Hamlet of Tuktoyaktuk, Town of Inuvik
Government of Northwest Territories

ISSUED FOR USE

RESPONSE TO THE MAY 25, 2012 DIRECTIVES FROM THE ENVIRONMENTAL IMPACT REVIEW BOARD FOR CONSTRUCTION OF THE INUVIK TO TUKTOYAKTUK HIGHWAY, NWT

EIRB FILE NO. 02/10-05

July 13, 2012

ACRONYMS

CEAA	Canadian Environmental Assessment Act
DOT	Department of Transportation (GNWT)
EIRB	Environmental Impact Review Board
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENR	Environment and Natural Resources
GNWT	Government of the Northwest Territories
HTC	Hunters and Trappers Committee
IFA	Inuvialuit Final Agreement, as Amended April 2005
IR	Information Request
ILA	Inuvialuit Land Administration
ISR	Inuvialuit Settlement Region

The Developers of the proposed Inuvik to Tuktoyaktuk Highway are pleased to provide responses to the six remaining Directives (1, 2, 5-8) issued by the Environmental Impact Review Board on May 25, 2012. Responses to Directive 4 (Information Requests #147 to #152) and Directive 5 (updating the socio-economic effects assessment with 2011 census data) were previously provided to the EIRB on June 11, 2012 and June 7, 2012, respectively.

The Developers' responses are included after each Directive. Please note that new tables or figures, created for the Directives are numbered according to their respective IR Number. Any tables or figures from the EIS or previous response documents have retained their original number.

Directive 1:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will provide to the Review Board printed and digital copies of draft and final reports identified in Table 1 [of Appendix 1, Directives] as soon as they are available.

Developer Response 1:

The Developer has committed and continues to commit to providing the EIRB with printed and digital copies of final (and/or draft) reports as identified in Table 1, according to the timeline discussed at the June 15, 2012 meeting with the EIRB in Yellowknife, NWT. Table 1 shown in Appendix 1 of the Directives, lists study programs and reports scheduled to be conducted in 2012.

Table 1, shown below, summarizes the list of reports scheduled for 2012 and identifies if the draft or final report has been submitted at this time. As discussed at the June 15, 2012 meeting, the EIRB agreed to accept draft reports to allow the technical and public hearings to proceed, with the final report to follow.

TABLE 1 – PROGRAM REPORTS SUBMITTED TO THE EIRB

Program	Submitted to the EIRB	
	Draft	Final
Traditional Knowledge/ Traditional Land Use Report		✓
Vegetation Baseline Report	✓	
Wildlife Habitat Suitability Report	✓	
Water Source Report: Bathymetric Mapping and Allowable Water Quantity Withdrawal	(likely to be submitted in August)	
Geotechnical Drilling Report	(likely to be submitted in August)	

Directive 2:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will, on the basis of the new information in the reports identified in Table 1, re-examine all impact predictions and indicate where any initial predictions should be changed and where such a change is made explain it and indicate whether the newly predicted impacts are significant or not. The Developer will identify and explain how proposed mitigation measures have changed, or any new mitigation measures have been developed, based on the new information. Where impact predictions have changed based on the new information, the Developer will identify and explain how the mitigation measures may have changed.

Developer Response 2:

The response to this Directive will be forthcoming, upon completion of the reports identified in Table 1 of Directive 1. However, based upon our preliminary review of the documents already submitted and updates from the studies in progress, the Developer does not expect any significant changes to the Developer's impact predictions nor any newly predicted impacts as a result of these studies.

Directive 3:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will provide for each proposed Plan identified in Table 2 sufficient information on the Plan details to enable the Review Board, in conducting its review of the Plans, to understand and evaluate the effectiveness of their contribution to the mitigation of impacts predicted in the EIS.

Developer Response 3:

As discussed at the June 15, 2012 meeting with the EIRB, the Developer is pleased to provide additional information regarding each of the plans shown in Table 2. Much of this information has been provided previously, but is provided again for ease of use.

Spill Contingency Plan

Appendix E-1 of the EIS includes INAC's (2007) Guidelines for Spill Contingency Planning. Section 3.7 and Appendix A of Appendix E-2 of the EIS describes fuel and oil management and provides a typical example of a spill response plan.

Appendix B of INAC's[1] (2007) Guidelines for Spill Contingency Planning lists the table of contents for an example spill contingency plan. The Table of Contents is as follows:

1.0 Introduction and Project Details
- 1.1 Company name, site name, site location and mailing address
- 1.2 Effective date of spill contingency plans
- 1.3 Last revisions to spill contingency plans
- 1.4 Distribution list
- 1.5 Purpose and scope
- 1.6 Company environmental policy
- 1.7 Project description
- 1.8 Site description
- 1.9 List of hazardous materials on-site
  - 1.9.1 amount normally stored and storage capacity
  - 1.9.2 types and number of storage containers
  - 1.9.3 storage location
  - 1.9.4 MSDS's for each material (in Appendices)
- 1.10 Existing preventative measures e.g. secondary containment, fuel handling
- 1.11 Additional copies – how to obtain
- 1.12 Process for staff response to media and public enquiries

