SEP-03
Potassium (K)			96		%		87-122	23-SEP-03
Sodium (Na)			89		%		85-116	23-SEP-03
Sulfate (SO4)			93		%		81-114	23-SEP-03
F2-ED	**Water**							
Batch R145752								
WG141746-3 DUP		**L131493-2**						
F2 (>C10-C16)		<0.05	<0.05	RPD-NA	mg/L	N/A	59	26-SEP-03
WG141746-4 DUP		**L131568-2**						
F2 (>C10-C16)		<0.05	<0.05	RPD-NA	mg/L	N/A	59	26-SEP-03
WG141746-2 LCS								
F2 (>C10-C16)			100		%		64-124	26-SEP-03
WG141746-1 MB								
F2 (>C10-C16)			<0.05		mg/L		0.05	26-SEP-03
HG-EXT-LOW-ED	**Water**							
Batch R145050								
WG140752-1 MB								
Mercury (Hg)-Extractable			<0.0001		mg/L		0.0005	23-SEP-03
MET1-EXT-LOW-ED	**Water**							

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET1-EXT-LOW-ED	**Water**							
Batch R145050								
WG140752-1 MB								
Antimony (Sb)			<0.0004		mg/L		0.002	23-SEP-03
Arsenic (As)			<0.0004		mg/L		0.002	23-SEP-03
Barium (Ba)			0.0001		mg/L		0.0005	23-SEP-03
Beryllium (Be)			<0.0005		mg/L		0.0025	23-SEP-03
Bismuth (Bi)			0.00020		mg/L		0.00025	23-SEP-03
Boron (B)			<0.002		mg/L		0.01	23-SEP-03
Cadmium (Cd)			<0.0001		mg/L		0.0005	23-SEP-03
Chromium (Cr)			0.0007		mg/L		0.002	23-SEP-03
Cobalt (Co)			<0.0001		mg/L		0.0005	23-SEP-03
Copper (Cu)			<0.0006		mg/L		0.003	23-SEP-03
Lead (Pb)			<0.0001		mg/L		0.0005	23-SEP-03
Molybdenum (Mo)			<0.0001		mg/L		0.0005	23-SEP-03
Nickel (Ni)			0.0002		mg/L		0.0005	23-SEP-03
Phosphorus (P)			<0.01		mg/L		0.01	23-SEP-03
Selenium (Se)			<0.0004		mg/L		0.002	23-SEP-03
Silver (Ag)			<0.0002		mg/L		0.001	23-SEP-03
Strontium (Sr)			<0.0001		mg/L		0.0005	23-SEP-03
Thallium (Tl)			0.00014		mg/L		0.00025	23-SEP-03
Tin (Sn)			<0.0002		mg/L		0.001	23-SEP-03
Titanium (Ti)			<0.0003		mg/L		0.0015	23-SEP-03
Uranium (U)			<0.0001		mg/L		0.0005	23-SEP-03
Vanadium (V)			<0.0001		mg/L		0.0005	23-SEP-03
Zinc (Zn)			<0.002		mg/L		0.01	23-SEP-03
MET2-EXT-ED	**Water**							
Batch R145296								
WG140910-4 DUP		**L131493-4**						
Calcium (Ca)		38.4	37.8		mg/L	1.5	20	24-SEP-03
Iron (Fe)		2.12	2.00		mg/L	5.9	15	24-SEP-03
Magnesium (Mg)		7.54	7.11		mg/L	5.9	20	24-SEP-03
Manganese (Mn)		0.183	0.173		mg/L	5.6	20	24-SEP-03
Potassium (K)		1.1	1.1		mg/L	0.28	20	24-SEP-03
Sodium (Na)		5.0	5.0	J	mg/L	0.0	1.5	24-SEP-03
WG140910-1 MB								
Calcium (Ca)			<0.5		mg/L		0.5	24-SEP-03
Iron (Fe)			<0.005		mg/L		0.025	24-SEP-03
Magnesium (Mg)			<0.01		mg/L		0.01	24-SEP-03
Manganese (Mn)			<0.001		mg/L		0.001	24-SEP-03

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET2-EXT-ED	**Water**							
Batch R145296								
WG140910-1 MB								
Potassium (K)			<0.1		mg/L		0.1	24-SEP-03
Sodium (Na)			<0.5		mg/L		0.5	24-SEP-03
WG140910-5 MS		**L131493-4**						
Calcium (Ca)			102	E	%		75-125	24-SEP-03
Iron (Fe)			97		%		86-108	24-SEP-03
Magnesium (Mg)			98	E	%		75-125	24-SEP-03
Manganese (Mn)			97	E	%		75-125	24-SEP-03
Potassium (K)			105		%		75-125	24-SEP-03
Sodium (Na)			102		%		75-125	24-SEP-03
N-TOTKJ-ED	**Water**							
Batch R145102								
WG140859-4 DUP		**L131453-2**						
Total Kjeldahl Nitrogen		0.6	0.6	J	mg/L	0.0	0.61	24-SEP-03
WG140859-2 LCS								
Total Kjeldahl Nitrogen			100		%		73-131	24-SEP-03
WG140859-1 MB								
Total Kjeldahl Nitrogen			<0.2		mg/L		0.2	24-SEP-03
N2N3-ED	**Water**							
Batch R144881								
WG140776-3 LCS								
Nitrate+Nitrite-N			99		%		88-105	23-SEP-03
WG140776-1 MB								
Nitrate+Nitrite-N			<0.1		mg/L		0.1	23-SEP-03
WG140776-4 MS		**L131493-5**						
Nitrate+Nitrite-N			89	H	%		90-108	23-SEP-03
WG140776-6 MS		**L131668-1**						
Nitrate+Nitrite-N			89	H	%		90-108	23-SEP-03
WG140776-5 MSD		**WG140776-4**						
Nitrate+Nitrite-N		89	90		%	0.12	5	23-SEP-03
WG140776-7 MSD		**WG140776-6**						
Nitrate+Nitrite-N		89	90		%	0.86	5	23-SEP-03
NH4-ED	**Water**							
Batch R144913								
WG140695-2 LCS								
Ammonia-N			104		%		89-116	23-SEP-03
Ammonia-N			104		%		89-116	23-SEP-03
WG140695-1 MB								
Ammonia-N			<0.05		mg/L		0.05	23-SEP-03
Ammonia-N			<0.05		mg/L		0.05	23-SEP-03
WG140695-4 MS		**L131493-5**						

ENVIRO-TEST QC REPORT

Workorder: L131493

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH4-ED		**Water**							
Batch	**R144913**								
WG140695-4	**MS**		**L131493-5**						
Ammonia-N				105		%		65-132	23-SEP-03
NO2-ED		**Water**							
Batch	**R144881**								
WG140776-3	**LCS**								
Nitrite-N				94	H	%		94-108	23-SEP-03
WG140776-1	**MB**								
Nitrite-N				<0.05		mg/L		0.05	23-SEP-03
WG140776-4	**MS**		**L131493-5**						
Nitrite-N				96		%		93-105	23-SEP-03
WG140776-6	**MS**		**L131668-1**						
Nitrite-N				97		%		93-105	23-SEP-03
WG140776-5	**MSD**		**WG140776-4**						
Nitrite-N			96	98		%	1.5	5	23-SEP-03
WG140776-7	**MSD**		**WG140776-6**						
Nitrite-N			97	98		%	1.1	5	23-SEP-03
OGG-ED		**Water**							
Batch	**R145358**								
WG141293-2	**LCS**								
Oil and Grease				86		%		79-100	25-SEP-03
WG141293-1	**MB**								
Oil and Grease				<1		mg/L		1	25-SEP-03
P-TOTAL-ED		**Water**							
Batch	**R145154**								
WG140998-8	**DUP**		**L131354-2**						
Phosphorus, Total			0.03	0.03	J	mg/L	0.00	0.061	24-SEP-03
WG140998-4	**LCS**								
Phosphorus, Total				96		%		87-109	24-SEP-03
WG140998-1	**MB**								
Phosphorus, Total				<0.02		mg/L		0.02	24-SEP-03
WG140998-9	**MS**		**L131394-7**						
Phosphorus, Total				108		%		80-120	24-SEP-03
PAH-CCME-ED		**Water**							
Batch	**R144969**								
WG140479-2	**LCS**								
Acenaphthene				67		%		66-103	24-SEP-03
Acridine				73		%		65-114	24-SEP-03
Anthracene				70	H	%		71-106	24-SEP-03
Benzo(a)anthracene				68	H	%		69-112	24-SEP-03
Benzo(a)pyrene				70		%		66-111	24-SEP-03

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-CCME-ED	**Water**							
Batch R144969								
WG140479-2 LCS								
Benzo(b)fluoranthene			95		%		66-103	24-SEP-03
Benzo(k)fluoranthene			90		%		63-111	24-SEP-03
Chrysene			74		%		66-114	24-SEP-03
Dibenzo(a,h)anthracene			72		%		63-111	24-SEP-03
Fluoranthene			78		%		68-113	24-SEP-03
Fluorene			72		%		66-109	24-SEP-03
Indeno(1,2,3-cd)pyrene			63	H	%		64-112	24-SEP-03
Naphthalene			69		%		65-107	24-SEP-03
Phenanthrene			72		%		70-114	24-SEP-03
Pyrene			79		%		68-121	24-SEP-03
Quinoline			78		%		70-110	24-SEP-03
WG140479-1 MB								
Acenaphthene			<0.00001		mg/L		0.00001	24-SEP-03
Acridine			<0.00001		mg/L		0.00001	24-SEP-03
Anthracene			<0.00001		mg/L		0.00001	24-SEP-03
Benzo(a)anthracene			<0.00001		mg/L		0.00001	24-SEP-03
Benzo(a)pyrene			<0.00001		mg/L		0.00001	24-SEP-03
Benzo(b)fluoranthene			<0.00001		mg/L		0.00001	24-SEP-03
Benzo(k)fluoranthene			<0.00001		mg/L		0.00001	24-SEP-03
Chrysene			<0.00001		mg/L		0.00001	24-SEP-03
Dibenzo(a,h)anthracene			<0.00001		mg/L		0.00001	24-SEP-03
Fluoranthene			<0.00001		mg/L		0.00001	24-SEP-03
Fluorene			<0.00001		mg/L		0.00001	24-SEP-03
Indeno(1,2,3-cd)pyrene			<0.00001		mg/L		0.00001	24-SEP-03
Naphthalene			<0.00001		mg/L		0.00001	24-SEP-03
Phenanthrene			<0.00001		mg/L		0.00001	24-SEP-03
Pyrene			<0.00001		mg/L		0.00001	24-SEP-03
Quinoline			<0.00001		mg/L		0.00001	24-SEP-03
PH/EC/ALK-ED	**Water**							
Batch R144945								
WG140567-4 DUP		**L131624-9**						
Alkalinity, Total (as CaCO3)		454	457		mg/L	0.75	5	23-SEP-03
Bicarbonate (HCO3)		554	558		mg/L	0.75	20	23-SEP-03
Carbonate (CO3)		<5	<5	RPD-NA	mg/L	N/A	20	23-SEP-03
Conductivity (EC)		1780	1780		uS/cm	0.28	5.5	23-SEP-03
Hydroxide (OH)		<5	<5	RPD-NA	mg/L	N/A	20	23-SEP-03
pH		7.5	7.5	J	pH	0.0	0.1	23-SEP-03
WG140567-5 DUP		**L131817-5**						

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-ED	**Water**							
Batch R144945								
WG140567-5 DUP		**L131817-5**						
Alkalinity, Total (as CaCO3)		398	400		mg/L	0.57	5	23-SEP-03
Bicarbonate (HCO3)		486	488		mg/L	0.58	20	23-SEP-03
Carbonate (CO3)		<5	<5	RPD-NA	mg/L	N/A	20	23-SEP-03
Conductivity (EC)		1990	1990		uS/cm	0.10	5.5	23-SEP-03
Hydroxide (OH)		<5	<5	RPD-NA	mg/L	N/A	20	23-SEP-03
pH		7.3	7.3	J	pH	0.0	0.1	23-SEP-03
WG140567-1 LCS								
Conductivity (EC)			99		%		97-105	23-SEP-03
WG140567-2 LCS								
pH			7.0		pH		6.9-7.1	23-SEP-03
WG140567-3 LCS								
Alkalinity, Total (as CaCO3)			100		%		96-109	23-SEP-03
PHENOLS-CL	**Water**							
Batch R145683								
WG141661-2 LCS								
Phenols (4AAP)			74	G	%		86-100	26-SEP-03
WG141661-1 MB								
Phenols (4AAP)			<0.001		mg/L		0.001	26-SEP-03
SI-EXT-ED	**Water**							
Batch R145296								
WG140910-4 DUP		**L131493-4**						
Silicon (Si)-Extractable		2.2	2.1		mg/L	6.9	20	24-SEP-03
WG140910-1 MB								
Silicon (Si)-Extractable			<0.1		mg/L		0.1	24-SEP-03
WG140910-5 MS		**L131493-4**						
Silicon (Si)-Extractable			97		%		75-125	24-SEP-03
C-TOT-ORG-WB-SK	**Soil**							
Batch R145638								
WG141253-1 DUP		**L131493-8**						
Organic Carbon		2.4	2.0		%	18	20	25-SEP-03
Organic Matter		4.1	3.4	H	%	19	15	25-SEP-03
WG141253-2 IRM								
Organic Matter			4.1		%		3.5-4.3	25-SEP-03
CL-SAR-CL	**Soil**							
Batch R145681								
WG141664-10 DUP		**L131573-49**						
Chloride (Cl)		236	227		mg/L	3.7	10	27-SEP-03
WG141664-4 DUP		**L131573-4**						
Chloride (Cl)		464	477		mg/L	2.8	10	26-SEP-03
WG141664-6 DUP		**L131573-6**						

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-SAR-CL	**Soil**							
Batch R145681								
WG141664-6 DUP		**L131573-6**						
Chloride (Cl)		1180	1240		mg/L	4.2	10	26-SEP-03
WG141664-7 DUP		**L131573-28**						
Chloride (Cl)		933	939		mg/L	0.65	10	26-SEP-03
WG141664-8 DUP		**L131573-29**						
Chloride (Cl)		911	878		mg/L	3.6	10	26-SEP-03
WG141664-9 DUP		**L131573-30**						
Chloride (Cl)		343	343		mg/L	0.16	10	26-SEP-03
WG141664-3 IRM								
Chloride (Cl)			86		%		84-118	26-SEP-03
WG141664-1 LCS								
Chloride (Cl)			95		%		92-112	26-SEP-03
WG141664-2 MB								
Chloride (Cl)			<1		mg/L		1	26-SEP-03
WG141664-11 MS		**L131573-49**						
Chloride (Cl)			99		%		89-111	27-SEP-03
WG141664-5 MS		**L131573-4**						
Chloride (Cl)			104		%		89-111	26-SEP-03
ETL-BTX,TVH-CCME-ED	**Soil**							
Batch R145894								
WG141909-2 LCS								
Benzene			75		%		60-122	29-SEP-03
Ethylbenzene			101		%		64-124	29-SEP-03
Toluene			98		%		61-126	29-SEP-03
TVH: (C6-C10 / No BTEX Correction)			118		%		59-128	29-SEP-03
Xylenes			106		%		68-122	29-SEP-03
WG141909-1 MB								
Benzene			<0.01		mg/kg		0.01	29-SEP-03
Ethylbenzene			<0.01		mg/kg		0.01	29-SEP-03
Toluene			<0.01		mg/kg		0.01	29-SEP-03
TVH: (C6-C10 / No BTEX Correction)			<5		mg/kg		5	29-SEP-03
Xylenes			<0.01		mg/kg		0.01	29-SEP-03
Batch R145900								
WG140387-5 DUP		**L131493-7**						
Benzene		<0.01	<0.04	RPD-NA	mg/kg	N/A	42	29-SEP-03
Ethylbenzene		<0.01	<0.04	RPD-NA	mg/kg	N/A	48	29-SEP-03
Toluene		<0.01	0.04	RPD-NA	mg/kg	N/A	39	29-SEP-03
TVH: (C6-C10 / No BTEX Correction)		<5	<5	RPD-NA	mg/kg	N/A	41	29-SEP-03
Xylenes		0.03	0.05	RPD-NA	mg/kg	N/A	52	29-SEP-03

COMMENTS: raise DL due to moisture content

WG141935-2 LCS

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ETL-BTX,TVH-CCME-ED	**Soil**							
Batch R145900								
WG141935-2 LCS								
Benzene			79		%		60-122	29-SEP-03
Ethylbenzene			120		%		64-124	29-SEP-03
Toluene			95		%		61-126	29-SEP-03
TVH: (C6-C10 / No BTEX Correction)			93		%		59-128	29-SEP-03
Xylenes			88		%		68-122	29-SEP-03
WG141935-1 MB								
Benzene			<0.01		mg/kg		0.01	29-SEP-03
Ethylbenzene			<0.01		mg/kg		0.01	29-SEP-03
Toluene			<0.01		mg/kg		0.01	29-SEP-03
TVH: (C6-C10 / No BTEX Correction)			<5		mg/kg		5	29-SEP-03
Xylenes			<0.01		mg/kg		0.01	29-SEP-03
WG140387-4 MS		**L131319-19**						
Benzene			82		%		47-118	08-OCT-03
Ethylbenzene			72		%		48-117	08-OCT-03
Toluene			73		%		48-120	08-OCT-03
TVH: (C6-C10 / No BTEX Correction)			92		%		50-114	08-OCT-03
Xylenes			73		%		50-117	08-OCT-03
ETL-TEH-CCME-ED	**Soil**							
Batch R145615								
WG141624-2 LCS								
TEH: (C10-C16)			66		%		58-118	25-SEP-03
TEH: (C16-C34)			66		%		58-118	25-SEP-03
TEH: (C34-C50)			66		%		58-118	25-SEP-03
WG141624-3 LCS								
TEH: (C10-C16)			64		%		58-118	26-SEP-03
TEH: (C16-C34)			64		%		58-118	26-SEP-03
TEH: (C34-C50)			64		%		58-118	26-SEP-03
WG141624-1 MB								
TEH: (C10-C16)			<5		mg/kg		5	25-SEP-03
TEH: (C16-C34)			<5		mg/kg		5	25-SEP-03
TEH: (C34-C50)			<5		mg/kg		5	25-SEP-03
HG-LOW-ED	**Soil**							
Batch R145372								
WG141201-2 CRM								
Mercury (Hg)			91		%		58-142	25-SEP-03
WG141201-1 MB								
Mercury (Hg)			<0.05		mg/kg		0.25	25-SEP-03
METAL-LOW-EXD-ED	**Soil**							

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
METAL-LOW-EXD-ED	**Soil**							
Batch R145372								
WG141201-2 CRM								
Aluminum (Al)			104		%		63-137	25-SEP-03
Arsenic (As)			97		%		88-112	25-SEP-03
Barium (Ba)			111		%		83-117	25-SEP-03
Boron (B)			100		%		48-152	25-SEP-03
Cadmium (Cd)			100		%		78-122	25-SEP-03
Calcium (Ca)			90		%		89-111	25-SEP-03
Chromium (Cr)			106		%		78-122	25-SEP-03
Cobalt (Co)			94		%		89-111	25-SEP-03
Copper (Cu)			88		%		81-119	25-SEP-03
Iron (Fe)			90		%		77-123	25-SEP-03
Lead (Pb)			119		%		80-120	25-SEP-03
Magnesium (Mg)			96		%		83-117	25-SEP-03
Manganese (Mn)			89		%		78-122	25-SEP-03
Nickel (Ni)			95		%		89-111	25-SEP-03
Potassium (K)			126	H	%		77-123	25-SEP-03
Selenium (Se)			75		%		59-141	25-SEP-03
Sodium (Na)			89		%		77-123	25-SEP-03
Strontium (Sr)			96		%		90-111	25-SEP-03
Vanadium (V)			116		%		73-127	25-SEP-03
Zinc (Zn)			96		%		85-115	25-SEP-03
WG141201-1 MB								
Aluminum (Al)			<50		mg/kg		250	25-SEP-03
Arsenic (As)			<0.1		mg/kg		0.5	25-SEP-03
Barium (Ba)			<0.5		mg/kg		2.5	25-SEP-03
Beryllium (Be)			<0.2		mg/kg		1	25-SEP-03
Bismuth (Bi)			<0.5		mg/kg		2.5	25-SEP-03
Boron (B)			<2		mg/kg		10	25-SEP-03
Cadmium (Cd)			<0.1		mg/kg		0.5	25-SEP-03
Calcium (Ca)			<100		mg/kg		500	25-SEP-03
Chromium (Cr)			<0.2		mg/kg		1	25-SEP-03
Cobalt (Co)			<0.1		mg/kg		0.5	25-SEP-03
Copper (Cu)			<0.5		mg/kg		2.5	25-SEP-03
Iron (Fe)			<200		mg/kg		1000	25-SEP-03
Lead (Pb)			<0.5		mg/kg		2.5	25-SEP-03
Magnesium (Mg)			<20		mg/kg		100	25-SEP-03
Manganese (Mn)			<1		mg/kg		5	25-SEP-03
Molybdenum (Mo)			0.2		mg/kg		0.5	25-SEP-03

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
METAL-LOW-EXD-ED	**Soil**							
Batch R145372								
WG141201-1 MB								
Nickel (Ni)			<0.5		mg/kg		2.5	25-SEP-03
Potassium (K)			<50		mg/kg		250	25-SEP-03
Selenium (Se)			<0.2		mg/kg		1	25-SEP-03
Silver (Ag)			0.4		mg/kg		1	25-SEP-03
Sodium (Na)			<100		mg/kg		500	25-SEP-03
Strontium (Sr)			<1		mg/kg		5	25-SEP-03
Thallium (Tl)			<0.05		mg/kg		0.25	25-SEP-03
Tin (Sn)			<2		mg/kg		10	25-SEP-03
Titanium (Ti)			<1		mg/kg		5	25-SEP-03
Uranium (U)			<0.05		mg/kg		0.25	25-SEP-03
Vanadium (V)			<0.2		mg/kg		1	25-SEP-03
Zinc (Zn)			<5		mg/kg		25	25-SEP-03
N-TOTKJ-SK	**Soil**							
Batch R145463								
WG140756-2 CRM								
Total Kjeldahl Nitrogen			0.22		%		.19-.25	25-SEP-03
WG140756-1 DUP		**L131394-4**						
Total Kjeldahl Nitrogen		1.70	1.67	J	%	0.03	0.1	25-SEP-03
NH4-ED	**Soil**							
Batch R145389								
WG141261-5 DUP		**L131330-1**						
Ammonia-N		2	2	J	mg/kg	0	3.1	25-SEP-03
OGG-ED	**Soil**							
Batch R145555								
WG141519-3 DUP		**L131260-30**						
Oil-Gravimetric		14800	14900		mg/kg	0.80	22	26-SEP-03
WG141519-2 LCS								
Oil-Gravimetric			99		%		94-109	26-SEP-03
WG141519-1 MB								
Oil-Gravimetric			<100		mg/kg		100	26-SEP-03
P-TOT-SK	**Soil**							
Batch R145568								
WG141146-3 CRM								
Phosphorus, Total			90		%		81-119	26-SEP-03
WG141146-1 DUP		**L131493-9**						
Phosphorus, Total		450	450		mg/kg	0.29	15	26-SEP-03
PAH-CCME-ED	**Soil**							

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-CCME-ED	**Soil**							
Batch R144969								
WG140481-1 MB								
Benzo(a)anthracene			<0.01		mg/kg		0.01	25-SEP-03
Benzo(a)pyrene			<0.01		mg/kg		0.01	25-SEP-03
Benzo(b)fluoranthene			<0.01		mg/kg		0.01	25-SEP-03
Benzo(k)fluoranthene			<0.01		mg/kg		0.01	25-SEP-03
Dibenzo(a,h)anthracene			<0.01		mg/kg		0.01	25-SEP-03
Indeno(1,2,3-cd)pyrene			<0.01		mg/kg		0.01	25-SEP-03
Naphthalene			<0.01		mg/kg		0.01	25-SEP-03
Phenanthrene			<0.01		mg/kg		0.01	25-SEP-03
Pyrene			<0.01		mg/kg		0.01	25-SEP-03
Quinoline			<0.01		mg/kg		0.01	25-SEP-03
PHENOLS-CL	**Soil**							
Batch R145683								
WG141661-2 LCS								
Phenols (4AAP)			74	G	%		86-100	26-SEP-03
WG141661-1 MB								
Phenols (4AAP)			<0.03		mg/kg		0.03	26-SEP-03
SAR-CALC-CL	**Soil**							
Batch R145572								
WG141558-10 DUP		**L131573-28**						
Calcium (Ca)		35.4	39.3		mg/L	10	10	26-SEP-03
Magnesium (Mg)		21.2	23.6	H	mg/L	11	10	26-SEP-03
Potassium (K)		55.2	61.1		mg/L	10	10	26-SEP-03
Sodium (Na)		822	907		mg/L	9.8	10	26-SEP-03
WG141558-11 DUP		**L131573-30**						
Calcium (Ca)		58.2	57.2		mg/L	1.7	10	26-SEP-03
Magnesium (Mg)		24.2	24.2		mg/L	0.089	10	26-SEP-03
Potassium (K)		7.9	7.9		mg/L	0.047	10	26-SEP-03
Sodium (Na)		369	378		mg/L	2.4	10	26-SEP-03
WG141558-12 DUP		**L131573-49**						
Calcium (Ca)		50.2	49.7		mg/L	1.1	10	26-SEP-03
Magnesium (Mg)		14.2	14.0		mg/L	1.5	10	26-SEP-03
Potassium (K)		141	141		mg/L	0.35	10	26-SEP-03
Sodium (Na)		233	233		mg/L	0.074	10	26-SEP-03
WG141558-4 DUP		**L131573-29**						
Calcium (Ca)		16.7	16.7		mg/L	0.18	10	26-SEP-03
Magnesium (Mg)		10.9	10.9		mg/L	0.069	10	26-SEP-03
Potassium (K)		32.4	31.9		mg/L	1.5	10	26-SEP-03
Sodium (Na)		739	760		mg/L	2.8	10	26-SEP-03

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAR-CALC-CL	**Soil**							
Batch R145572								
WG141558-8 DUP		**L131573-4**						
Calcium (Ca)		200	209		mg/L	4.5	10	26-SEP-03
Magnesium (Mg)		50.6	52.0		mg/L	2.8	10	26-SEP-03
Potassium (K)		87.8	88.8		mg/L	1.2	10	26-SEP-03
Sodium (Na)		291	294		mg/L	1.2	10	26-SEP-03
WG141558-9 DUP		**L131573-6**						
Calcium (Ca)		78.5	80.7		mg/L	2.8	10	26-SEP-03
Magnesium (Mg)		37.4	39.1		mg/L	4.4	10	26-SEP-03
Potassium (K)		102	106		mg/L	3.6	10	26-SEP-03
Sodium (Na)		843	885		mg/L	4.9	10	26-SEP-03
WG141558-3 IRM								
Calcium (Ca)			95		%		88-110	26-SEP-03
Magnesium (Mg)			89		%		88-108	26-SEP-03
Potassium (K)			97		%		86-116	26-SEP-03
Sodium (Na)			92		%		87-109	26-SEP-03
WG141558-1 LCS								
Calcium (Ca)			104		%		90-110	26-SEP-03
Magnesium (Mg)			99		%		90-110	26-SEP-03
Potassium (K)			99		%		90-110	26-SEP-03
Sodium (Na)			99		%		90-110	26-SEP-03
WG141558-2 MB								
Calcium (Ca)			<0.5		mg/L		0.5	26-SEP-03
Magnesium (Mg)			<0.1		mg/L		0.1	26-SEP-03
Potassium (K)			<0.1		mg/L		0.1	26-SEP-03
Sodium (Na)			<1		mg/L		1	26-SEP-03
WG141558-5 MS		**L131573-29**						
Calcium (Ca)			109		%		87-111	26-SEP-03
Magnesium (Mg)			99		%		90-108	26-SEP-03
Potassium (K)			104		%		89-105	26-SEP-03
Sodium (Na)			108		%		85-109	26-SEP-03
SAT/PH/EC-CL	**Soil**							
Batch R145651								
WG141638-4 DUP		**L131573-1**						
% Saturation		46.3	46.3		%	0.0	10	26-SEP-03
Conductivity Sat. Paste		7.74	7.92		dS m-1	2.3	10	26-SEP-03
pH in Saturated Paste		7.3	7.2	J	pH	0.1	0.2	26-SEP-03
WG141638-5 DUP		**L131573-4**						
% Saturation		45.0	45.0		%	0.0	10	26-SEP-03
Conductivity Sat. Paste		2.74	2.85		dS m-1	3.9	10	26-SEP-03
				J		0.0	0.2	

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAT/PH/EC-CL	**Soil**							
Batch R145651								
WG141638-5 DUP		**L131573-4**						
pH in Saturated Paste		7.3	7.3	J	pH	0.0	0.2	26-SEP-03
WG141638-6 DUP		**L131573-6**						
% Saturation		25.0	25.0		%	0.0	10	26-SEP-03
Conductivity Sat. Paste		4.97	5.07		dS m-1	2.0	10	26-SEP-03
pH in Saturated Paste		8.0	8.0	J	pH	0.0	0.2	26-SEP-03
WG141638-7 DUP		**L131573-29**						
% Saturation		38.4	38.2		%	0.37	10	26-SEP-03
Conductivity Sat. Paste		3.90	3.72		dS m-1	4.7	10	26-SEP-03
pH in Saturated Paste		8.7	8.7	J	pH	0.0	0.2	26-SEP-03
WG141638-8 DUP		**L131573-30**						
% Saturation		50.0	49.7		%	0.62	10	26-SEP-03
Conductivity Sat. Paste		2.04	2.06		dS m-1	0.98	10	26-SEP-03
pH in Saturated Paste		7.7	7.7	J	pH	0.0	0.2	26-SEP-03
WG141638-9 DUP		**L131573-49**						
% Saturation		23.2	23.2		%	0.0	10	26-SEP-03
Conductivity Sat. Paste		1.88	1.83		dS m-1	2.7	10	26-SEP-03
pH in Saturated Paste		8.1	8.1	J	pH	0.0	0.2	26-SEP-03
WG141638-1 IRM								
% Saturation			101		%		90-110	26-SEP-03
Conductivity Sat. Paste			103		%		90-110	26-SEP-03
pH in Saturated Paste			7.2		pH		7-7.4	26-SEP-03
WG141638-2 IRM								
% Saturation			103		%		90-110	26-SEP-03
Conductivity Sat. Paste			106		%		90-110	26-SEP-03
pH in Saturated Paste			7.3		pH		7-7.4	26-SEP-03
WG141638-3 IRM								
% Saturation			103		%		90-110	26-SEP-03
Conductivity Sat. Paste			106		%		90-110	26-SEP-03
pH in Saturated Paste			7.3		pH		7-7.4	26-SEP-03
SO4-SAR-CL	**Soil**							
Batch R145681								
WG141664-10 DUP		**L131573-49**						
Sulphate (SO4)		325	320		mg/L	1.6	10	27-SEP-03
WG141664-4 DUP		**L131573-4**						
Sulphate (SO4)		253	259		mg/L	2.5	10	26-SEP-03
WG141664-6 DUP		**L131573-6**						
Sulphate (SO4)		507	529		mg/L	4.4	10	26-SEP-03
WG141664-7 DUP		**L131573-28**						
Sulphate (SO4)		351	354		mg/L	0.85	10	26-SEP-03
WG141664-8 DUP		**L131573-29**						

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-SAR-CL	**Soil**							
Batch R145681								
WG141664-8 DUP		**L131573-29**						
Sulphate (SO4)		304	291		mg/L	4.4	10	26-SEP-03
WG141664-9 DUP		**L131573-30**						
Sulphate (SO4)		119	130		mg/L	8.2	10	26-SEP-03
WG141664-3 IRM								
Sulphate (SO4)			99		%		86-118	26-SEP-03
WG141664-1 LCS								
Sulphate (SO4)			98		%		90-108	26-SEP-03
WG141664-2 MB								
Sulphate (SO4)			<0.5		mg/L		0.5	26-SEP-03
WG141664-11 MS		**L131573-49**						
Sulphate (SO4)			99		%		89-113	27-SEP-03
WG141664-5 MS		**L131573-4**						
Sulphate (SO4)			103		%		89-113	26-SEP-03

Product - Batch and Sample Number Relations:

BTX,F1-ED		1					
	R145747		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
C-TOT-ORG-CL		1					
	R145696		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
CL-ED		1					
	R145187		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
CN-TOT-WT		1					
	R145625		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
ETL-ROUTINE-ICP-ED		1					
	R144764		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
F2-ED		1					
	R145752		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
HG-EXT-LOW-ED		1					
	R145050		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
MET1-EXT-LOW-ED		1					
	R145050		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
MET2-EXT-ED		1					
	R145296		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
N-TOTKJ-ED		1					
	R145102		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
N2N3-ED		1					
	R144881		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
NH4-ED		1					
	R144913		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
NO2-ED		1					
	R144881		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
NO3-ED		1					
	R144881		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Product - Batch and Sample Number Relations:

OGG-ED	1					
R145358		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
P-TOTAL-ED	1					
R145154		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
PAH-CCME-ED	1					
R144969		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
PH/EC/ALK-ED	1					
R144945		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
PHENOLS-CL	1					
R145683		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
SI-EXT-ED	1					
R145296		L131493-1	L131493-2	L131493-3	L131493-4	L131493-5
C-TOT-ORG-WB-SK	2					
R145638		L131493-6	L131493-7	L131493-8	L131493-9	
CL-SAR-CL	2					
R145681		L131493-6	L131493-7	L131493-8	L131493-9	
CN-TOT-WT	2					
R146339		L131493-6	L131493-7	L131493-8	L131493-9	
ETL-BTX,TVH-CCME-ED	2					
R145894		L131493-8	L131493-9			
ETL-BTX,TVH-CCME-ED	2					
R145900		L131493-6	L131493-7			
ETL-TEH-CCME-ED	2					
R145615		L131493-6	L131493-7	L131493-8	L131493-9	
HG-LOW-ED	2					
R145372		L131493-6	L131493-7	L131493-8	L131493-9	
METAL-LOW-EXD-ED	2					
R145372		L131493-6	L131493-7	L131493-8	L131493-9	
N-TOTKJ-SK	2					
R145463		L131493-6	L131493-7	L131493-8	L131493-9	
NH4-ED	2					
R145389		L131493-6	L131493-7	L131493-8	L131493-9	
OGG-ED	2					
R145555		L131493-6	L131493-7	L131493-8	L131493-9	
P-TOT-SK	2					
R145568		L131493-6	L131493-7	L131493-8	L131493-9	
PAH-CCME-ED	2					
R144969		L131493-6	L131493-7	L131493-8	L131493-9	
PHENOLS-CL	2					
R145683		L131493-6	L131493-7	L131493-8	L131493-9	
PREP-MOISTURE-ED	2					
R144772		L131493-6	L131493-7	L131493-8	L131493-9	
SAR-CALC-CL	2					
R145572		L131493-6	L131493-7	L131493-8	L131493-9	

ENVIRO-TEST QC REPORT

Workorder: L131493

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Product - Batch and Sample Number Relations:

SAT/PH/EC-CL		2			
	R145651	L131493-6	L131493-7	L131493-8	L131493-9
SI-ED		2			
	R146001	L131493-6	L131493-7	L131493-8	L131493-9
SO4-SAR-CL		2			
	R145681	L131493-6	L131493-7	L131493-8	L131493-9

Workorder # L131493

Legend:

Limit 95% Confidence Interval (Laboratory Warning Limits)
DUP Duplicate
RPD Relative Percent Difference ((higher result-lower result)/Average, expressed as %)
N/A Not Available
LCS Laboratory Control Sample
SRM Standard Reference Materials
MS Matrix Spike
MSD Matrix Spike Duplicate
ADE Average Desorption Efficiency
MB Method Blank
IRM Internal Reference Material
CRM Certified Reference Material

Qualifier:

RPD-NA Relative Percent Difference Not Available due to result(s) being less than detection limit.
A Method blank exceeds acceptance limit. Blank correction not applied, unless the qualifier "RAMB" (result adjusted for method blank) appears in the Analytical Report.
B Method blank result exceeds acceptance limit, however, it is less than 5% of sample concentration. Blank correction not applied.
E Matrix spike recovery may fall outside the acceptance limits due to high sample background.
F Silver recovery low, likely due to elevated choride levels in sample.
G Outlier - No assignable cause for nonconformity has been determined.
H Result falls within the 99% Confidence Interval (Laboratory Control Limits)
J Duplicate results and limit(s) are expressed in terms of absolute difference.
K The sample referenced above is of a non-standard matrix type; standard QC acceptance criteria may not be achievable.

Table A-3. Mean daily air temperature (°C)[1] and diurnal variation recorded[2] during July to September 2003 at the north causeway of the proposed Deh Cho Bridge.

Day	July 2003				August 2003				September 2003			
	Mean	Range		Fluct.	**Mean**	Range		Fluct.	**Mean**	Range		Fluct.
1	**23.41**	21.60	24.20	2.60	**20.86**	19.10	22.70	3.60	**14.71**	12.00	16.80	4.80
2	**21.09**	18.90	23.40	4.50	**16.03**	12.70	19.10	6.40	**15.51**	12.60	18.80	6.20
3					**12.86**	11.40	14.50	3.10	**16.42**	14.80	18.10	3.30
4					**14.20**	11.80	17.20	5.40	**14.43**	11.50	16.90	5.40
5					**14.57**	12.10	16.90	4.80	**14.75**	13.30	16.60	3.30
6					**15.62**	13.20	19.90	6.70	**14.48**	12.00	17.40	5.40
7					**15.64**	12.90	18.90	6.00	**15.84**	14.60	17.80	3.20
8					**14.33**	9.90	18.00	8.10	**15.32**	13.60	17.40	3.80
9					**9.92**	8.00	12.10	4.10	**14.84**	12.60	16.80	4.20
10					**9.76**	8.90	10.60	1.70	**14.28**	12.60	16.30	3.70
11					**12.10**	9.90	15.70	5.80	**12.97**	10.60	15.70	5.10
12					**15.26**	12.30	18.60	6.30	**12.22**	10.20	14.30	4.10
13					**17.32**	14.50	21.00	6.50	**11.62**	7.30	14.00	6.70
14					**16.86**	14.60	19.70	5.10	**6.85**	5.90	8.00	2.10
15					**19.17**	15.90	23.40	7.50	**5.12**	3.40	7.00	3.60
16					**20.46**	18.60	22.40	3.80	**5.48**	2.80	8.10	5.30
17					**18.57**	17.40	20.60	3.20	**6.18**	4.70	7.80	3.10
18					**17.96**	15.20	20.30	5.10	**6.10**	5.30	6.80	1.50
19					**16.50**	15.10	17.80	2.70	**7.35**	5.90	9.30	3.40
20					**16.53**	14.60	18.80	4.20	**5.60**	2.80	8.10	5.30
21					**17.07**	15.50	19.40	3.90	**2.96**	1.90	4.40	2.50
22					**16.15**	13.90	18.60	4.70				
23					**16.27**	14.20	17.20	3.00				
24					**13.80**	12.70	15.10	2.40				
25					**13.62**	11.20	16.50	5.30				
26					**12.78**	9.90	15.50	5.60				
27					**13.76**	11.50	16.30	4.80				
28					**14.74**	12.40	17.50	5.10				
29					**15.81**	12.60	19.40	6.80				
30					**15.73**	13.30	18.00	4.70				
31					**16.44**	14.30	18.60	4.30				
Mean	**22.25**	**18.90**	**24.20**	**3.55**	**15.51**	**8.00**	**23.40**	**4.86**	**11.10**	**1.90**	**18.80**	**4.10**

[1]Temperatures recorded with a continuous recorder

[2]Daily temperature fluctuation (maximum - minimum daily temperature)

Table A-4. Mean daily water temperature (°C)[1] and diurnal variation recorded[2] during July to September 2003 at the south causeway of the proposed Deh Cho Bridge.

	July 2003			August 2003			September 2003		
Day	**Mean**	Range	Fluct.	**Mean**	Range	Fluct.	**Mean**	Range	Fluct.
1	**21.04**	20.50 - 21.40	0.90	**20.19**	19.50 - 20.60	1.10	**15.88**	15.20 - 16.50	1.30
2	**20.15**	19.40 - 21.00	1.60	**19.07**	17.40 - 20.30	2.90	**15.76**	14.90 - 16.50	1.60
3				**16.22**	15.70 - 17.20	1.50	**15.98**	15.40 - 16.60	1.20
4				**15.89**	15.10 - 16.80	1.70	**15.89**	14.90 - 16.90	2.00
5				**15.73**	15.10 - 16.20	1.10	**15.96**	15.40 - 16.60	1.20
6				**16.15**	15.20 - 17.20	2.00	**15.94**	15.10 - 16.80	1.70
7				**16.77**	15.70 - 17.80	2.10	**16.04**	15.90 - 16.30	0.40
8				**17.33**	16.30 - 18.10	1.80	**15.48**	14.90 - 15.90	1.00
9				**14.91**	14.50 - 16.20	1.70	**15.37**	14.60 - 16.30	1.70
10				**13.67**	13.20 - 14.50	1.30	**15.58**	15.10 - 16.30	1.20
11				**13.78**	12.70 - 15.10	2.40	**14.44**	14.00 - 15.20	1.20
12				**14.90**	14.00 - 16.00	2.00	**13.89**	13.20 - 14.60	1.40
13				**16.10**	14.90 - 17.40	2.50	**13.30**	12.40 - 14.00	1.60
14				**17.34**	16.30 - 18.60	2.30	**10.67**	9.20 - 12.40	3.20
15				**18.37**	17.20 - 19.90	2.70	**8.01**	7.50 - 9.20	1.70
16				**19.11**	18.40 - 19.90	1.50	**7.09**	6.70 - 7.40	0.70
17				**18.04**	17.40 - 18.90	1.50	**6.65**	6.50 - 7.00	0.50
18				**18.02**	17.20 - 18.80	1.60	**5.94**	5.60 - 6.40	0.80
19				**17.86**	17.40 - 18.30	0.90	**6.20**	5.60 - 7.00	1.40
20				**17.58**	16.90 - 18.30	1.40	**6.73**	6.10 - 7.30	1.20
21				**17.83**	17.10 - 18.60	1.50	**6.15**	5.80 - 6.80	1.00
22				**17.56**	16.80 - 18.30	1.50			
23				**17.38**	16.90 - 17.80	0.90			
24				**15.36**	13.90 - 16.80	2.90			
25				**13.81**	12.90 - 14.90	2.00			
26				**14.11**	13.20 - 15.20	2.00			
27				**14.43**	13.50 - 15.50	2.00			
28				**15.08**	14.00 - 16.30	2.30			
29				**15.85**	14.80 - 16.90	2.10			
30				**16.65**	15.70 - 17.70	2.00			
31				**16.29**	15.70 - 16.90	1.20			
Mean	**20.60**	**19.40 - 21.40**	**1.25**	**16.50**	**12.70 - 20.60**	**1.82**	**12.24**	**5.60 - 16.90**	**1.33**

[1]Temperatures recorded with a continuous recorder

[2]Daily temperature fluctuation (maximum - minimum daily temperature)

Table A-5. Mean daily water temperature (°C)[1] and diurnal variation recorded[2] during July to September 2003 at the north causeway of the proposed Deh Cho Bridge.

Day	July 2003			August 2003			September 2003		
	Mean	Range	Fluct.	**Mean**	Range	Fluct.	**Mean**	Range	Fluct.
1	**22.76**	22.10 - 23.10	1.00	**20.76**	20.50 - 21.40	0.90	**15.98**	15.50 - 16.50	1.00
2	**21.87**	21.40 - 22.40	1.00	**19.52**	17.70 - 20.60	2.90	**15.79**	15.20 - 16.30	1.10
3				**16.16**	15.70 - 17.50	1.80	**16.11**	15.50 - 16.60	1.10
4				**15.10**	14.50 - 15.70	1.20	**16.34**	15.70 - 17.10	1.40
5				**15.03**	14.30 - 15.70	1.40	**16.26**	15.70 - 16.80	1.10
6				**16.11**	15.10 - 17.40	2.30	**16.07**	15.40 - 16.60	1.20
7				**17.39**	16.50 - 18.40	1.90	**16.14**	16.00 - 16.50	0.50
8				**18.15**	17.50 - 18.80	1.30	**15.59**	15.20 - 16.00	0.80
9				**16.14**	15.40 - 17.40	2.00	**15.29**	14.80 - 16.00	1.20
10				**14.11**	13.30 - 15.20	1.90	**15.52**	15.10 - 16.00	0.90
11				**13.65**	12.70 - 14.80	2.10	**14.69**	14.50 - 15.50	1.00
12				**15.10**	14.20 - 16.30	2.10	**14.08**	13.50 - 14.50	1.00
13				**16.65**	15.70 - 17.80	2.10	**13.56**	12.70 - 14.30	1.60
14				**17.76**	16.80 - 18.80	2.00	**11.35**	10.10 - 12.70	2.60
15				**18.70**	17.80 - 19.90	2.10	**8.87**	8.10 - 10.10	2.00
16				**19.26**	18.80 - 19.70	0.90	**7.51**	7.30 - 8.00	0.70
17				**18.28**	17.70 - 19.10	1.40	**7.11**	6.80 - 7.40	0.60
18				**18.14**	17.50 - 18.80	1.30	**6.32**	5.90 - 7.00	1.10
19				**17.94**	17.50 - 18.40	0.90	**6.33**	5.80 - 7.00	1.20
20				**17.67**	17.10 - 18.10	1.00	**7.03**	6.40 - 7.50	1.10
21				**17.72**	17.20 - 18.30	1.10	**6.82**	6.50 - 7.40	0.90
22				**17.80**	17.20 - 18.40	1.20			
23				**17.72**	17.10 - 18.30	1.20			
24				**15.41**	14.20 - 16.90	2.70			
25				**13.59**	13.00 - 14.20	1.20			
26				**13.69**	12.90 - 14.50	1.60			
27				**14.20**	13.30 - 15.10	1.80			
28				**15.18**	14.30 - 16.20	1.90			
29				**16.17**	15.40 - 17.10	1.70			
30				**16.84**	16.20 - 17.50	1.30			
31				**16.53**	16.20 - 17.20	1.00			
Mean	**22.32**	**21.40 - 23.10**	**1.00**	**16.66**	**12.70 - 21.40**	**1.62**	**12.51**	**5.80 - 17.10**	**1.15**

[1]Temperatures recorded with a continuous recorder

[2]Daily temperature fluctuation (maximum - minimum daily temperature)

Table A-6. Water quality data collected during summer fish sampling in vicinity of the proposed Deh Cho Bridge near Fort Providence, NT, 2003.

Site	Location[1]	UTM (11V) NAD27		Date	Time	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	TSS[2] (mg/L)	Conduc-tivity (µS/cm)	pH (units)
		Easting	Northing									
South Causeway	u/s	471794	6791563	30-Jul-03	10:45	26.0	20.0	11.5	10.2	6	217.0	8.3
South Causeway	@ ferry dock	471730	6791600	30-Jul-03	10:45	26.0	20.0	11.5	11.7	8	217.0	8.3
North Causeway	d/s	471912	6792736	30-Jul-03	16:00	28.9	22.6	11.8	9.0	4	224.0	8.7
North Causeway	u/s	472086	6792779	30-Jul-03	16:02	28.9	23.1	11.9	8.0	<3	225.0	8.6
South Causeway	d/s	471536	6791572	31-Jul-03	14:00	23.6	19.3	8.9	11.5	8	216.0	8.1
South Causeway	u/s	471822	6791542	31-Jul-03	14:10	23.6	19.7	8.9	11.6	6	216.0	8.2
Main channel	118 m from SC	471794	6791727	1-Aug-03	15:47	22.3	16.1	9.5	12.7	6	218.0	8.1
Main channel	94 m from NC	471923	6792546	1-Aug-03	16:07	22.3	20.2	8.6	13.3	8	220.0	8.4
Main channel	456 m from SC	471839	6792063	1-Aug-03	16:20	22.1	16.8	9.2	11.8	6	220.0	8.0
Means						**24.9**	**19.8**	**10.2**	**11.1**	**7**	**219.2**	**8.3**
North Causeway	d/s	471912	6792736	18-Sep-03	14:00	6.7	6.6	-	17.0	-	251.0	7.6
North Causeway	u/s	472086	6792779	18-Sep-03	15:00	6.7	6.6	-	20.3	-	253.0	7.9
South Causeway	u/s	471822	6791542	18-Sep-03	15:50	6.5	5.9	-	25.3	-	196.0	8.0
South Causeway	d/s	471536	6791572	18-Sep-03	16:20	6.5	6.1	-	71.0	-	195.2	8.0
South Causeway	d/s	471536	6791572	18-Sep-03	14:45	6.5	6.1	-	67.9	173	190.8	7.6
South Causeway	u/s	471794	6791563	18-Sep-03	14:55	6.5	6.1	-	64.6	139	194.5	7.5
South Causeway	u/s	471822	6791542	20-Sep-03	13:20	8.0	6.5	-	16.6	15	175.2	8.0
South Causeway	d/s	471536	6791572	20-Sep-03	13:30	8.0	6.5	-	12.9	10	176.5	8.0
North Causeway	u/s	472086	6792779	20-Sep-03	13:45	8.0	6.5	-	12.9	10	182.9	7.9
North Causeway	d/s	471912	6792736	20-Sep-03	13:50	8.0	6.5	-	12.9	13	168.6	7.8
South Causeway	u/s	471794	6791563	21-Sep-03	11:00	7.0	6.0	-	10.8	10	159.3	7.2
South Causeway	d/s	471536	6791572	21-Sep-03	11:05	7.0	6.0	-	12.4	11	169.1	7.4
North Causeway	u/s	472086	6792779	21-Sep-03	11:15	7.0	6.0	-	11.8	9	179.8	7.3
North Causeway	d/s	471912	6792736	21-Sep-03	11:20	7.0	6.0	-	11.6	12	183.4	7.3
Means						**7.1**	**6.2**		**26.3**	**40**	**191.1**	**7.7**

[1] NC = north causeway; SC = south causeway; u/s = upstream of causeway; d/s = downstream of causeway.

[2] TSS = total suspended solids. Summer samples were analysed by Taiga Environmental Laboratories (Yellowknife); the fall samples were analysed by Enviro-Test Laboratories (Edmonton).

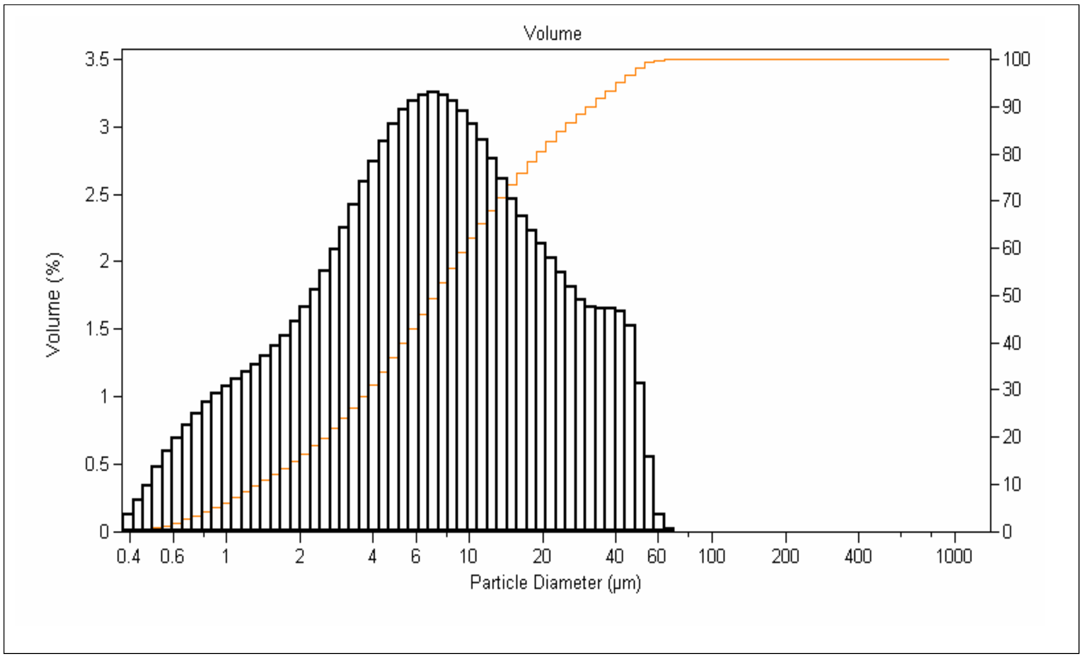
Table A-7

Enviro-Test Particle Size Report

Coulter LS Particle Size Analyzer

SITE = NE

File Name:	52135-03-0962_1	Group ID: Enviro-Test Laboratories (Edmonton)
Sample ID:	L131493-6	
Run number:	1	Operator: JN
Comments:	1227648	
Optical model:	Fraunhofer.rfz	
LS 100Q	Fluid Module	



Volume Statistics (Arithmetic) 52135-03-0962_1

Calculations from 0.375µm to 948.3µm

Volume:		100%			
Mean:		11.43 µm	S.D.:	12.03 µm	
Median:		6.892 µm	Skewness:	1.661 Right skewed	
Mode		7.083 µm	Kurtosis:	2.254 Leptokurtic	
d50		6.892 µm			
%<	10	25	50	75	90
µm	1.314	3.063	6.892	15.13	29.91

Volume %	Particle Diameter µm <
5	0.863
10	1.314
16	1.966
25	3.063
40	5.143
50	6.892
75	15.13
84	22.08
90	29.91
95	39.63
100	69.61

Channel Number	Channel Diameter (Lower) µm	Channel Diameter (Center) µm	Channel Diameter (Upper) µm	Diff. Volume %	Cum. < Volume %	Channel Number	Channel Diameter (Upper)	Channel Diameter (Center)	Channel Diameter (Lower)	Diff. Volum %	Cum.< Volume %
1	0.375	0.393	0.412	0.13	0	43	18.86	19.76	20.71	2.13	80.5
2	0.412	0.431	0.452	0.23	0.13	44	20.71	21.69	22.73	2.03	82.6
3	0.452	0.474	0.496	0.33	0.36	45	22.73	23.81	24.95	1.92	84.7
4	0.496	0.52	0.545	0.48	0.69	46	24.95	26.14	27.39	1.81	86.6
5	0.545	0.571	0.598	0.59	1.17	47	27.39	28.7	30.07	1.72	88.4
6	0.598	0.627	0.656	0.69	1.76	48	30.07	31.5	33.01	1.66	90.1
7	0.656	0.688	0.721	0.79	2.45	49	33.01	34.58	36.24	1.65	91.8
8	0.721	0.755	0.791	0.88	3.24	50	36.24	37.97	39.78	1.65	93.4
9	0.791	0.829	0.868	0.95	4.11	51	39.78	41.68	43.67	1.63	95.1
10	0.868	0.91	0.953	1.02	5.07	52	43.67	45.75	47.94	1.52	96.7
11	0.953	0.999	1.047	1.07	6.09	53	47.94	50.22	52.62	1.09	98.2
12	1.047	1.097	1.149	1.13	7.16	54	52.62	55.13	57.77	0.55	99.3
13	1.149	1.204	1.261	1.18	8.29	55	57.77	60.52	63.41	0.13	99.9
14	1.261	1.321	1.384	1.24	9.47	56	63.41	66.44	69.61	0.013	99.99
15	1.384	1.451	1.52	1.3	10.7	57	69.61	72.94	76.42	0	100
16	1.52	1.592	1.668	1.37	12	58	76.42	80.07	83.89	0	100
17	1.668	1.748	1.832	1.45	13.4	59	83.89	87.9	92.09	0	100
18	1.832	1.919	2.011	1.55	14.8	60	92.09	96.49	101.1	0	100
19	2.011	2.107	2.207	1.67	16.4	61	101.1	105.9	111	0	100
20	2.207	2.313	2.423	1.79	18.1	62	111	116.3	121.8	0	100
21	2.423	2.539	2.66	1.93	19.8	63	121.8	127.6	133.7	0	100
22	2.66	2.787	2.92	2.09	21.8	64	133.7	140.1	146.8	0	100
23	2.92	3.059	3.205	2.25	23.9	65	146.8	153.8	161.2	0	100
24	3.205	3.358	3.519	2.42	26.1	66	161.2	168.9	176.9	0	100
25	3.519	3.687	3.863	2.59	28.5	67	176.9	185.4	194.2	0	100
26	3.863	4.047	4.24	2.75	31.1	68	194.2	203.5	213.2	0	100
27	4.24	4.443	4.655	2.89	33.9	69	213.2	223.4	234	0	100
28	4.655	4.877	5.11	3.02	36.8	70	234	245.2	256.9	0	100
29	5.11	5.354	5.61	3.12	39.8	71	256.9	269.2	282.1	0	100
30	5.61	5.878	6.158	3.2	42.9	72	282.1	295.5	309.6	0	100
31	6.158	6.452	6.76	3.24	46.1	73	309.6	324.4	339.9	0	100
32	6.76	7.083	7.421	3.25	49.4	74	339.9	356.1	373.1	0	100
33	7.421	7.775	8.147	3.24	52.6	75	373.1	390.9	409.6	0	100
34	8.147	8.536	8.943	3.19	55.8	76	409.6	429.2	449.7	0	100
35	8.943	9.37	9.818	3.12	59	77	449.7	471.1	493.6	0	100
36	9.818	10.29	10.78	3.02	62.2	78	493.6	517.2	541.9	0	100
37	10.78	11.29	11.83	2.9	65.2	79	541.9	567.7	594.8	0	100
38	11.83	12.4	12.99	2.76	68.1	80	594.8	623.3	653	0	100
39	12.99	13.61	14.26	2.61	70.8	81	653	684.2	716.8	0	100
40	14.26	14.94	15.65	2.47	73.5	82	716.8	751.1	786.9	0	100
41	15.65	16.4	17.18	2.34	75.9	83	786.9	824.5	863.9	0	100
42	17.18	18	18.86	2.23	78.3	84	863.9	905.1	948.3	0	100
							948.3				100

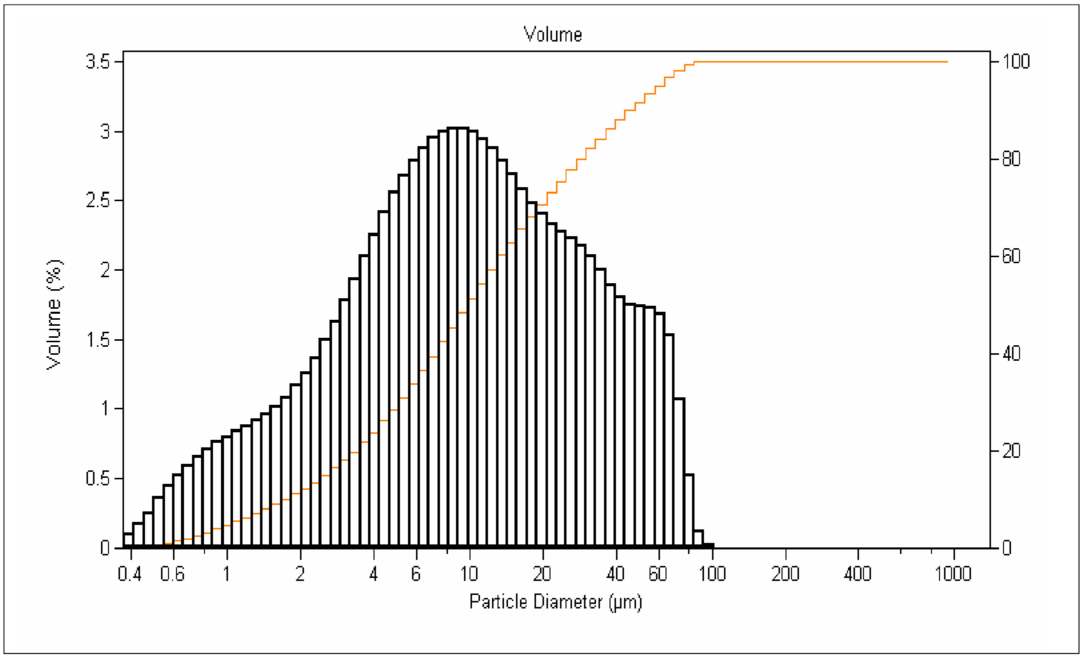
Coulter LS Particle Size Analyzer

SITE = NW

File Name: 52135-03-0962_2
Sample ID: L131493-7
Run number: 2
Comments: 1227656
Optical model: Fraunhofer.rfz
LS 100Q Fluid Module

Group ID: Enviro-Test Laboratories (Edmonton)

Operator: JN



Volume Statistics (Arithmetic) 52135-03-0962_2

Calculations from 0.375µm to 948.3µm

Volume:	100%			
Mean:	16.45 µm	S.D.:	17.69 µm	
Median:	9.437 µm	Skewness:	1.616 Right skewed	
Mode	8.536 µm	Kurtosis:	2.033 Leptokurtic	
d50	9.437 µm			

%<	10	25	50	75	90
µm	1.677	4.072	9.437	22.38	44.02

Volume %	Particle Diameter µm <
5	1.007
10	1.677
16	2.61
25	4.072
40	6.911
50	9.437
75	22.38
84	32.77
90	44.02
95	57.56
100	101.1

Channel Number	Channel Diameter (Lower) µm	Channel Diameter (Center) µm	Channel Diameter (Upper) µm	Diff. Volume %	Cum. < Volume %	Channel Number	Channel Diameter (Upper)	Channel Diameter (Center)	Channel Diameter (Lower)	Diff. Volum %	Cum.< Volume %
1	0.375	0.393	0.412	0.096	0	43	18.86	19.76	20.71	2.4	70.7
2	0.412	0.431	0.452	0.17	0.096	44	20.71	21.69	22.73	2.33	73.1
3	0.452	0.474	0.496	0.25	0.27	45	22.73	23.81	24.95	2.28	75.4
4	0.496	0.52	0.545	0.36	0.52	46	24.95	26.14	27.39	2.23	77.7
5	0.545	0.571	0.598	0.44	0.87	47	27.39	28.7	30.07	2.17	79.9
6	0.598	0.627	0.656	0.52	1.32	48	30.07	31.5	33.01	2.09	82.1
7	0.656	0.688	0.721	0.59	1.84	49	33.01	34.58	36.24	1.99	84.2
8	0.721	0.755	0.791	0.65	2.42	50	36.24	37.97	39.78	1.89	86.2
9	0.791	0.829	0.868	0.71	3.08	51	39.78	41.68	43.67	1.8	88.1
10	0.868	0.91	0.953	0.76	3.79	52	43.67	45.75	47.94	1.75	89.9
11	0.953	0.999	1.047	0.8	4.54	53	47.94	50.22	52.62	1.73	91.6
12	1.047	1.097	1.149	0.83	5.34	54	52.62	55.13	57.77	1.73	93.3
13	1.149	1.204	1.261	0.88	6.17	55	57.77	60.52	63.41	1.68	95.1
14	1.261	1.321	1.384	0.92	7.05	56	63.41	66.44	69.61	1.52	96.7
15	1.384	1.451	1.52	0.96	7.97	57	69.61	72.94	76.42	1.07	98.3
16	1.52	1.592	1.668	1.02	8.93	58	76.42	80.07	83.89	0.53	99.3
17	1.668	1.748	1.832	1.08	9.95	59	83.89	87.9	92.09	0.12	99.9
18	1.832	1.919	2.011	1.16	11	60	92.09	96.49	101.1	0.012	99.99
19	2.011	2.107	2.207	1.26	12.2	61	101.1	105.9	111	0	100
20	2.207	2.313	2.423	1.37	13.5	62	111	116.3	121.8	0	100
21	2.423	2.539	2.66	1.49	14.8	63	121.8	127.6	133.7	0	100
22	2.66	2.787	2.92	1.63	16.3	64	133.7	140.1	146.8	0	100
23	2.92	3.059	3.205	1.78	17.9	65	146.8	153.8	161.2	0	100
24	3.205	3.358	3.519	1.94	19.7	66	161.2	168.9	176.9	0	100
25	3.519	3.687	3.863	2.1	21.7	67	176.9	185.4	194.2	0	100
26	3.863	4.047	4.24	2.26	23.8	68	194.2	203.5	213.2	0	100
27	4.24	4.443	4.655	2.41	26	69	213.2	223.4	234	0	100
28	4.655	4.877	5.11	2.55	28.4	70	234	245.2	256.9	0	100
29	5.11	5.354	5.61	2.68	31	71	256.9	269.2	282.1	0	100
30	5.61	5.878	6.158	2.79	33.7	72	282.1	295.5	309.6	0	100
31	6.158	6.452	6.76	2.88	36.4	73	309.6	324.4	339.9	0	100
32	6.76	7.083	7.421	2.95	39.3	74	339.9	356.1	373.1	0	100
33	7.421	7.775	8.147	3	42.3	75	373.1	390.9	409.6	0	100
34	8.147	8.536	8.943	3.02	45.3	76	409.6	429.2	449.7	0	100
35	8.943	9.37	9.818	3.02	48.3	77	449.7	471.1	493.6	0	100
36	9.818	10.29	10.78	2.99	51.3	78	493.6	517.2	541.9	0	100
37	10.78	11.29	11.83	2.94	54.3	79	541.9	567.7	594.8	0	100
38	11.83	12.4	12.99	2.87	57.2	80	594.8	623.3	653	0	100
39	12.99	13.61	14.26	2.79	60.1	81	653	684.2	716.8	0	100
40	14.26	14.94	15.65	2.69	62.9	82	716.8	751.1	786.9	0	100
41	15.65	16.4	17.18	2.59	65.6	83	786.9	824.5	863.9	0	100
42	17.18	18	18.86	2.49	68.2	84	863.9	905.1	948.3	0	100
							948.3				100

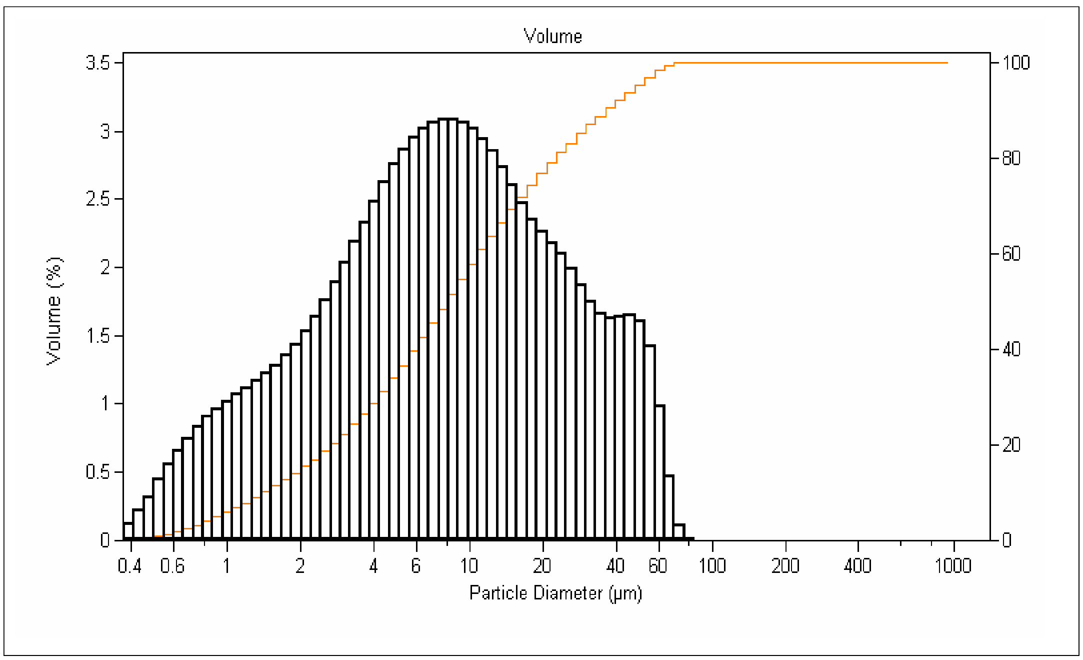
Coulter LS Particle Size Analyzer

SITE = SE

File Name: 52135-03-0962_3
Sample ID: L131493-8
Run number: 3
Comments: 1227664
Optical model: Fraunhofer.rfz
LS 100Q Fluid Module

Group ID: Enviro-Test Laboratories (Edmonton)

Operator: JN



Volume Statistics (Arithmetic) 52135-03-0962_3

Calculations from 0.375µm to 948.3µm

Volume:	100%		
Mean:	13.27 µm	S.D.:	14.32 µm
Median:	7.779 µm	Skewness:	1.679 Right skewed
Mode	7.775 µm	Kurtosis:	2.321 Leptokurtic
d50	7.779 µm		

%<	10	25	50	75	90
µm	1.374	3.318	7.779	17.65	35.28

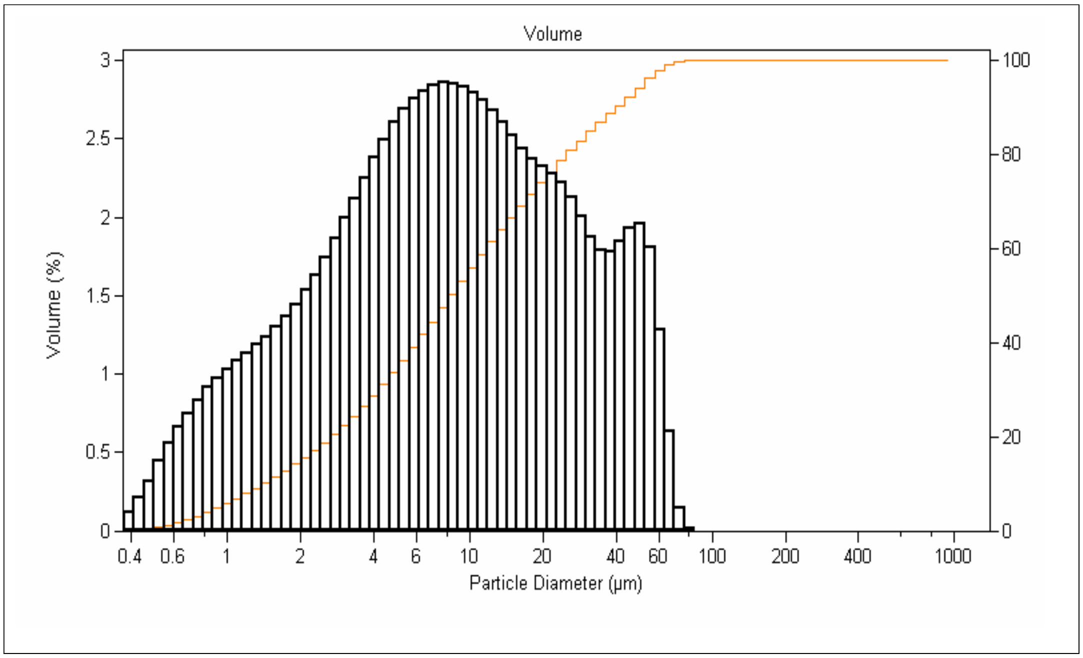
Volume %	Particle Diameter µm <
5	0.888
10	1.374
16	2.092
25	3.318
40	5.713
50	7.779
75	17.65
84	25.9
90	35.28
95	46.86
100	83.89

Channel Number	Channel Diameter (Lower) µm	Channel Diameter (Center) µm	Channel Diameter (Upper) µm	Diff. Volume %	Cum. < Volume %	Channel Number	Channel Diameter (Upper)	Channel Diameter (Center)	Channel Diameter (Lower)	Diff. Volum %	Cum.< Volume %
1	0.375	0.393	0.412	0.12	0	43	18.86	19.76	20.71	2.26	76.7
2	0.412	0.431	0.452	0.21	0.12	44	20.71	21.69	22.73	2.18	79
3	0.452	0.474	0.496	0.31	0.33	45	22.73	23.81	24.95	2.09	81.1
4	0.496	0.52	0.545	0.45	0.65	46	24.95	26.14	27.39	1.99	83.2
5	0.545	0.571	0.598	0.56	1.09	47	27.39	28.7	30.07	1.87	85.2
6	0.598	0.627	0.656	0.65	1.65	48	30.07	31.5	33.01	1.75	87.1
7	0.656	0.688	0.721	0.74	2.3	49	33.01	34.58	36.24	1.66	88.8
8	0.721	0.755	0.791	0.83	3.05	50	36.24	37.97	39.78	1.63	90.5
9	0.791	0.829	0.868	0.9	3.87	51	39.78	41.68	43.67	1.64	92.1
10	0.868	0.91	0.953	0.96	4.77	52	43.67	45.75	47.94	1.65	93.8
11	0.953	0.999	1.047	1.02	5.74	53	47.94	50.22	52.62	1.6	95.4
12	1.047	1.097	1.149	1.06	6.75	54	52.62	55.13	57.77	1.42	97
13	1.149	1.204	1.261	1.12	7.82	55	57.77	60.52	63.41	0.98	98.4
14	1.261	1.321	1.384	1.17	8.93	56	63.41	66.44	69.61	0.47	99.4
15	1.384	1.451	1.52	1.22	10.1	57	69.61	72.94	76.42	0.11	99.9
16	1.52	1.592	1.668	1.28	11.3	58	76.42	80.07	83.89	0.011	99.99
17	1.668	1.748	1.832	1.35	12.6	59	83.89	87.9	92.09	0	100
18	1.832	1.919	2.011	1.43	13.9	60	92.09	96.49	101.1	0	100
19	2.011	2.107	2.207	1.53	15.4	61	101.1	105.9	111	0	100
20	2.207	2.313	2.423	1.63	16.9	62	111	116.3	121.8	0	100
21	2.423	2.539	2.66	1.76	18.5	63	121.8	127.6	133.7	0	100
22	2.66	2.787	2.92	1.89	20.3	64	133.7	140.1	146.8	0	100
23	2.92	3.059	3.205	2.03	22.2	65	146.8	153.8	161.2	0	100
24	3.205	3.358	3.519	2.18	24.2	66	161.2	168.9	176.9	0	100
25	3.519	3.687	3.863	2.33	26.4	67	176.9	185.4	194.2	0	100
26	3.863	4.047	4.24	2.48	28.7	68	194.2	203.5	213.2	0	100
27	4.24	4.443	4.655	2.62	31.2	69	213.2	223.4	234	0	100
28	4.655	4.877	5.11	2.75	33.8	70	234	245.2	256.9	0	100
29	5.11	5.354	5.61	2.86	36.6	71	256.9	269.2	282.1	0	100
30	5.61	5.878	6.158	2.95	39.4	72	282.1	295.5	309.6	0	100
31	6.158	6.452	6.76	3.02	42.4	73	309.6	324.4	339.9	0	100
32	6.76	7.083	7.421	3.06	45.4	74	339.9	356.1	373.1	0	100
33	7.421	7.775	8.147	3.09	48.5	75	373.1	390.9	409.6	0	100
34	8.147	8.536	8.943	3.09	51.6	76	409.6	429.2	449.7	0	100
35	8.943	9.37	9.818	3.06	54.7	77	449.7	471.1	493.6	0	100
36	9.818	10.29	10.78	3.01	57.7	78	493.6	517.2	541.9	0	100
37	10.78	11.29	11.83	2.94	60.7	79	541.9	567.7	594.8	0	100
38	11.83	12.4	12.99	2.85	63.7	80	594.8	623.3	653	0	100
39	12.99	13.61	14.26	2.74	66.5	81	653	684.2	716.8	0	100
40	14.26	14.94	15.65	2.61	69.3	82	716.8	751.1	786.9	0	100
41	15.65	16.4	17.18	2.47	71.9	83	786.9	824.5	863.9	0	100
42	17.18	18	18.86	2.35	74.3	84	863.9	905.1	948.3	0	100
							948.3				100

Coulter LS Particle Size Analyzer

SITE = SW

File Name:	52135-03-0962_4	Group ID: Enviro-Test Laboratories (Edmonton)
Sample ID:	L131493-9	
Run number:	4	Operator: JN
Comments:	1227672	
Optical model:	Fraunhofer.rfz	
LS 100Q	Fluid Module	



Volume Statistics (Arithmetic) 52135-03-0962_4

Calculations from 0.375µm to 948.3µm

Volume:	100%				
Mean:	14.26 µm		S.D.:	15.34 µm	
Median:	8.111 µm		Skewness:	1.541 Right skewed	
Mode	7.775 µm		Kurtosis:	1.672 Leptokurtic	
d50	8.111 µm				
%<	10	25	50	75	90
µm	1.361	3.303	8.111	19.68	39.03

Volume %	Particle Diameter µm <
5	0.885
10	1.361
16	2.065
25	3.303
40	5.833
50	8.111
75	19.68
84	28.83
90	39.03
95	49.95
100	83.89

Channel Number	Channel Diameter (Lower) µm	Channel Diameter (Center) µm	Channel Diameter (Upper) µm	Diff. Volume %	Cum. < Volume %	Channel Number	Channel Diameter (Upper)	Channel Diameter (Center)	Channel Diameter (Lower)	Diff. Volum %	Cum.< Volume %
1	0.375	0.393	0.412	0.12	0	43	18.86	19.76	20.71	2.32	74
2	0.412	0.431	0.452	0.21	0.12	44	20.71	21.69	22.73	2.28	76.3
3	0.452	0.474	0.496	0.32	0.34	45	22.73	23.81	24.95	2.22	78.6
4	0.496	0.52	0.545	0.45	0.65	46	24.95	26.14	27.39	2.13	80.8
5	0.545	0.571	0.598	0.56	1.1	47	27.39	28.7	30.07	2	82.9
6	0.598	0.627	0.656	0.66	1.66	48	30.07	31.5	33.01	1.88	84.9
7	0.656	0.688	0.721	0.75	2.32	49	33.01	34.58	36.24	1.79	86.8
8	0.721	0.755	0.791	0.84	3.07	50	36.24	37.97	39.78	1.78	88.6
9	0.791	0.829	0.868	0.91	3.9	51	39.78	41.68	43.67	1.85	90.4
10	0.868	0.91	0.953	0.98	4.82	52	43.67	45.75	47.94	1.93	92.2
11	0.953	0.999	1.047	1.03	5.79	53	47.94	50.22	52.62	1.96	94.2
12	1.047	1.097	1.149	1.08	6.82	54	52.62	55.13	57.77	1.81	96.1
13	1.149	1.204	1.261	1.14	7.91	55	57.77	60.52	63.41	1.28	97.9
14	1.261	1.321	1.384	1.19	9.04	56	63.41	66.44	69.61	0.63	99.2
15	1.384	1.451	1.52	1.24	10.2	57	69.61	72.94	76.42	0.15	99.8
16	1.52	1.592	1.668	1.3	11.5	58	76.42	80.07	83.89	0.015	99.99
17	1.668	1.748	1.832	1.37	12.8	59	83.89	87.9	92.09	0	100
18	1.832	1.919	2.011	1.44	14.1	60	92.09	96.49	101.1	0	100
19	2.011	2.107	2.207	1.53	15.6	61	101.1	105.9	111	0	100
20	2.207	2.313	2.423	1.63	17.1	62	111	116.3	121.8	0	100
21	2.423	2.539	2.66	1.74	18.7	63	121.8	127.6	133.7	0	100
22	2.66	2.787	2.92	1.86	20.5	64	133.7	140.1	146.8	0	100
23	2.92	3.059	3.205	1.99	22.3	65	146.8	153.8	161.2	0	100
24	3.205	3.358	3.519	2.12	24.3	66	161.2	168.9	176.9	0	100
25	3.519	3.687	3.863	2.25	26.5	67	176.9	185.4	194.2	0	100
26	3.863	4.047	4.24	2.38	28.7	68	194.2	203.5	213.2	0	100
27	4.24	4.443	4.655	2.5	31.1	69	213.2	223.4	234	0	100
28	4.655	4.877	5.11	2.6	33.6	70	234	245.2	256.9	0	100
29	5.11	5.354	5.61	2.69	36.2	71	256.9	269.2	282.1	0	100
30	5.61	5.878	6.158	2.76	38.9	72	282.1	295.5	309.6	0	100
31	6.158	6.452	6.76	2.81	41.6	73	309.6	324.4	339.9	0	100
32	6.76	7.083	7.421	2.84	44.4	74	339.9	356.1	373.1	0	100
33	7.421	7.775	8.147	2.85	47.3	75	373.1	390.9	409.6	0	100
34	8.147	8.536	8.943	2.85	50.1	76	409.6	429.2	449.7	0	100
35	8.943	9.37	9.818	2.83	53	77	449.7	471.1	493.6	0	100
36	9.818	10.29	10.78	2.79	55.8	78	493.6	517.2	541.9	0	100
37	10.78	11.29	11.83	2.74	58.6	79	541.9	567.7	594.8	0	100
38	11.83	12.4	12.99	2.68	61.4	80	594.8	623.3	653	0	100
39	12.99	13.61	14.26	2.61	64	81	653	684.2	716.8	0	100
40	14.26	14.94	15.65	2.52	66.6	82	716.8	751.1	786.9	0	100
41	15.65	16.4	17.18	2.44	69.2	83	786.9	824.5	863.9	0	100
42	17.18	18	18.86	2.37	71.6	84	863.9	905.1	948.3	0	100
							948.3				100

APPENDIX B

HABITAT DATA

Table B-1. Water velocity and depth data collected at the proposed Deh Cho Bridge 1 Aug, 2003.

Site	Location[1]	UTM (11V) NAD27		Date	Depth (m)	Velocity (m/s)
		Easting	Northing			
1	114 m from South Causeway	471830	6791725	1-Aug-03	Surface	1.06
					1.0	1.22
					2.0	0.95
					3.0	0.84
					3.5	0.67
					3.8 (bottom)	-
					Mean	**0.9**
2	216 m from South Causeway	471836	6791841	1-Aug-03	Surface	1.22
					1.0	1.39
					2.0	1.28
					3.0	1.11
					4.0	0.56
					4.4 (bottom)	-
					Mean	**1.1**
3	338 m from South Causeway	471834	6791956	1-Aug-03	Surface	1.55
					1.0	1.50
					2.0	1.50
					3.0	1.44
					4.0	1.22
					4.3	0.95
					4.7 (bottom)	-
					Mean	**1.4**
4	470 m from South Causeway	471840	6792053	1-Aug-03	Surface	1.44
					1.0	1.39
					2.0	1.28
					3.0	1.17
					4.0	0.73
					4.3 (bottom)	-
					Mean	**1.2**
5	588 m from South Causeway	471844	6792203	1-Aug-03	Surface	1.66
					1.0	1.55
					2.0	1.55
					3.0	1.44
					4.0	1.44
					5.0	1.22
					5.7	1.06
					6.1 (bottom)	-
					Mean	**1.4**
6	728 m from South Causeway	471877	6792343	1-Aug-03	Surface	1.50
					1.0	1.55
					2.0	1.61
					3.0	1.44
					4.0	1.39
					5.0	1.33
					6.0	1.17
					7.0	0.84
					7.3 (bottom)	-
					Mean	**1.4**
7	842 m from South Causeway	471890	6792427	1-Aug-03	Surface	1.44
					1.0	1.44
					2.0	1.44
					3.0	1.17
					4.0	1.28
					5.0	0.62
					5.5	0.34
					5.7 (bottom)	-
					Mean	**1.1**
8	86 m from North Causeway	471927	6792546	1-Aug-03	Surface	0.95
					1.0	1.06
					2.0	1.00
					3.0	0.95
					4.0	0.89
					5.0	0.62
					5.6	0.50
					5.9 (bottom)	-
					Mean	**0.9**

APPENDIX C

FISH DATA

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
162	ARGR	115	15		ES		18-Sep-03	3				Mackenzie R.	0	
126	ARGR	330	555		ES	SC	17-Sep-03	1				Mackenzie R.	0	
129	ARGR	377	565	10	ES	SC	17-Sep-03	1				Mackenzie R.	0	
130	ARGR	378	705	10	ES	SC	17-Sep-03	1				Mackenzie R.	0	
131	ARGR	380	715	10	ES	SC	17-Sep-03	1				Mackenzie R.	0	
127	ARGR	396	720	10	ES	SC	17-Sep-03	1				Mackenzie R.	0	
128	ARGR	403	815	10	ES	SC	17-Sep-03	1				Mackenzie R.	0	
175	BURB	102			ES		18-Sep-03	4				Mackenzie R.	0	
431	BURB	261	65		FN		19-Sep-03	2		Upst	5	Mackenzie R.	0	
423	BURB	381	315		FN		18-Sep-03	2		Dnst	4	Mackenzie R.	1	Regurgitated from NRPK
430	BURB	433	500		FN		19-Sep-03	2		Upst	5	Mackenzie R.	0	
506	BURB	525	655		FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
426	BURB	844	3080	14	FN	OT	19-Sep-03	2		Upst	5	Mackenzie R.	1	ST = 20 (BURB, LKWH)
385	EMSH	12			BS		17-Sep-03	3				Mackenzie R.	0	
531	EMSH	15			BS		20-Sep-03	9				Mackenzie R.	0	
536	EMSH	15			BS		20-Sep-03	9				Mackenzie R.	0	
551	EMSH	15			BS		20-Sep-03	9				Mackenzie R.	0	
908	EMSH	15			BS		21-Sep-03	11				Mackenzie R.	0	
944	EMSH	15			BS		21-Sep-03	11				Mackenzie R.	0	
972	EMSH	15			BS		21-Sep-03	12				Mackenzie R.	0	
1010	EMSH	15			BS		21-Sep-03	12				Mackenzie R.	0	
374	EMSH	16			BS		17-Sep-03	3				Mackenzie R.	0	
448	EMSH	16			BS		19-Sep-03	5				Mackenzie R.	0	
625	EMSH	16			BS		20-Sep-03	10				Mackenzie R.	0	
1001	EMSH	16			BS		21-Sep-03	12				Mackenzie R.	0	
1007	EMSH	16			BS		21-Sep-03	12				Mackenzie R.	0	
1012	EMSH	16			BS		21-Sep-03	12				Mackenzie R.	0	
1018	EMSH	16			BS		21-Sep-03	12				Mackenzie R.	0	
381	EMSH	17			BS		17-Sep-03	3				Mackenzie R.	0	
987	EMSH	17			BS		21-Sep-03	12				Mackenzie R.	0	
222	EMSH	18			BS		17-Sep-03	1				Mackenzie R.	0	
226	EMSH	18			BS		17-Sep-03	1				Mackenzie R.	0	
227	EMSH	18			BS		17-Sep-03	1				Mackenzie R.	0	
382	EMSH	18			BS		17-Sep-03	3				Mackenzie R.	0	
491	EMSH	18			BS		19-Sep-03	7				Mackenzie R.	0	
540	EMSH	18			BS		20-Sep-03	9				Mackenzie R.	0	
543	EMSH	18			BS		20-Sep-03	9				Mackenzie R.	0	
598	EMSH	18			BS		20-Sep-03	10				Mackenzie R.	0	
610	EMSH	18			BS		20-Sep-03	10				Mackenzie R.	0	
626	EMSH	18			BS		20-Sep-03	10				Mackenzie R.	0	
921	EMSH	18			BS		21-Sep-03	11				Mackenzie R.	0	
925	EMSH	18			BS		21-Sep-03	11				Mackenzie R.	0	
954	EMSH	18			BS		21-Sep-03	11				Mackenzie R.	0	
957	EMSH	18			BS		21-Sep-03	11				Mackenzie R.	0	
978	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
981	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
984	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
986	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
1000	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
1002	EMSH	18			BS		21-Sep-03	12				Mackenzie R.	0	
192	EMSH	19			BS		17-Sep-03	1				Mackenzie R.	0	
220	EMSH	19			BS		17-Sep-03	1				Mackenzie R.	0	
221	EMSH	19			BS		17-Sep-03	1				Mackenzie R.	0	
441	EMSH	19			BS		19-Sep-03	5				Mackenzie R.	0	
936	EMSH	19			BS		21-Sep-03	11				Mackenzie R.	0	
979	EMSH	19			BS		21-Sep-03	12				Mackenzie R.	0	
191	EMSH	20			BS		17-Sep-03	1				Mackenzie R.	0	
224	EMSH	20			BS		17-Sep-03	1				Mackenzie R.	0	
379	EMSH	20			BS		17-Sep-03	3				Mackenzie R.	0	
380	EMSH	20			BS		17-Sep-03	3				Mackenzie R.	0	
453	EMSH	20			BS		19-Sep-03	5				Mackenzie R.	0	
530	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
534	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
537	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
538	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
542	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
545	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
547	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
552	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
560	EMSH	20			BS		20-Sep-03	9				Mackenzie R.	0	
575	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
577	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
588	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
589	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
591	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
592	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
593	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
594	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
596	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
597	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
615	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
617	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
618	EMSH	20			BS		20-Sep-03	10				Mackenzie R.	0	
909	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
910	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
914	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
915	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
918	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
926	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
927	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
930	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
935	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
938	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
939	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
942	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
951	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
952	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	
956	EMSH	20			BS		21-Sep-03	11				Mackenzie R.	0	

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
977	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
982	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
990	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
998	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1003	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1005	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1008	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1009	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1011	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
1020	EMSH	20			BS		21-Sep-03	12				Mackenzie R.	0	
184	EMSH	21			BS		17-Sep-03	1				Mackenzie R.	0	
188	EMSH	21			BS		17-Sep-03	1				Mackenzie R.	0	
297	EMSH	21			BS		17-Sep-03	2				Mackenzie R.	0	
378	EMSH	21			BS		17-Sep-03	3				Mackenzie R.	0	
383	EMSH	21			BS		17-Sep-03	3				Mackenzie R.	0	
384	EMSH	21			BS		17-Sep-03	3				Mackenzie R.	0	
404	EMSH	21			BS		17-Sep-03	4				Mackenzie R.	0	
409	EMSH	21			BS		17-Sep-03	4				Mackenzie R.	0	
469	EMSH	21			BS		19-Sep-03	5				Mackenzie R.	0	
487	EMSH	21			BS		19-Sep-03	7				Mackenzie R.	0	
573	EMSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
576	EMSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
595	EMSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
627	EMSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
928	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
932	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
940	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
943	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
946	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
953	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
958	EMSH	21			BS		21-Sep-03	11				Mackenzie R.	0	
970	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
974	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
983	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
985	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
988	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
989	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
1004	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
1013	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
1021	EMSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
190	EMSH	22			BS		17-Sep-03	1				Mackenzie R.	0	
203	EMSH	22			BS		17-Sep-03	1				Mackenzie R.	0	
208	EMSH	22			BS		17-Sep-03	1				Mackenzie R.	0	
216	EMSH	22			BS		17-Sep-03	1				Mackenzie R.	0	
286	EMSH	22			BS		17-Sep-03	2				Mackenzie R.	0	
377	EMSH	22			BS		17-Sep-03	3				Mackenzie R.	0	
406	EMSH	22			BS		17-Sep-03	4				Mackenzie R.	0	
440	EMSH	22			BS		19-Sep-03	5				Mackenzie R.	0	
458	EMSH	22			BS		19-Sep-03	5				Mackenzie R.	0	
485	EMSH	22			BS		19-Sep-03	7				Mackenzie R.	0	
526	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
529	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
532	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
535	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
539	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
546	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
549	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
555	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
561	EMSH	22			BS		20-Sep-03	9				Mackenzie R.	0	
568	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
572	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
580	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
607	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
609	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
622	EMSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
911	EMSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
913	EMSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
916	EMSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
920	EMSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
947	EMSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
973	EMSH	22			BS		21-Sep-03	12				Mackenzie R.	0	
980	EMSH	22			BS		21-Sep-03	12				Mackenzie R.	0	
1016	EMSH	22			BS		21-Sep-03	12				Mackenzie R.	0	
1019	EMSH	22			BS		21-Sep-03	12				Mackenzie R.	0	
194	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
196	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
201	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
202	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
209	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
210	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
215	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
218	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
219	EMSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
289	EMSH	23			BS		17-Sep-03	2				Mackenzie R.	0	
290	EMSH	23			BS		17-Sep-03	2				Mackenzie R.	0	
294	EMSH	23			BS		17-Sep-03	2				Mackenzie R.	0	
403	EMSH	23			BS		17-Sep-03	4				Mackenzie R.	0	
449	EMSH	23			BS		19-Sep-03	5				Mackenzie R.	0	
462	EMSH	23			BS		19-Sep-03	5				Mackenzie R.	0	
468	EMSH	23			BS		19-Sep-03	5				Mackenzie R.	0	
528	EMSH	23			BS		20-Sep-03	9				Mackenzie R.	0	
553	EMSH	23			BS		20-Sep-03	9				Mackenzie R.	0	
556	EMSH	23			BS		20-Sep-03	9				Mackenzie R.	0	
559	EMSH	23			BS		20-Sep-03	9				Mackenzie R.	0	
563	EMSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
574	EMSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
608	EMSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
912	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
923	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
924	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
941	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
945	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
950	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
959	EMSH	23			BS		21-Sep-03	11				Mackenzie R.	0	
971	EMSH	23			BS		21-Sep-03	12				Mackenzie R.	0	
193	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
200	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
205	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
207	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
217	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
223	EMSH	24			BS		17-Sep-03	1				Mackenzie R.	0	
287	EMSH	24			BS		17-Sep-03	2				Mackenzie R.	0	
298	EMSH	24			BS		17-Sep-03	2				Mackenzie R.	0	
400	EMSH	24			BS		17-Sep-03	4				Mackenzie R.	0	
402	EMSH	24			BS		17-Sep-03	4				Mackenzie R.	0	
405	EMSH	24			BS		17-Sep-03	4				Mackenzie R.	0	
444	EMSH	24			BS		19-Sep-03	5				Mackenzie R.	0	
447	EMSH	24			BS		19-Sep-03	5				Mackenzie R.	0	
457	EMSH	24			BS		19-Sep-03	5				Mackenzie R.	0	
461	EMSH	24			BS		19-Sep-03	5				Mackenzie R.	0	
464	EMSH	24			BS		19-Sep-03	5				Mackenzie R.	0	
488	EMSH	24			BS		19-Sep-03	7				Mackenzie R.	0	
489	EMSH	24			BS		19-Sep-03	7				Mackenzie R.	0	
558	EMSH	24			BS		20-Sep-03	9				Mackenzie R.	0	
564	EMSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
567	EMSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
601	EMSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
606	EMSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
624	EMSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
919	EMSH	24			BS		21-Sep-03	11				Mackenzie R.	0	
922	EMSH	24			BS		21-Sep-03	11				Mackenzie R.	0	
955	EMSH	24			BS		21-Sep-03	11				Mackenzie R.	0	
976	EMSH	24			BS		21-Sep-03	12				Mackenzie R.	0	
1017	EMSH	24			BS		21-Sep-03	12				Mackenzie R.	0	
206	EMSH	25			BS		17-Sep-03	1				Mackenzie R.	0	
214	EMSH	25			BS		17-Sep-03	1				Mackenzie R.	0	
225	EMSH	25			BS		17-Sep-03	1				Mackenzie R.	0	
296	EMSH	25			BS		17-Sep-03	2				Mackenzie R.	0	
396	EMSH	25			BS		17-Sep-03	4				Mackenzie R.	0	
399	EMSH	25			BS		17-Sep-03	4				Mackenzie R.	0	
401	EMSH	25			BS		17-Sep-03	4				Mackenzie R.	0	
407	EMSH	25			BS		17-Sep-03	4				Mackenzie R.	0	
445	EMSH	25			BS		19-Sep-03	5				Mackenzie R.	0	
446	EMSH	25			BS		19-Sep-03	5				Mackenzie R.	0	
454	EMSH	25			BS		19-Sep-03	5				Mackenzie R.	0	
459	EMSH	25			BS		19-Sep-03	5				Mackenzie R.	0	
471	EMSH	25			BS		19-Sep-03	6				Mackenzie R.	0	
481	EMSH	25			BS		19-Sep-03	7				Mackenzie R.	0	
484	EMSH	25			BS		19-Sep-03	7				Mackenzie R.	0	
541	EMSH	25			BS		20-Sep-03	9				Mackenzie R.	0	
544	EMSH	25			BS		20-Sep-03	9				Mackenzie R.	0	
554	EMSH	25			BS		20-Sep-03	9				Mackenzie R.	0	
557	EMSH	25			BS		20-Sep-03	9				Mackenzie R.	0	
569	EMSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
581	EMSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
583	EMSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
948	EMSH	25			BS		21-Sep-03	11				Mackenzie R.	0	
960	EMSH	25			BS		21-Sep-03	11				Mackenzie R.	0	
999	EMSH	25			BS		21-Sep-03	12				Mackenzie R.	0	
1006	EMSH	25			BS		21-Sep-03	12				Mackenzie R.	0	
1015	EMSH	25			BS		21-Sep-03	12				Mackenzie R.	0	
198	EMSH	26			BS		17-Sep-03	1				Mackenzie R.	0	
211	EMSH	26			BS		17-Sep-03	1				Mackenzie R.	0	
213	EMSH	26			BS		17-Sep-03	1				Mackenzie R.	0	
375	EMSH	26			BS		17-Sep-03	3				Mackenzie R.	0	
397	EMSH	26			BS		17-Sep-03	4				Mackenzie R.	0	
398	EMSH	26			BS		17-Sep-03	4				Mackenzie R.	0	
408	EMSH	26			BS		17-Sep-03	4				Mackenzie R.	0	
410	EMSH	26			BS		17-Sep-03	4				Mackenzie R.	0	
442	EMSH	26			BS		19-Sep-03	5				Mackenzie R.	0	
451	EMSH	26			BS		19-Sep-03	5				Mackenzie R.	0	
463	EMSH	26			BS		19-Sep-03	5				Mackenzie R.	0	
476	EMSH	26			BS		19-Sep-03	7				Mackenzie R.	0	
478	EMSH	26			BS		19-Sep-03	7				Mackenzie R.	0	
486	EMSH	26			BS		19-Sep-03	7				Mackenzie R.	0	
490	EMSH	26			BS		19-Sep-03	7				Mackenzie R.	0	
565	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
566	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
582	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
590	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
600	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
603	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
611	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
621	EMSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
917	EMSH	26			BS		21-Sep-03	11				Mackenzie R.	0	
949	EMSH	26			BS		21-Sep-03	11				Mackenzie R.	0	
975	EMSH	26			BS		21-Sep-03	12				Mackenzie R.	0	
212	EMSH	27			BS		17-Sep-03	1				Mackenzie R.	0	
460	EMSH	27			BS		19-Sep-03	5				Mackenzie R.	0	
465	EMSH	27			BS		19-Sep-03	5				Mackenzie R.	0	
466	EMSH	27			BS		19-Sep-03	5				Mackenzie R.	0	
929	EMSH	27			BS		21-Sep-03	11				Mackenzie R.	0	
931	EMSH	27			BS		21-Sep-03	11				Mackenzie R.	0	
934	EMSH	27			BS		21-Sep-03	11				Mackenzie R.	0	
937	EMSH	27			BS		21-Sep-03	11				Mackenzie R.	0	
992	EMSH	27			BS		21-Sep-03	12				Mackenzie R.	0	

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
473	EMSH	28			BS		19-Sep-03	6				Mackenzie R.	0	
584	EMSH	28			BS		20-Sep-03	10				Mackenzie R.	0	
961	EMSH	28			BS		21-Sep-03	11				Mackenzie R.	0	
1014	EMSH	28			BS		21-Sep-03	12				Mackenzie R.	0	
295	EMSH	29			BS		17-Sep-03	2				Mackenzie R.	0	
571	EMSH	30			BS		20-Sep-03	10				Mackenzie R.	0	
933	EMSH	30			BS		21-Sep-03	11				Mackenzie R.	0	
443	EMSH	32			BS		19-Sep-03	5				Mackenzie R.	0	
161	EMSH	70			ES		18-Sep-03	3				Mackenzie R.	0	
3	EMSH	80			GN		30-Jul-03	2	0.75			Mackenzie R.	1	
4	EMSH	80			GN		30-Jul-03	2	0.75			Mackenzie R.	1	
177	EMSH	80			ES		18-Sep-03	4				Mackenzie R.	0	
176	EMSH	82			ES		18-Sep-03	4				Mackenzie R.	0	
502	EMSH	86			FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
2	EMSH	90			GN		30-Jul-03	2	0.75			Mackenzie R.	0	
180	EMSH	90			ES		18-Sep-03	4				Mackenzie R.	0	
179	EMSH	93			ES		18-Sep-03	4				Mackenzie R.	0	
178	EMSH	95			ES		18-Sep-03	4				Mackenzie R.	0	
181	EMSH	100			ES		18-Sep-03	4				Mackenzie R.	0	
228	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
229	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
230	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
231	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
232	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
233	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
234	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
235	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
236	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
237	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
238	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
239	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
240	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
241	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
242	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
243	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
244	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
245	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
246	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
247	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
248	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
249	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
250	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
251	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
252	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
253	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
254	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
255	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
256	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
257	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
258	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
259	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
260	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
261	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
262	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
263	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
264	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
265	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
266	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
267	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
268	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
269	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
270	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
271	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
272	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
273	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
274	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
275	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
276	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
277	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
278	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
279	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
280	EMSH				BS		17-Sep-03	1				Mackenzie R.	0	RND
318	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
319	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
320	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
321	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
322	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
323	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
324	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
325	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
326	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
327	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
328	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
329	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
330	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
331	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
332	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
333	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
334	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
335	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
336	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
337	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
338	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
339	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
340	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
341	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
342	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
343	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
344	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
345	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
346	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
347	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
348	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
349	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
350	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
351	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
352	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
353	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
354	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
355	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
356	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
357	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
358	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
359	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
360	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
361	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
362	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
363	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
364	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
365	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
366	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
367	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
368	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
369	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
370	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
371	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
372	EMSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
386	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
387	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
388	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
389	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
390	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
391	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
392	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
393	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
394	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
395	EMSH				BS		17-Sep-03	3				Mackenzie R.	0	RND
411	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
412	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
413	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
414	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
415	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
416	EMSH				BS		17-Sep-03	4				Mackenzie R.	0	RND
629	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
630	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
631	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
632	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
633	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
634	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
635	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
636	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
637	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
638	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
639	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
640	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
641	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
642	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
643	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
644	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
645	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
646	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
647	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
648	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
649	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
650	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
651	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
652	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
653	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
654	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
655	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
656	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
657	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
658	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
659	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
660	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
661	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
662	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
663	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
664	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
665	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
666	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
667	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
668	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
669	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
670	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
671	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
672	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
673	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
674	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
675	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
676	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
677	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
678	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
679	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
680	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
681	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
682	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
683	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
684	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
685	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
686	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
687	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
688	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
689	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
690	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
691	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
692	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
693	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
694	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
695	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
696	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
697	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
698	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
699	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
700	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
701	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
702	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
703	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
704	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
705	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
706	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
707	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
708	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
709	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
710	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
711	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
712	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
713	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
714	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
715	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
716	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
717	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
718	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
719	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
720	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
721	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
722	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
723	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
724	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
725	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
726	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
727	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
728	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
729	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
730	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
731	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
732	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
733	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
734	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
735	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
736	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
737	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
738	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
739	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
740	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
741	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
742	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
743	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
744	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
745	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
746	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
747	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
748	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
749	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
750	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
751	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
752	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
753	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
754	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
755	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
756	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
757	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
758	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
759	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
760	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
761	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
762	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
763	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
764	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
765	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
766	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
767	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
768	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
769	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
770	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
771	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
772	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
773	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
774	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
775	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
776	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
777	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
778	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
779	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
780	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
781	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
782	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
783	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
784	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
785	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
786	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
787	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
788	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
789	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
790	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
791	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
792	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
793	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
794	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
795	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
796	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
797	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
798	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
799	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
800	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
801	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
802	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
803	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
804	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
805	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
806	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
807	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
808	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
809	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
810	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
811	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
812	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
813	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
814	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
815	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
816	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
817	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
818	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
819	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
820	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
821	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
822	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
823	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
824	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
825	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
826	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
827	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
828	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
829	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
830	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
831	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
832	EMSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
963	EMSH				BS		21-Sep-03	11				Mackenzie R.	0	RND
964	EMSH				BS		21-Sep-03	11				Mackenzie R.	0	RND
965	EMSH				BS		21-Sep-03	11				Mackenzie R.	0	RND
966	EMSH				BS		21-Sep-03	11				Mackenzie R.	0	RND
967	EMSH				BS		21-Sep-03	11				Mackenzie R.	0	RND
1022	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1023	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1024	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1025	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1026	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1027	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1028	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1029	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1030	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1031	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1032	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1033	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1034	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1035	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1036	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1037	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1038	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1039	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1040	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1041	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1042	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1043	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
1044	EMSH				BS		21-Sep-03	12				Mackenzie R.	0	RND
107	LKWH	117	10		ES		17-Sep-03	1				Mackenzie R.	0	
141	LKWH	219	300		ES		18-Sep-03	2				Mackenzie R.	0	
1	LKWH	248	230		GN	SC	30-Jul-03	2	2.50			Mackenzie R.	0	
902	LKWH	264	215	1	GN		21-Sep-03	14				Mackenzie R.	1	ST = 10 (Caddisflies/mayflies/scuds)
61	LKWH	270	285		GN	SC	2-Aug-03	10				Mackenzie R.	1	ST = 0
511	LKWH	285	345		GN		20-Sep-03	12				Mackenzie R.	1	
103	LKWH	289	355		ES	SC	17-Sep-03	1				Mackenzie R.	0	
20	LKWH	293	390		GN	SC	31-Jul-03	5	3.50			Mackenzie R.	0	
156	LKWH	305	370		ES		18-Sep-03	3				Mackenzie R.	0	
5	LKWH	324	480		GN	SC	30-Jul-03	2	2.50			Mackenzie R.	1	ST = 10 (plants and clams)
140	LKWH	340	470		ES		18-Sep-03	2				Mackenzie R.	0	
15	LKWH	347	465		GN	SC	30-Jul-03	2	3.50			Mackenzie R.	0	
147	LKWH	360	680		ES		18-Sep-03	3				Mackenzie R.	0	
135	LKWH	365	840		ES		18-Sep-03	2				Mackenzie R.	0	
168	LKWH	368	740		ES		18-Sep-03	4				Mackenzie R.	0	
105	LKWH	370	645		ES	SC	17-Sep-03	1				Mackenzie R.	0	
901	LKWH	374	640	11	GN		21-Sep-03	14				Mackenzie R.	1	ST = 5 (Water boatmen)

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
152	LKWH	375	760		ES		18-Sep-03	3				Mackenzie R.	0	
474	LKWH	384	805		GN		19-Sep-03	12				Mackenzie R.	1	ST = 20 (Water boatmen, clams)
891	LKWH	385	770	1	GN		21-Sep-03	14				Mackenzie R.	1	
898	LKWH	386	890	15	GN		21-Sep-03	14				Mackenzie R.	1	ST =15 (scuds)
59	LKWH	390	920	14	GN	SC	2-Aug-03	10				Mackenzie R.	1	ST = 10 (caddis fly, mayfly,beetles)
133	LKWH	395	875	5	ES		18-Sep-03	2				Mackenzie R.	1	ST = 20 (back swimmers)
136	LKWH	402	1025		ES		18-Sep-03	2				Mackenzie R.	0	
900	LKWH	402	920	17	GN		21-Sep-03	14				Mackenzie R.	1	ST = 20 (Water boatmen)
83	LKWH	405	1005	14	GN	SC	2-Aug-03	11				Mackenzie R.	1	ST = 5 (clams)
60	LKWH	409	985	4	GN	SC	2-Aug-03	10				Mackenzie R.	1	ST = 5 (plants and clams)
182	LKWH	410			ES		18-Sep-03	5				Mackenzie R.	0	
148	LKWH	412	895	17	ES		18-Sep-03	3				Mackenzie R.	1	ST = 10 (Aquatic veg)
78	LKWH	416	855	11	GN	SC	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
895	LKWH	416	915	5	GN		21-Sep-03	14				Mackenzie R.	1	ST = 15 (Water boatmen)
96	LKWH	417	1220	14	GN	SC	3-Aug-03	8	3.50			Mackenzie R.	1	ST = 10 (water boatmen, back swimmers)
73	LKWH	418	1025	4	GN	SC	2-Aug-03	8	3.50			Mackenzie R.	1	ST = 5 (clams)
516	LKWH	419	1005	7	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST = 0
102	LKWH	420	1095	15	ES	OT/SC	17-Sep-03	1				Mackenzie R.	1	
518	LKWH	420	1145	15	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST = 5 (clams)
897	LKWH	420	1145	5	GN		21-Sep-03	14				Mackenzie R.	1	ST = 5 (Water boatmen)
77	LKWH	425	1120	4	GN	SC	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
132	LKWH	425	1065	15	ES		18-Sep-03	2				Mackenzie R.	1	ST = 10 (back swimmers)
110	LKWH	427	1160		ES	SC	17-Sep-03	1				Mackenzie R.	0	
26	LKWH	432	1255	14	GN	SC	31-Jul-03	5	3.50			Mackenzie R.	1	ST = 5 (clams)
170	LKWH	433	1295		ES		18-Sep-03	4				Mackenzie R.	0	
893	LKWH	434	1035	5	GN		21-Sep-03	14				Mackenzie R.	1	ST = 0
167	LKWH	435	1380		ES		18-Sep-03	4				Mackenzie R.	0	
424	LKWH	439	1090		FN		18-Sep-03	2		Dnst	4	Mackenzie R.	0	
899	LKWH	440	1225	5	GN		21-Sep-03	14				Mackenzie R.	1	ST = 0
138	LKWH	442	990		ES		18-Sep-03	2				Mackenzie R.	0	
149	LKWH	442	1080		ES		18-Sep-03	3				Mackenzie R.	0	
894	LKWH	442	1175	7	GN		21-Sep-03	14				Mackenzie R.	1	ST = 10 (Caddisflies)
134	LKWH	445	1225		ES		18-Sep-03	2				Mackenzie R.	0	
892	LKWH	445	1600	17	GN		21-Sep-03	14				Mackenzie R.	1	ST = 15 (Water boatmen)
164	LKWH	447	1290		ES		18-Sep-03	4				Mackenzie R.	0	
166	LKWH	447	1545		ES		18-Sep-03	4				Mackenzie R.	0	
890	LKWH	449	1350	17	GN		21-Sep-03	15				Mackenzie R.	1	ST = 10 (Water boatmen)
513	LKWH	450	1390	7	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST =10 (clams, caddisflies)
886	LKWH	454	935	5	GN		21-Sep-03	15				Mackenzie R.	1	ST = 15 (Snails, clams)
887	LKWH	455	1240	17	GN		21-Sep-03	15				Mackenzie R.	1	ST = 0
104	LKWH	460	1245	15	ES	OT/SC	17-Sep-03	1				Mackenzie R.	1	
514	LKWH	462	1595	17	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST =5 (clams)
512	LKWH	468	1410	17	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST = 0
50	LKWH	470	1605		GN		1-Aug-03	7	2.50			Mackenzie R.	1	
146	LKWH	474	1410		ES		18-Sep-03	3				Mackenzie R.	1	ST = 0
150	LKWH	475	1715	15	ES		18-Sep-03	3				Mackenzie R.	1	ST = 20 (Snails, back swimmers)
522	LKWH	475	1420	17	GN	SC	20-Sep-03	13				Mackenzie R.	1	ST = 0
896	LKWH	475	1690	17	GN		21-Sep-03	14				Mackenzie R.	1	ST = 10 (Water boatmen)
517	LKWH	479	1555	7	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST = 0
169	LKWH	480	1700		ES		18-Sep-03	4				Mackenzie R.	0	
25	LKWH	485	1820	14	GN	SC	31-Jul-03	5	3.50			Mackenzie R.	1	ST = 10 (clams)
58	LKWH	485	1640	14	GN	SC	2-Aug-03	10				Mackenzie R.	1	ST = 10 (caddis fly, mayfly,beetles)
515	LKWH	485	2020	17	GN	SC	20-Sep-03	12				Mackenzie R.	1	ST = 5 (Unid)
76	LKWH	490	1475	4	GN	SC	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
165	LKWH	498	1830		ES		18-Sep-03	4				Mackenzie R.	0	
151	LKWH	524	2020		ES		18-Sep-03	3				Mackenzie R.	0	
475	LKWH	555	1555		GN		19-Sep-03	12				Mackenzie R.	1	ST = 5 (Caddisflies)
519	LKWH				GN		20-Sep-03	12				Mackenzie R.	0	RND
520	LKWH				GN		20-Sep-03	12				Mackenzie R.	0	RND
521	LKWH				GN		20-Sep-03	12				Mackenzie R.	0	RND
174	LNSC	175	70		ES		18-Sep-03	4				Mackenzie R.	0	
157	LNSC	184	75		ES		18-Sep-03	3				Mackenzie R.	0	
158	LNSC	210	105		ES		18-Sep-03	3				Mackenzie R.	0	
82	LNSC	313	380		GN		2-Aug-03	11	2.50			Mackenzie R.	0	
969	NNST	27			BS		21-Sep-03	12				Mackenzie R.	0	
492	NNST	30			BS		19-Sep-03	7				Mackenzie R.	0	
455	NNST	33			BS		19-Sep-03	5				Mackenzie R.	0	
472	NNST	35			BS		19-Sep-03	6				Mackenzie R.	0	
470	NNST	36			BS		19-Sep-03	6				Mackenzie R.	0	
499	NNST	37			BS		19-Sep-03	8				Mackenzie R.	0	
498	NNST	38			BS		19-Sep-03	8				Mackenzie R.	0	
373	NNST	42			BS		17-Sep-03	3				Mackenzie R.	0	
493	NNST	42			BS		19-Sep-03	8				Mackenzie R.	0	
968	NNST	42			BS		21-Sep-03	12				Mackenzie R.	0	
497	NNST	44			BS		19-Sep-03	8				Mackenzie R.	0	
496	NNST	45			BS		19-Sep-03	8				Mackenzie R.	0	
494	NNST	46			BS		19-Sep-03	8				Mackenzie R.	0	
495	NNST	48			BS		19-Sep-03	8				Mackenzie R.	0	
550	NNST	50			BS		20-Sep-03	9				Mackenzie R.	0	
17	NRPK	88	8		MT		31-Jul-03	1				Mackenzie R.	0	
39	NRPK	100	6		FN		1-Aug-03	1			1	Mackenzie R.	0	
37	NRPK	102	6		FN		1-Aug-03	1			1	Mackenzie R.	0	
35	NRPK	105	6		FN		1-Aug-03	1			1	Mackenzie R.	0	
38	NRPK	105	8		FN		1-Aug-03	1			1	Mackenzie R.	0	
36	NRPK	109	6		FN		1-Aug-03	1			1	Mackenzie R.	0	
33	NRPK	110	8		FN		1-Aug-03	1			1	Mackenzie R.	1	
29	NRPK	113	10		FN		1-Aug-03	1			1	Mackenzie R.	0	
90	NRPK	114	10		FN	OT/SC	3-Aug-03	1			3	Mackenzie R.	1	
101	NRPK	114	10		FN	SC	3-Aug-03	1			3	Mackenzie R.	0	
32	NRPK	115	8		FN		1-Aug-03	1			1	Mackenzie R.	0	
34	NRPK	120	14		FN		1-Aug-03	1			1	Mackenzie R.	0	
30	NRPK	122	10		FN		1-Aug-03	1			1	Mackenzie R.	0	
13	NRPK	124	20		GN		30-Jul-03	2	1.50			Mackenzie R.	0	
85	NRPK	127	15		GN	SC	2-Aug-03	11	0.75			Mackenzie R.	0	
145	NRPK	130	5		ES		18-Sep-03	2				Mackenzie R.	0	
183	NRPK	134			ES		18-Sep-03	5				Mackenzie R.	0	
122	NRPK	135	15		ES	SC	17-Sep-03	1				Mackenzie R.	0	
144	NRPK	140	20		ES		18-Sep-03	2				Mackenzie R.	0	

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap Direction	Trap Check #	Location	Capture Code	Comments
160	NRPK	141	20		ES		18-Sep-03	3				Mackenzie R.	0	
31	NRPK	148	16		FN	FR	1-Aug-03	1			1	Mackenzie R.	0	
562	NRPK	152			BS		20-Sep-03	10				Mackenzie R.	0	
143	NRPK	155	30		ES		18-Sep-03	2				Mackenzie R.	0	
100	NRPK	161	30		FN	OT/SC	3-Aug-03	1			3	Mackenzie R.	1	
159	NRPK	228	75		ES		18-Sep-03	3				Mackenzie R.	0	
121	NRPK	290	140		ES	FR	17-Sep-03	1				Mackenzie R.	0	
14	NRPK	306	170	11	GN	FR	30-Jul-03	2	3.50			Mackenzie R.	1	ST = 0
142	NRPK	325	190		ES		18-Sep-03	2				Mackenzie R.	0	
86	NRPK	360	395		GN	FR	2-Aug-03	7	2.50			Mackenzie R.	0	
23	NRPK	415	520		GN	FR	31-Jul-03	6	2.50			Mackenzie R.	0	
12	NRPK	424	455		GN	FR	30-Jul-03	1	3.50			Mackenzie R.	0	
53	NRPK	428	552		GN	FR	1-Aug-03	10				Mackenzie R.	0	
45	NRPK	440	595		GN	FR	1-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
80	NRPK	440	650	4	GN	FR	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 20 (mouse)
52	NRPK	447	612		GN	FR	1-Aug-03	7	2.50			Mackenzie R.	0	
11	NRPK	450	600		GN	FR	30-Jul-03	1	2.50			Mackenzie R.	0	
65	NRPK	450	630	1	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
417	NRPK	456	635		FN		18-Sep-03	2		Upst	4	Mackenzie R.	0	
22	NRPK	457	745		GN	FR	31-Jul-03	5	3.50			Mackenzie R.	0	
118	NRPK	463	575		ES	FR	17-Sep-03	1				Mackenzie R.	0	
67	NRPK	473	700	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
81	NRPK	474	680		GN	FR	2-Aug-03	7	2.50			Mackenzie R.	0	
113	NRPK	493	765		ES	FR	17-Sep-03	1				Mackenzie R.	0	
10	NRPK	495	810	14	GN	FR	30-Jul-03	2	3.50			Mackenzie R.	1	ST = 20 (pike and shiner)
418	NRPK	495	845		FN		18-Sep-03	2		Upst	4	Mackenzie R.	0	
6	NRPK	497	875		GN	FR	30-Jul-03	2	2.50			Mackenzie R.	0	
504	NRPK	505	830		FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
48	NRPK	510	780		GN		1-Aug-03	7	2.50			Mackenzie R.	1	
70	NRPK	514	980	14	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
97	NRPK	514	970	4	GN	FR	3-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
120	NRPK	514	885		ES	FR	17-Sep-03	1				Mackenzie R.	0	
510	NRPK	514	925		GN		20-Sep-03	12				Mackenzie R.	0	
171	NRPK	518	945		ES		18-Sep-03	4				Mackenzie R.	0	
139	NRPK	520	855		ES		18-Sep-03	2				Mackenzie R.	0	
79	NRPK	525	1095	4	GN	FR	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
903	NRPK	527	945	14	GN		21-Sep-03	14				Mackenzie R.	1	ST = 0
438	NRPK	528	945		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
508	NRPK	529	985		GN		20-Sep-03	12				Mackenzie R.	0	
69	NRPK	532	1060	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
68	NRPK	534	1080	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
429	NRPK	538	920		FN		19-Sep-03	2		Upst	5	Mackenzie R.	0	
509	NRPK	538	1120		GN		20-Sep-03	12				Mackenzie R.	0	
439	NRPK	542	1065		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
906	NRPK	544	1045	14	GN		21-Sep-03	14				Mackenzie R.	1	ST = 0
47	NRPK	550	1195		GN		1-Aug-03	8	3.50			Mackenzie R.	1	
51	NRPK	550	1150		GN		1-Aug-03	10				Mackenzie R.	0	
71	NRPK	550	1235		GN	FR	2-Aug-03	8	3.50			Mackenzie R.	0	
9	NRPK	551	1230	4	GN	FR	30-Jul-03	1	3.50			Mackenzie R.	1	
44	NRPK	555	1240		GN	FR	1-Aug-03	8	3.50			Mackenzie R.	1	ST = 0
84	NRPK	557	1285	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 20 (pike)
503	NRPK	559	1180		FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
91	NRPK	560	1320		GN	FR	3-Aug-03	8	3.50			Mackenzie R.	0	
89	NRPK	562	980		FN	FR	3-Aug-03	1			3	Mackenzie R.	0	
172	NRPK	563	1165		ES		18-Sep-03	4				Mackenzie R.	0	
40	NRPK	565	1345		GN	FR	1-Aug-03	8	3.50			Mackenzie R.	0	
72	NRPK	565	1280	4	GN	FR	2-Aug-03	8	3.50			Mackenzie R.	1	ST = 0
119	NRPK	573	1435		ES	FR	17-Sep-03	1				Mackenzie R.	0	
422	NRPK	573	1335		FN		18-Sep-03	2		Dnst	4	Mackenzie R.	0	
98	NRPK	575	750	14	GN	FR	3-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
16	NRPK	584	1355	4	GN	FR	31-Jul-03	4	4.50			Mackenzie R.	0	
49	NRPK	585	1480		GN		1-Aug-03	7	2.50			Mackenzie R.	0	
433	NRPK	588	1310		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
114	NRPK	590	1525		ES	FR	17-Sep-03	1				Mackenzie R.	0	
419	NRPK	594	805		FN		18-Sep-03	2		Upst	4	Mackenzie R.	0	
428	NRPK	594	1285		FN		19-Sep-03	2		Upst	5	Mackenzie R.	0	
66	NRPK	604	1580	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
115	NRPK	605	1880		ES	FR	17-Sep-03	1				Mackenzie R.	0	
7	NRPK	606	1705		GN	FR	30-Jul-03	1	2.50			Mackenzie R.	0	
112	NRPK	608	1305		ES	FR	17-Sep-03	1				Mackenzie R.	0	
8	NRPK	627	1800		GN	FR	30-Jul-03	1	2.50			Mackenzie R.	0	
117	NRPK	635	1840		ES	FR	17-Sep-03	1				Mackenzie R.	0	
888	NRPK	650	1845	14	GN		21-Sep-03	15				Mackenzie R.	1	ST = 0
905	NRPK	650	2410	14	GN		21-Sep-03	14				Mackenzie R.	1	ST = 10 (BURB)
437	NRPK	655	1705		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
525	NRPK	656	2385		GN		20-Sep-03	13				Mackenzie R.	0	
421	NRPK	657	1750		FN		18-Sep-03	2		Dnst	4	Mackenzie R.	0	
427	NRPK	668	1770		FN		19-Sep-03	2		Upst	5	Mackenzie R.	0	
21	NRPK	672	2045		GN	FR	31-Jul-03	5	3.50			Mackenzie R.	0	
54	NRPK	680	2410		FN	FR	2-Aug-03	1			2	Mackenzie R.	0	
889	NRPK	680	2695	14	GN		21-Sep-03	15				Mackenzie R.	1	ST = 20 (LKWH)
500	NRPK	697	1550		FN		20-Sep-03	2		Dnst	6	Mackenzie R.	0	
88	NRPK	698	1805		FN	FR	3-Aug-03	1			3	Mackenzie R.	0	Skinny
420	NRPK	715	2520		FN		18-Sep-03	2		Upst	4	Mackenzie R.	0	
116	NRPK	720	2825		ES	FR	17-Sep-03	1				Mackenzie R.	0	
436	NRPK	722	2200		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
435	NRPK	729	3060		FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
505	NRPK	733	2405		FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
907	NRPK	735	3330	14	GN		21-Sep-03	14				Mackenzie R.	1	ST =20 (BURB)
904	NRPK	740	2265	14	GN		21-Sep-03	14				Mackenzie R.	1	ST = 0
524	NRPK	764	3675		GN	FR	20-Sep-03	13				Mackenzie R.	0	
173	NRPK	765	3170		ES		18-Sep-03	4				Mackenzie R.	0	Tumor on jaw
163	NRPK	802	4475		ES		18-Sep-03	3				Mackenzie R.	0	
523	NRPK	910	3875		GN	FR	20-Sep-03	13				Mackenzie R.	0	
434	NRPK	928	5485		FN	FR	19-Sep-03	2		Dnst	5	Mackenzie R.	0	
123	RNWH	173	65		ES	SC	17-Sep-03	1				Mackenzie R.	0	
111	RNWH	388	790		ES	SC	17-Sep-03	1				Mackenzie R.	0	
124	RNWH	399	825		ES	SC	17-Sep-03	1				Mackenzie R.	0	

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
109	RNWH	410	940		ES	SC	17-Sep-03	1				Mackenzie R.	0	
106	RNWH	412	985	17	ES	OT/SC	17-Sep-03	1				Mackenzie R.	1	
108	RNWH	445	1060	7	ES	OT/SC	17-Sep-03	1				Mackenzie R.	1	
483	SPSH	21			BS		19-Sep-03	7				Mackenzie R.	0	
548	SPSH	21			BS		20-Sep-03	9				Mackenzie R.	0	
585	SPSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
604	SPSH	21			BS		20-Sep-03	10				Mackenzie R.	0	
997	SPSH	21			BS		21-Sep-03	12				Mackenzie R.	0	
623	SPSH	22			BS		20-Sep-03	10				Mackenzie R.	0	
962	SPSH	22			BS		21-Sep-03	11				Mackenzie R.	0	
996	SPSH	22			BS		21-Sep-03	12				Mackenzie R.	0	
199	SPSH	23			BS		17-Sep-03	1				Mackenzie R.	0	
376	SPSH	23			BS		17-Sep-03	3				Mackenzie R.	0	
480	SPSH	23			BS		19-Sep-03	7				Mackenzie R.	0	
482	SPSH	23			BS		19-Sep-03	7				Mackenzie R.	0	
533	SPSH	23			BS		20-Sep-03	9				Mackenzie R.	0	
578	SPSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
602	SPSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
612	SPSH	23			BS		20-Sep-03	10				Mackenzie R.	0	
292	SPSH	24			BS		17-Sep-03	2				Mackenzie R.	0	
477	SPSH	24			BS		19-Sep-03	7				Mackenzie R.	0	
579	SPSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
616	SPSH	24			BS		20-Sep-03	10				Mackenzie R.	0	
994	SPSH	24			BS		21-Sep-03	12				Mackenzie R.	0	
195	SPSH	25			BS		17-Sep-03	1				Mackenzie R.	0	
479	SPSH	25			BS		19-Sep-03	7				Mackenzie R.	0	
586	SPSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
599	SPSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
605	SPSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
613	SPSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
614	SPSH	25			BS		20-Sep-03	10				Mackenzie R.	0	
197	SPSH	26			BS		17-Sep-03	1				Mackenzie R.	0	
204	SPSH	26			BS		17-Sep-03	1				Mackenzie R.	0	
570	SPSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
587	SPSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
628	SPSH	26			BS		20-Sep-03	10				Mackenzie R.	0	
991	SPSH	26			BS		21-Sep-03	12				Mackenzie R.	0	
187	SPSH	27			BS		17-Sep-03	1				Mackenzie R.	0	
189	SPSH	27			BS		17-Sep-03	1				Mackenzie R.	0	
456	SPSH	27			BS		19-Sep-03	5				Mackenzie R.	0	
619	SPSH	27			BS		20-Sep-03	10				Mackenzie R.	0	
185	SPSH	28			BS		17-Sep-03	1				Mackenzie R.	0	
186	SPSH	28			BS		17-Sep-03	1				Mackenzie R.	0	
284	SPSH	28			BS		17-Sep-03	2				Mackenzie R.	0	
452	SPSH	28			BS		19-Sep-03	5				Mackenzie R.	0	
620	SPSH	28			BS		20-Sep-03	10				Mackenzie R.	0	
527	SPSH	29			BS		20-Sep-03	9				Mackenzie R.	0	
293	SPSH	30			BS		17-Sep-03	2				Mackenzie R.	0	
995	SPSH	30			BS		21-Sep-03	12				Mackenzie R.	0	
291	SPSH	31			BS		17-Sep-03	2				Mackenzie R.	0	
288	SPSH	32			BS		17-Sep-03	2				Mackenzie R.	0	
467	SPSH	33			BS		19-Sep-03	5				Mackenzie R.	0	
450	SPSH	34			BS		19-Sep-03	5				Mackenzie R.	0	
282	SPSH	36			BS		17-Sep-03	2				Mackenzie R.	0	
432	SPSH	78			FN		19-Sep-03	2		Dnst	5	Mackenzie R.	0	
425	SPSH	80	5		FN		18-Sep-03	2		Dnst	4	Mackenzie R.	0	
306	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
307	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
308	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
309	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
310	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
311	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
312	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
313	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
314	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
315	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
316	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
317	SPSH				BS		17-Sep-03	2				Mackenzie R.	0	RND
833	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
834	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
835	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
836	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
837	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
838	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
839	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
840	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
841	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
842	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
843	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
844	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
845	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
846	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
847	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
848	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
849	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
850	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
851	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
852	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
853	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
854	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
855	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
856	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
857	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
858	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
859	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
860	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
861	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
862	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND

Table C-1. Raw data for fish captured in the vicinity of the proposed Deh Cho Bridge, 2003.

Sample	Species	Fork Length (mm)	Weight (g)	Sex	Capture Method	Ageing Structure	Date	Site	Mesh Size	Trap		Location	Capture Code	Comments
										Direction	Check #			
863	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
864	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
865	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
866	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
867	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
868	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
869	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
870	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
871	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
872	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
873	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
874	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
875	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
876	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
877	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
878	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
879	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
880	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
881	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
882	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
883	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
884	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
885	SPSH				BS		20-Sep-03	10				Mackenzie R.	0	RND
299	TRPR	21			BS		17-Sep-03	2				Mackenzie R.	0	
301	TRPR	22			BS		17-Sep-03	2				Mackenzie R.	0	
993	TRPR	23			BS		21-Sep-03	12				Mackenzie R.	0	
285	TRPR	24			BS		17-Sep-03	2				Mackenzie R.	0	
281	TRPR	25			BS		17-Sep-03	2				Mackenzie R.	0	
300	TRPR	25			BS		17-Sep-03	2				Mackenzie R.	0	
302	TRPR	27			BS		17-Sep-03	2				Mackenzie R.	0	
303	TRPR	33			BS		17-Sep-03	2				Mackenzie R.	0	
283	TRPR	40			BS		17-Sep-03	2				Mackenzie R.	0	
507	TRPR	55			FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
501	TRPR	56			FN		20-Sep-03	2		Upst	6	Mackenzie R.	0	
304	TRPR				BS		17-Sep-03	2				Mackenzie R.	0	RND
305	TRPR				BS		17-Sep-03	2				Mackenzie R.	0	RND
99	WALL	318	685	14	GN	FR	3-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
75	WALL	387	700	4	GN	FR	2-Aug-03	7	2.50			Mackenzie R.	1	ST = 0
94	WALL	400	675	4	GN	FR	3-Aug-03	8	3.50			Mackenzie R.	1	ST = 5 (fish remains)
41	WALL	405	675		GN	FR	1-Aug-03	8	3.50			Mackenzie R.	1	ST = 20 (pike)
95	WALL	417	800	4	GN	FR	3-Aug-03	8	3.50			Mackenzie R.	1	ST = 0
19	WALL	475	1200		GN	FR	31-Jul-03	5	4.50			Mackenzie R.	0	
57	WALL	517	1470	4	GN	FR	2-Aug-03	10				Mackenzie R.	1	ST = 0
74	WALL	535	1500	4	GN	FR	2-Aug-03	8	3.50			Mackenzie R.	1	ST = 0
46	WALL	540	1805		GN	FR	1-Aug-03	8	3.50			Mackenzie R.	0	
27	WHSC	350	655	4	GN		31-Jul-03	5	3.50			Mackenzie R.	1	ST = 0
125	WHSC	350	605		ES		17-Sep-03	1				Mackenzie R.	0	
93	WHSC	357	755		GN		3-Aug-03	8	3.50			Mackenzie R.	0	
62	WHSC	358	710		GN		2-Aug-03	10				Mackenzie R.	1	
18	WHSC	417	990		GN		31-Jul-03	5	3.50			Mackenzie R.	0	
64	WHSC	420	1305		GN		2-Aug-03	10				Mackenzie R.	1	
155	WHSC	420	975		ES		18-Sep-03	3				Mackenzie R.	0	
24	WHSC	430	1280		GN		31-Jul-03	5	3.50			Mackenzie R.	0	
56	WHSC	435	1340		GN		2-Aug-03	10				Mackenzie R.	0	
137	WHSC	435	1165		ES		18-Sep-03	2				Mackenzie R.	0	
87	WHSC	442	1430		GN		2-Aug-03	8	3.50			Mackenzie R.	0	
63	WHSC	445	1280		GN		2-Aug-03	10				Mackenzie R.	1	
154	WHSC	447	1350		ES		18-Sep-03	3				Mackenzie R.	0	
28	WHSC	449	1266		FN		1-Aug-03	1			1	Mackenzie R.	0	Small Lesion
55	WHSC	452	1460		GN		2-Aug-03	10				Mackenzie R.	0	
43	WHSC	465	1545		GN		1-Aug-03	8	3.50			Mackenzie R.	0	
153	WHSC	465	1740		ES		18-Sep-03	3				Mackenzie R.	0	
42	WHSC	475	1600		GN		1-Aug-03	8	3.50			Mackenzie R.	1	ST = 0
92	WHSC	507	1867		GN		3-Aug-03	8	3.50			Mackenzie R.	0	

Species: For a list of species codes see Table 4.4

Explanation of Codes:

Sex:
1 = male; immature, never spawned before and will not spawn during the coming season
2 = male; maturity questionable due to small gonad size
3 = male; developing, never spawned before but will spawn during the coming season
4 = male; definite gonad development, has spawned before
5 = male; definite gonad development, has spawned before but will not spawn during the coming season
7 = male; gravid, fully developed
8 = male; ripe, milt is extruded by slight pressure on the belly
9 = male; spent, spawning completed but residual milt still present
10 = male; determined by external characteristics
11 = female; immature, never spawned before and will not spawn during the coming season
12 = female; maturity questionable due to small gonad size
13 = female; developing, never spawned before but will spawn during the coming season
14 = female; definite gonad development, has spawned before
15 = female; definite gonad development, has spawned before but will not spawn during the coming season
16 = female; definite gonad development, cannot be determined if it is 13, 14 or 15
17 = female; gravid, fully developed
18 = female; ripe, roe are extruded by slight pressure on the belly
19 = female; spent, spawning completed, resorbtion of residual eggs not yet completed
20 = female; determined by external characteristics

Ageing methods:
SC = scales
FR = fin rays
OT = otoliths

Capture code:
0 = first capture, released
1 = first capture, sacrificed

Capture method:
FN = fyke net
GN = gill net
MT = Minnow trap
BS = beach seine
ES= boat electrofishing

Comments: RND = released no data ST = Stomach contents; number indicates fullness 100% = 20 points (items encountered in brackets)

APPENDIX D

CONSTRUCTION MONITORING PROGRAM

Monitoring Water Quality in the Mackenzie River During Construction of the Deh Cho Bridge – Proposed Work Plan

Introduction

The Deh Cho Bridge Corporation Ltd. (DCBC) of Fort Providence, NT, is currently investigating the construction and operation of a bridge across the Mackenzie River at Km 23 of Highway #3 (Latitude: 61° 15' 45", Longitude: 117° 31' 30"). The proposed bridge would replace the existing ferry and ice bridge crossings, making Highway #3 an all-weather corridor, and creating an uninterrupted link between the City of Yellowknife and southern Canada. The proposed bridge is 1045 m in length and will consist of nine continuous spans, steel girder-concrete deck composite construction. The superstructure will be supported on eight piers constructed in the watercourse and two abutments constructed on approach causeways.

The Mackenzie Valley Land and Water Board and the federal Department of Indian and Northern Affairs, South Mackenzie District (DIAND-SMD) reviewed the water license application for the proposed bridge. As a result of this review, the DCBC was requested to provide a document outlining their approach to monitoring water quality (particularly suspended possible sediment and ammonia loadings into the Mackenzie River) during construction phases with instream components. The main instream activities and associated water quality concerns include:

- Installation of eight instream bridge piers involves the excavation and removal of riverbed materials. Drilled and excavated riverbed materials will be temporarily stored (on the ice if construction occurs during winter, and in a barge if construction occurs during the open-water season). The stored materials will then be disposed of off-site or returned to the river (i.e., controlled monitored release into the main channel). During the temporary storage of riverbed material on barges, excess water will be drained from the barges with the released waters being returned to the river. The rate of the release of runoff waters from the barges can be controlled such that excessive sediment loads are not realized (i.e., below established guideline concentrations). Preliminary data indicate that the clay till underlaying river sediments is not prone to suspension [i.e., no more than 5% of mass is liberated following one minute laboratory shake tests (Ed Hoeve, EBA Engineering Consultants Ltd., Yellowknife, NT, personal communication)]. Thus, the controlled release of runoff water from barges containing clay till should be easy to manage. Installation and removal of the sheet-pile cofferdams, release of sediment-laden water contained by the cofferdams, and controlled disposal of excavated materials into the river (should this occur) will introduce sediments into the river.

- The bridge approaches will utilize existing ferry causeways, although some modifications will be required (north and south causeways widened, south causeway extended, north causeway shortened). Excavation and subsequent placement of materials will result in the release of suspended sediment into the river. In addition, ammonia may be introduced to the watercourse as a result of explosive residues leaching from recently blasted rock placed into the river. The construction and subsequent removal of a detour access road on the west perimeter of the north causeway also will facilitate the release of sediments and ammonia into the Mackenzie River.

- Seepage and other sources of water will be pumped out of each pier cofferdam. Some of this water may come in contact with fresh concrete used to construct the piers and footings. Fresh concrete is typically alkaline (i.e., high pH), thereby potentially affecting waters that have contacted it. During pier construction, all waters pumped from cofferdams will be monitored for pH and, where necessary, neutralized with the use an approved, environmentally benign agent prior to release.

- Blasted rock will be used for fill and armouring material on various aspects of the bridge. The regulatory agencies have indicated some concern with respect to possible elevated levels of regulated metals (e.g., arsenic, lead) in the rock. DCBC commissioned a geochemical assessment of limestone from three quarries in the project area; heavy metal concentrations were found to be well below levels established for regulated metals. Additional sampling will be carried out as required (i.e., for rock originating from sources other than tested or at the request of the regulatory agencies).

Monitoring can be applied at a wide range of levels (i.e., synoptic to detailed). The level of effort selected for implementation depends on the desired results (comprehensiveness, reliability of data, etc.) and the level of funding available. In the present work, we have focused our efforts largely at monitoring the effects (and safeguards) specific areas and sites that have been identified as, or are suspected to be, important sensitive fish habitats. These habitats are located in nearshore areas along both the north and south banks. Given the high flow volume and the relatively deep/high velocity conditions in much of the main channel (which will result in a rapid flushing and dilution of sediment and ammonia) we recommend a synoptic level program for this zone (e.g., sampling of selected instream pier construction events). In order to capture a wide range of construction activities and events while keeping costs reasonable, the sampling strategy would incorporate a stratified sampling regime.

OBJECTIVES

The main objectives of the water quality monitoring program are as follows:

- To monitor total suspended sediment (TSS) and ammonia concentrations in the vicinity of the crossing according to a spatially (crossing, upstream and downstream) and temporally (sampling periods during major construction events and different seasons) stratified sampling regime.

- To provide timely feedback on sediment and ammonia concentrations to construction managers, thus allowing adjustment to construction activity (i.e., to minimize/mitigate potential effect on the aquatic environment).

- To establish the distance of downstream sediment and ammonia travel with particular reference to the loadings reaching aquatic habitats of known or potentially high fisheries value or sensitivity.

- To assess the impacts of suspended sediment and ammonia on fish populations, benthic macroinvertebrates, and aquatic habitat based on concentrations recorded and a summary of key published scientific literature.

APPROACH

Due to the large size of the river, and the requirement for representative sampling at widely spaced locations, the monitoring program would be most effectively conducted using two, 2-person crews (i.e., four individuals including two specifically trained and two local assistants).

Two boats (18' Lunds with minimum 25 hp outboards) would be utilized during the open-water season, whereas four snow machines and ice augers will be required during the winter. One of the crew members would be a project biologist who would be responsible for overall coordination of the monitoring program. Specific duties of the project biologist, however, include a Safety Watch role (i.e., in constant site to site communication with the boat crews, implementation of a rescue program if necessary), providing a liaison between the construction supervisors and the monitoring team (i.e., provide advice and feedback as required, logging construction activities for correlation to the sediment and ammonia data), and participating in the sampling program.

Due to the extended duration of the construction period, field sampling effort will be stratified. This will involve representative sampling in the major construction phases: excavation and infilling of causeway approaches, placement and removal of cofferdams, etc. Representative sampling also will be required during critical fisheries periods (e.g., spring and fall spawning periods) or when construction activity occurs in close proximity to valued fish habitats. Close contact will be maintained with DCBC field personnel and construction contractors to optimize the timing of the sampling/monitoring events.

RATIONALE

Preliminary habitat surveys indicate that the Mackenzie River in the vicinity of the existing ferry crossing can be characterized, on a gross level, as: rapidly flowing deep-run habitat in the main channel bracketed by nearshore, backwater habitats that receive protection from natural spur-like structures (peninsulas) and the ferry causeways, and discrete riffle/run habitats positioned off the tip of the peninsulas. As a consequence, instream construction activities that are nearshore (e.g., modification of causeway approaches) are likely to have a greater influence on fish and habitat resources than main channel (e.g., instream piers) construction. This is partly due to fish being able to utilize nearshore habitats for holding, rearing, and spawning and the fact that any materials entering the mainstem thalweg are expected to be quickly dispersed downstream and diluted. As such, monitoring pier construction activities is anticipated to result in sediment loadings that will be difficult to detect, with the possible exception of the piers located nearest the north and south shorelines.

The Mackenzie River is used by residents of Fort Providence for domestic fishing. Furthermore, the town's drinking water is drawn from the river; the intake pipe is approximately 11 km downstream of the proposed bridge. To address concerns that citizens of Fort Providence and DIAND-SMD will likely have, it is recommended that the monitoring program include important fishing areas and Fort Providence's water intake.

Based on the above, the monitoring program would include the following sampling locations and construction events:

- The program would focus on the construction of the two outside piers (i.e., the northern and southern-most piers). These piers are situated nearest to important/sensitive fish habitat (the nearshore backwater areas and riffle-run complexes which may be used for spawning and rearing by key species such as northern pike and lake whitefish.

- A sub-set of the remaining pier structures (i.e., one or two) will be monitored. Should results indicate negligible effects to the aquatic environment, monitoring during construction of the remaining piers will not be carried out. However, if monitoring proves to be useful (i.e., detectable sediment loads and ability to provide feedback to construction crews), a decision could be made (based on preliminary data, and following discussions with the DCBC and the regulatory authorities) as to continue or suspend main channel monitoring.

- Pier construction will be monitored for suspended sediment and ammonia. The water pumped from the coffer dams will be tested and treated to balance pH levels prior to release. Since blasted rock will be used to develop protective aprons around instream piers ammonia monitoring will be required (i.e., ammonia from explosive residues).

- Habitats in the vicinity of the approach causeways will be monitored during all construction phases (for suspended sediments and ammonia) due to their high fisheries value and depositional nature (i.e., tendency to collect and store sediment).

- The sampling design will include upstream reference areas (e.g., 100 to 500 m upstream of construction zones) and appropriate downstream reaches and locations, as follows:

  - ***Piers*** - downstream sampling locations will be established based on site-specific channel and flow features and observations by field crew members, but will likely involve sampling within observed or anticipated sediment plumes at 100 m, 500 m, and 1000 m downstream.

  - ***Approach Causeways*** – on both the north and south sides, upstream reference samples should be collected from a typical backwater habitat and riffle-run complex; downstream sites should include at least two backwater and two riffle-run habitats.

  - ***Fort Providence Water Intake*** – one monitoring location should be established immediately upstream of the town's water intake manifold.

  - ***Areas of Domestic Fisheries*** **–** monitoring sites should be established in known domestic fishing areas.

METHODOLOGY

Coordination (DCBC, Contractors, and Field Staff)

The importance of effective and timely communication between the fisheries consultant, DCBC (office and on-site), and construction supervisors is recognized. This will ensure that monitoring is completed in a professional and safe manner and the data collected meets the requirements of the client and regulatory agencies. The monitoring contractor is expected to provide the following services:

- Pre-construction meetings at the crossing site with the DCBC field supervisor and the contractor to discuss the day-to-day operations at the site and establishment of a meeting schedule (e.g., daily tail-gate meetings to discuss progress, problems, and safety concerns).

- The monitoring field crew will be equipped with a satellite telephone and site-to-site communications systems (two-way radios). As such, they will be in close communication with the DCBC staff (office/field), construction contractors, and the monitoring contractor's home office.

- An experienced Project Biologist, with bridge construction and sediment monitoring experience, should be on-site at the bridge location during major construction events (e.g., pier and approach causeway construction) to record a detailed log of construction activities as they pertain to the downstream sediment and ammonia monitoring and to advise the contractor/client on fisheries mitigation issues as required.

Field Sampling

It should be stressed that the actual locations of monitoring sites will be adjusted in the field as necessary and will take into consideration stream and habitat configuration, water depth, current velocity and turbulence, site access, and worker safety. An attempt will be made to determine the maximum linear extent of sediment and ammonia transport; however, since fine particles such as silt and clay can travel substantial distances, particularly if entrained in the main channel thalweg, this may not be practical. In this case, downstream sample sites should be established at areas of greatest impact on aquatic resources or of human interest (e.g., high quality holding, potential spawning, and rearing habitats; immediately upstream of Fort Providence's water intake).

Initially, a turbidity/TSS relationship (turbidity is positively correlated to TSS concentrations for a given waterbody and is typically used as a surrogate during field monitoring programs; see below) will be developed for the bridge project area and will be used to calculate TSS values from turbidity data and aid in locating affected river reaches (e.g., distance downstream at which the sediment guidelines of above federal guidelines are no longer exceeded). This relationship will be derived from data historically collected at the present crossing area; however, a sufficient number and range of TSS samples will need to be collected during the proposed monitoring program for further refinement of the turbidity/TSS relationship.

Frequency of Sampling

As outlined in above, sampling events will be stratified and will cover the main instream construction events at the crossing. Sampling has been based on a 12 h day for four crew members. During each sampling event, the frequency of sampling will depend on such factors as instream activity at the crossing and the linear spread of the sediment and ammonia plumes. Sampling at one-hour intervals is expected at most locations; however, the first downstream locations will be sampled more frequently since sediment and ammonia increases will presumably be greatest at such locations and the duration of the sediment episode will be more rapid than at downstream sites. At minimum, the upstream control (reference) sites will be sampled three times per day (morning, mid-day, evening).

Suspended Sediment Sampling

Turbidity will be recorded to provide a surrogate measurement of TSS, since turbidity is more readily measured in the field. A relationship between the two variables will be derived (e.g., linear regression) using data from a subset of samples sent to a commercial lab for analysis of suspended solids. This relationship will then be used to predict TSS values on-site given the turbidity values. Samples will be analyzed using a portable turbidity meter.

Water samples for turbidity analysis will be collected using either a hand-held (shallow water habitats) or a hand line/winch operated, depth-integrated sediment sampler (deep water areas or areas of greater velocity). Depth-integrated sediment sampling is method used by the Water Survey of Canada.

For quality assurance/quality control (QA/QC) purposes, replicate sampling will be undertaken and will consist of two components. Triplicate turbidity measurements will be taken from 10% of all samples collected. Triplicate water samples will also be taken for 10% of each sampling event and turbidity will be measured for each sample.

Turbidity values will be determined for each vertical haul and can be reported as a mean for each potential transect monitored. Total Suspended Sediment will generally be reported as a mean value; however, the use of weighted averages will be investigated.

Bridge construction may be during any part of the year and instream activities will occur at any time, except for periods in the early spring and early winter when ice flows are considerable. Close communication will be maintained with the construction crew and DCBC personnel prior to the commencement of the sampling program, to obtain updates on ice conditions. In the event that ice cover is still present at the time of initiation of sampling a modified program will be implemented. If ice cover permits, an ice auger will be used to drill transect holes for collection of water samples. Access to sampling sites will be made with the use of snow machines. Due to safety concerns, should monitoring programs be required during ice break-up or early winter ice flow periods, sampling would be limited to near shore areas (i.e., grab samples) and locations.

Ammonia Sampling

It is not known whether or not the ammonia content of blasted rock will be high enough to considerably affect aquatic habitats of the Mackenzie River (see Potential Impacts section). To evaluate this situation, representative rock samples from existing rock in the ferry approaches and from blasted rock imported to the construction sites should be collected and submitted to an analytical laboratory for ammonia analyses. The laboratory would test for the presence of ammonia leachate (shake flask extraction test) in the rock samples. Should the laboratory results and the initial field monitoring results indicate that ammonia levels are negligible or of no concern to aquatic life, a decision would be made to suspend or significantly reduce the scope of the ammonia sampling program. This decision would be made only after a thorough review of the preliminary data and following discussions with the DCBC and the regulatory authorities

Initially, the sampling program for ammonia will be similar to that described above for TSS; however, ammonia will be analysed only when blasted rock materials are disturbed or introduced into the Mackenzie River. In the field, ammonia concentrations will be determined with the use of portable singe-parameter test kits. A representative number of samples from both the river and the blasted rock material will be collected and submitted to an analytical laboratory to verify: a) the presence of ammonia in blasted rock, and b) field data collections. A field QA/QC program for ammonia will be developed similar to that described above for TSS.

Total Suspended Solids (TSS) and Ammonia Determination and Relevant Guidelines

Analysis of TSS and ammonia will be conducted at a commercial laboratory. To obtain an accurate relationship between TSS and turbidity, samples that span the entire range of measured turbidities will be collected and analyzed (minimum of 30 samples per season).

Current federal TSS water quality guidelines for the protection of aquatic (freshwater) life (CCME 1999) are as follows:

- Total Suspended Sediment (TSS) guidelines

  1) Clear flow conditions (TSS ≤ 25 mg/L)

    a) short-term exposure (≤ 24 h); levels not to exceed 25 mg/L above background.

    b) long-term exposure (24 h – 30 d); levels not to exceed 5 mg/L above background.

  2) High flow conditions (TSS 25 – 250 mg/L)
  maximum allowable increase of 25 m/L above background.

  3) Highflow conditions (TSS > 250 mg/L)
  maximum allowable increase of not more than 10% above background.

Current federal ammonia water quality guidelines for the protection of aquatic (freshwater) life are fairly complex, in comparison to TSS guidelines. Although ammonia guideline concentrations are dependent on ambient pH and water temperature, recommended maximum concentrations generally vary between 1.0 and 25 mg/L for most surface waters (CCME 1999). The maximum ammonia concentration for the Deh Cho Bridge will be established based upon a review of background water quality data and site-specific pH and temperature levels during monitoring periods. For example, total ammonia concentrations should not exceed 0.499 mg/L at a temperature of 20°C and pH of 8.0 and should not exceed 7.32 mg/L at a temperature of 0°C and pH of 7.5 (i.e., conditions expected in the Mackenzie River).

These guidelines will be used to track the sediment and ammonia loading events for reporting purposes (i.e., post-field data collections) and to comment on the linear and aerial extent downstream of various bridge construction phases that the existing guidelines are exceeded. Comparisons of TSS data collected at the bridge crossing and guideline values will be based on calculated values for TSS (i.e., the majority of TSS values will be derived from the turbidity/TSS relationship).

Sediment Deposition Monitoring (Optional)

Measurement of sediment deposition can be achieved using a variety of methods including substrate sampling, sediment traps, and visual analyses. The feasibility (and necessity) of quantifying sediment deposition will be assessed following a detailed review of the site conditions an the results of the fisheries impact assessment. The methods which will be considered are outlined below.

To assess substrate composition for size distribution and percent of fine material, a core sampler may be used. The sediments and water collected are strained through a series of sieves to determine the particle size distribution and percent fines.

A second option to assess sediment deposition involves the use of sediment traps which would be placed in valued fish habitats (e.g., riffle-run areas potentially used for spawning by lake whitefish), including the upstream control (minimum of five per transect). Each trap would be buried flush with the surface of the stream bed. Traps would be installed prior to instream construction activities and would be removed at the end of the sampling program for particle-size analysis and determination of fine material accumulation. While this technique works well in many situations, it is thought that its applicability to the present crossing may be limited due to the large size of the river (i.e., deep, high velocity channel) and high percentage of fine materials in the substrate. Use of this method will be evaluated further following a more detailed review of the construction plans and a field test.

Visual analyses such as embeddedness rates the degree that the larger particles (e.g., gravel, cobble) are surrounded or covered by fine sediment. The rating is a measurement of how much of the surface and interstitial area of the larger size particles is covered by fine sediment. Embeddedness ratings would be taken at several locations before and after construction activities.

Other Parameters

Water velocity (mean column velocity) will be measured during the sampling periods at the various monitoring sites established. Discharge data will be obtained from Water Survey of Canada. Water temperature will be recorded continuously with a thermograph; the data can then be correlated to potential spawning activity by key fish species in the area. In addition, daily water temperatures will be measured with a pocket thermometer and recorded (particularly required for establishment of ammonia criteria). Conductivity, pH, dissolved oxygen will be measured daily at monitoring locations both upstream and downstream of the crossing; measurements also will be taken in the thalweg and at several points across the channel.

Potential Impacts on Aquatic Life and Habitat

TSS

The effects of introduced suspended sediment on fish are many and varied, ranging from direct mortality (in extreme cases) to various sub-lethal effects including: habitat avoidance and redistribution, reduced feeding and growth, respiratory impairment, and reduced tolerance to disease (Waters 1995). Deposited sediment has the potential to alter the diversity and density of benthic macroinvertebrates (a major food source for stream-dwelling fish populations) and reduce habitat suitability for a range of critical life-requisite functions (e.g., spawning, incubation of eggs, rearing, overwintering). It is generally accepted that the severity of effects of suspended sediment pollution on fish increases as a function of sediment concentration and duration of exposure, or dose (the product of concentration and exposure time).

Since a determination of the potential impacts on aquatic life and habitat are objectives of the monitoring program, the assessment will relate the turbidity/TSS data collected as well as effects documented in the scientific literature. It is recommended that the results of previous investigations regarding fish species presence and abundance in the Deh Cho Bridge study area be consulted when using assessing potential effects of sediment loading.

Ammonia

It was determined from reviewing toxicity and exposure data that freshwater organisms are most at risk from releases of ammonia in the aquatic environment. Rainbow trout, freshwater shrimp, walleye, mountain whitefish, and fingernail clams were identified as species with higher sensitivity to ammonia. Of these organisms, freshwater shrimp, walleye, and several whitefish species are present in the study area. Aquatic insects and micro-crustaceans are more resistant to ammonia, although there is a large variation in sensitivity within aquatic insects (Environment Canada and Health Canada 2001).

The ecological impact of ammonia in aquatic ecosystems is likely to occur through chronic toxicity to fish and benthic invertebrate populations as a result of reduced reproductive capacity and reduced growth of young. These are subtle impacts that will likely not be noticed for some distance below an outfall. The zone of impact varies greatly with discharge conditions, river flow rate, temperature, and pH. Under estimated average conditions, some municipal wastewater discharges could be harmful for 10 to 20 km. Severe disruption of the benthic flora and fauna has been noted below municipal wastewater discharges. Recovery may not occur for many (20 to 100) kilometres. It is not clear whether these impacts are solely from ammonia or from a combination of factors, but ammonia is a major, potentially harmful constituent of municipal wastewater effluents (Environment Canada and Health Canada 2001).

The issue of ammonia residue from blasted rock is likely not to be of concern in relation to the construction of the Deh Cho Bridge in the Mackenzie River. Although ammonia can be toxic, it is unlikely to be a problem in this situation. While Environment Canada and Health Canada (2001) clearly states that freshwater may be potentially affected, the toxicity concerns are focused primarily on the municipal sewage treatment facilities that produce ammonia in substantial quantities and on a continual basis. The report also mentioned that they had concerns with some of the industrial operations (e.g., intensive livestock operations). There was no mention in the synopsis report of concerns associated with ammonia residues in riprap or other rock material. The report also noted that the degree of toxicity is strongly dependent on several key factors in the receiving water body, including:

- dilutional capacity (the greater the flows the lower the concern);
- water temperature (the lower the water temperature the lower the concern);
- pH (lower concern at basic pH values); and,
- dissolved oxygen (higher dissolved oxygen results in rapid decline in ammonia concentrations).

Environment Canada and Health Canada (2001) also indicated that ammonia toxicity was more of a problem in southern regions of Canada (presumably due to higher prevailing water temperatures). In the end, it is unlikely that ammonia will be a problem in the Deh Cho Bridge study area, for a number of reasons: high flow through (dilutional capacity), generally low water temperatures, high dissolved oxygen content of the river and the potential inputs associated with bridge construction represents a one time exposure.

REPORTING

The report will summarize (in tabular form) the turbidity, ammonia, and velocity data for the various monitoring locations. The site-specific relationship between turbidity and TSS for the Mackenzie River will be determined using linear regression. This relationship (and its associated mathematical equation) will be represented graphically. The equation will be used to calculate TSS values for recorded turbidity measurements.

Data on TSS and ammonia concentrations at the various locations over the duration of the study period will be presented both in tabular and graphic form and a linkage of the TSS regime to individual construction events will be described. Comparison of the data collected with federal water quality guidelines will be conducted. The downstream extent of sediment and ammonia transport will be determined to the extent feasible (i.e., for TSS it will be based on travel of larger particle sizes; not wash-load component).

A literature review of potential effects of the bridge crossing due to suspended sediment and sediment deposition, and ammonia loadings on aquatic biota will be conducted. It will concentrate on key sport fish species (e.g., whitefish species, Arctic grayling, northern pike, and walleye). The potential effects of TSS will take into consideration sediment concentration and duration. The potential effects of ammonia will include a review of the scientific literature in comparison with results obtained.

LITERATURE CITED

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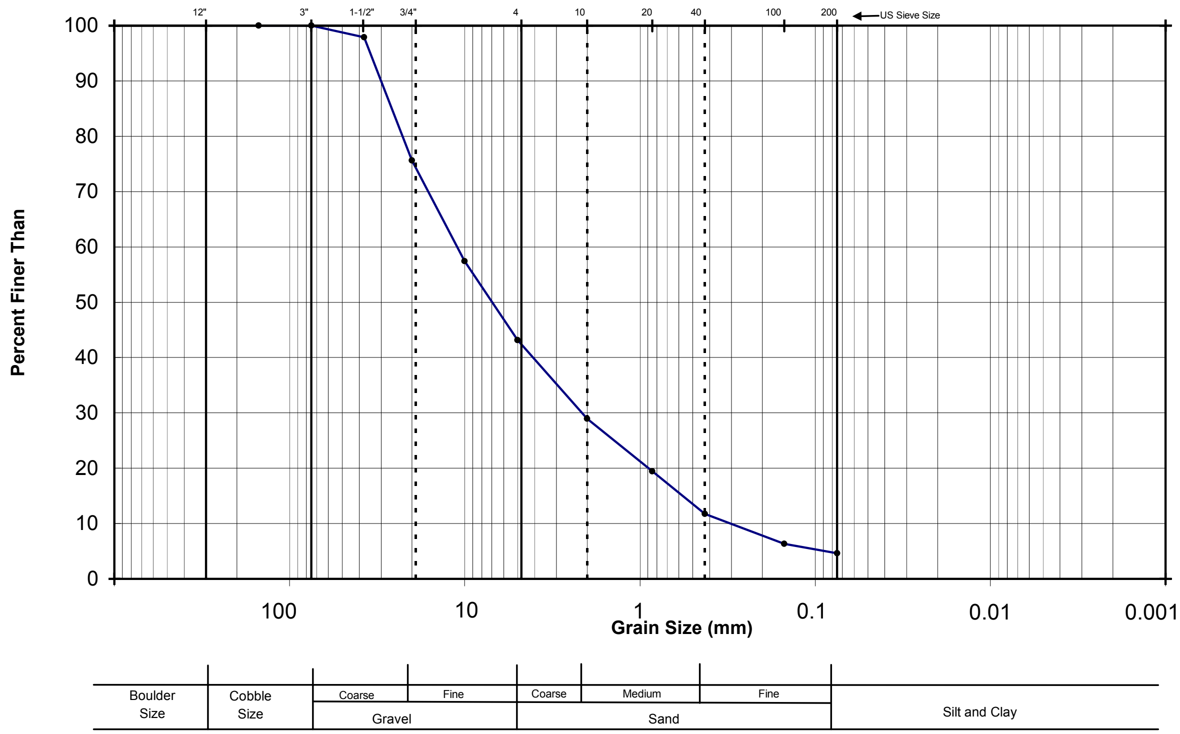
APPENDIX E

SEDIMENT TRANSPORT

Golder Associates

PARTICLE SIZE ANALYSIS OF SOIL
(ASTM D422)

Project No.: 03-1370-021 Lab No.: 538101
Project Title: Jivko/Mackenzie Bridge/NT
Borehole: - Sample No.: North Ferry
Depth: -
Date Tested: 14-Oct-03 By: SH



Diameter of Sieve (mm)	Percent Passing (%)
150.000	100.0
75.000	100.0
37.500	97.9
20.000	75.6
10.000	57.4
5.000	43.2
2.000	29.0
0.850	19.5
0.425	11.8
0.150	6.4
0.075	4.7

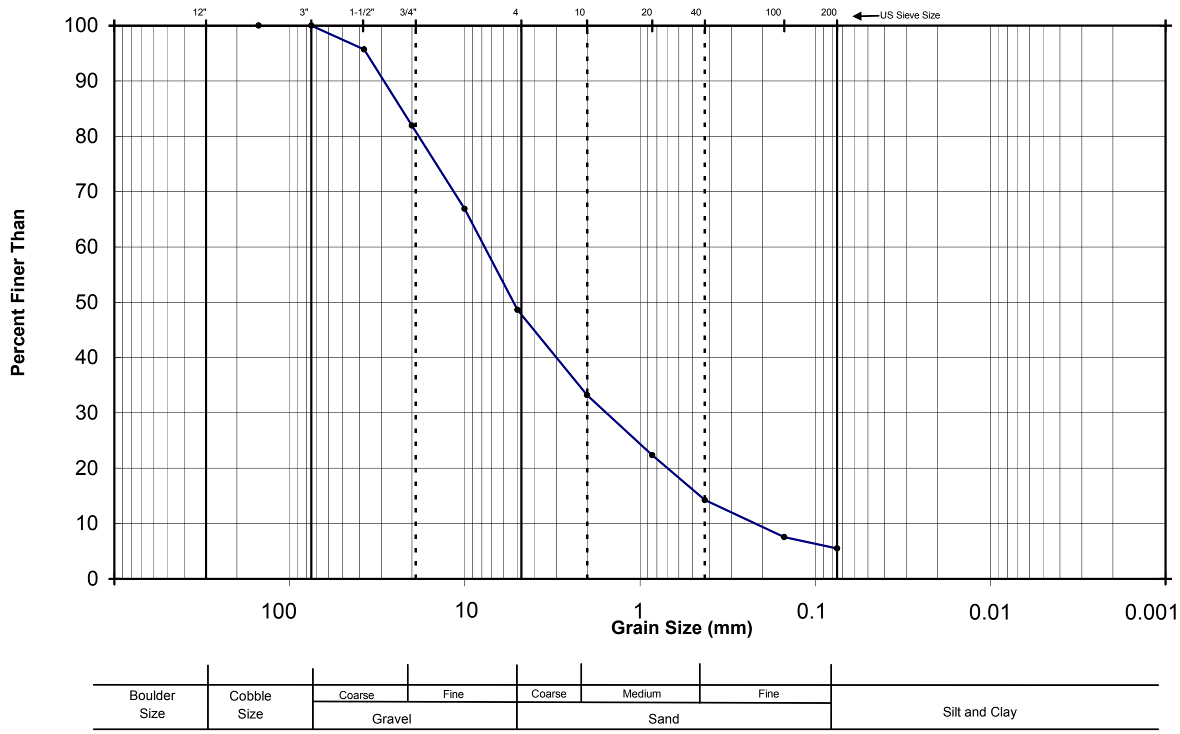
Comments/Limits:

Figure E-1. Grain Size Analysis of Silty Gravel Fill Material from North Ferry Stockpile

Golder Associates

PARTICLE SIZE ANALYSIS OF SOIL
(ASTM D422)

Project No.:	03-1370-021	Lab No.:	538102
Project Title:	Jivko/Mackenzie Bridge/NT		
Borehole:	-	Sample No.:	South Ferry
Depth:	-		
Date Tested:	14-Oct-03	By:	SH



Diameter of Sieve (mm)	Percent Passing (%)
150.000	100.0
75.000	100.0
37.500	95.7
20.000	82.0
10.000	66.9
5.000	48.6
2.000	33.2
0.850	22.4
0.425	14.3
0.150	7.5
0.075	5.5

Comments/Limits:

Figure E-2. Grain Size Analysis of Silty Gravel Fill Material from North Ferry Stockpile

APPENDIX F

WILDLIFE ISSUES MEMORANDUM

MEMORANDUM

10525 – 170th Street
Edmonton, Alberta, Canada
T5P 4W2

Golder Associates Ltd.
Telephone No.: 780-483-3499
Fax No.: 780-483-1574

DATE: November 10, 2003 03-1370-021

TO: Mr. Jivko Jivkov, JIVKO Engineering, Yellowknife, NT

FROM: Corey De La Mare, Mark Dunnigan and Jim O'Neil

RE: Wildlife Issues Related to the proposed Deh Cho Bridge on the Mackenzie River near Fort Providence.

During the regulatory review process for the proposed Deh Cho Bridge Project, the following wildlife-related issues were identified:

- interaction of wildlife with infrastructure (i.e., bridge structure itself and associated lighting); and,
- creation of bird nesting habitat, and subsequent conflicts with maintenance/operations;

The remainder of this document discusses these issues in the context of the proposed bridge and outlines potential mitigation strategies.

Interaction of Wildlife with Infrastructure

The proposed Deh Cho Bridge may affect aerial wildlife (e.g., waterfowl, raptors, songbirds and bats) by impeding flight patterns resulting in strikes, and by associated lighting which may act as an attractant during migration periods. Structures (e.g., bridges, towers, poles, associated overhead powerlines and other vertical towers) may lead to bird or bat strikes, especially during migration under adverse weather conditions, such as fog, and during night feeding.

Many species of birds, especially small insect-eaters, migrate at night (FLAP 2000). Navigational tools used by birds include the constellations. Thus, birds are attracted to illuminated towers, stacks and other tall structures such as bridges. These lighted structures may cause birds to become confused or to strike the structure. Bird strikes occur most often during spring and fall migration when large flocks of birds are moving, especially during inclement weather (e.g., fog, rain and low cloud) (Blokpoel and Hatch 1976; Avery et al. 1977). When there is low cloud ceiling or foggy conditions, lights on towers refract off water particles in the air creating an illuminated area (Towerkill 2003).

Strikes may occur to a variety of birds, including songbirds, waterbirds and raptors. It is anticipated that with effective mitigation strategies negative effects can be minimized.

Bridge and Nesting Habitat

The proposed bridge, once constructed, will provide potential nesting habitat for species such as pigeons, raptors and in particular swallows. Although, the provision of nesting habitat as a result of the construction of the bridge is not an issue, nesting birds may hinder maintenance operations during breeding months (May-July), particularly for communal nesters such as swallows. Visual maintenance operations are likely unobtrusive, and will not require detailed mitigation strategies. It is anticipated that with effective mitigation strategies, the effects of intensive maintenance operations on nesting birds will be minimized.

Mitigation

Mitigation measures that will minimize the effects of wildlife interactions with infrastructure resulting from construction and operation of the Deh Cho Bridge include the following:

Interaction of Wildlife with Infrastructure

- markers, such as aviation spheres, can be used to mark suspension lines guy wires and appropriate infrastructure;
- the use of solid red or pulsating red lights should be avoided (USDOI 2000);
- use the minimum number of lights required with the following specifications (FLAP 2003):
    - solid backing or down-shielded to keep light within the boundaries of the bridge deck;
    - lights directed downwards towards the bridge deck; and
    - use lighting with the minimum intensity necessary to meet lightng objectives.

Bridge and Nesting Habitat

- ensure visual inspections are as unobtrusive as possible, particularly during the breeding season;
- restrict any obtrusive mechanical inspections and maintenance until after the breeding season (15 May-15 July); and

- during years of intensive maintenance, prevent nesting of species, if required, through strategies such as visual deterrents or surface gels.

Closure

We trust this document meets your needs, should you require any further information or have any questions please feel free to contact either of the undersigned at 780-483-3499.

Prepared By:	Reviewed By:
Corey De La Mare, P. Biol. Terrestrial Ecologist	Jim O’Neil, P. Biol. Principal, Senior Fisheries Biologist

References

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