[1] http://www.aadnc-aandc.gc.ca/eng/1100100024236

2.0 Response Organization
  2.1 Flow chart of response organization
3.0 Action Plan
  3.1 Potential spill sizes and sources for each hazardous material on site
  3.2 Potential environmental impacts of spill (include worst case scenario)
  3.3 Procedures (include alternative action in case of impeding environmental conditions):
    - Procedures for initial actions
    - Spill reporting procedures
    - Procedures for containing and controlling the spill e.g. on land, water, snow, ice, etc.
    - Procedures for transferring, storing, and managing spill-related wastes
    - Procedures for restoring affected areas
4.0 Resource Inventory – describe all resources available for responding to spills
  4.1 On-site resources e.g. spill kits, booms, sorbent materials, earth moving equipment
  4.2 Off-site resources e.g. contact numbers for deployment and time estimate
5.0 Training Program
  5.1 Outline of training program
  5.2 Training schedule and record keeping

Figures

Figure 1: Site location map (1:50,000 scale)

Figure 2: Sketch of site plan including buildings, roads, water bodies, hazardous material locations, spill kit locations and direction of flow

Figure 3: Flowchart of response organization

Tables

Table 1: List of hazardous materials stored on-site, type and number of storage containers, the normal and maximum storage quantities and storage locations

Table 2: List of hazardous materials, potential discharge events and volumes and direction of flow

Health and Safety Plan

The Developers Response to Information Requests #44.2/3 provided a copy of the Health, Safety and Environment (HSE) Manual and Orientation Package used during construction of the Tuktoyaktuk to Source 177 Road (see Attachment 3 of Response to Information Requests – January 16, 2012).

The HSE Manual was included in the orientation package and provided to every E. Gruben's Transport Ltd. employee and sub-contractor working on the project. Once the package was

received and reviewed, employees were required to sign a form indicating their acceptance of the package and program. Furthermore, regular safety meetings and safety presentations were conducted as an integral part of the Health and Safety Plan. A copy of the presentation is provided in Attachment 1 of this document.

Developer Response #44.2/3 stated that upon approval of the Inuvik to Tuktoyaktuk Highway one or more contractors would be selected and required to produce a similar Health and Safety Manual.

A typical Health and Safety Plan is comprised of the following components:

1.0 Emergency Contact List
2.0 Policy and Leadership
    2.1 Philosophy
    2.2 Mission Statement
    2.3 Corporate Objectives
    2.4 Substance Abuse Policy
    2.5 Roles and Responsibilities
    2.6 Organizational Chart
3.0 Management Involvement and Commitment
    3.1 Health, Safety and Environmental Guiding Principles
    3.2 Health, Safety and Environmental Policy
    3.3 Company Responsibilities
        3.3.1 Management Responsibilities
        3.3.2 Supervisors Responsibilities
        3.3.3 Workers Responsibilities
        3.3.4 Subcontractors Responsibilities
        3.3.5 Visitors Responsibilities
    3.4 Safety Responsibility Evaluation
4.0 Hazard Identification and Risk Control
    4.1 Hazard Identification
    4.2 Observation of Worker Behaviour
    4.3 Observation of Worksite Physical Conditions
    4.4 Inspection
    4.5 First Time Purchase of Hazardous Materials
5.0 Rules and Safe Work Procedures
    5.1 Process for Developing Standard Work Procedures
    5.2 Safety Rules
    5.3 Enforcement
    5.4 Legislative Compliance
    5.5 Harassment Policy
    5.6 Camp Rules
    5.7 Camp Emergency Service Contacts
    5.8 Company Vehicle Policy

5.9 Journey Management
5.10 Abandoned Vehicle Protocol Procedures
5.11 Ice Road Safety
5.12 Cold Weather Operations
5.13 Smoking in the Workplace
5.14 Emergency Response Injury to Worker Chart
5.15 Emergency Response – General Practices
5.16 Radio Emergency Calls
5.17 Fire Response Plan
6.0 Emergency Response and Spill Contingency Plan
6.1 Introduction
6.2 Immediate Response to Emergency Situations
6.2.1 Fire
6.2.2 Vehicle and Equipment Incident
6.2.3 Serious Medical Incident
6.2.4 Wildlife Encounters
6.3 Spill Contingency Plan
6.3.1 Preliminary Requirements
6.3.2 Initial Response Procedures
6.3.3 General Spill Containment Procedures
6.3.4 Spill Adjacent to a Water Body
6.3.5 Spot Spills
6.3.6 Spill Reporting
6.3.7 Reporting Procedure Chain of Events
6.3.8 Spill Kits
6.3.9 NWT Regulatory Agencies
6.3.10 Spill Report Threshold Quantities
7.0 Safety Training
7.1 Certificates
7.2 Employee Files
7.3 On the Job Training
8.0 Communication
8.1 Role of Communication
8.2 Communication Frequency
8.3 Management Communication
8.4 Communication of Expectations
8.5 Types of Communication
9.0 Meetings
9.1 Regular or Start-Up Health, Safety and Environmental Meetings
9.2 Pre-Shift Meetings

9.3 Tailgate Meetings
9.4 Orientations
10.0 Accident/Incident Investigation and Reporting
10.1 Introduction to Investigation and Reporting
10.2 Accident/ Incident Investigation Procedures
10.3 Applying the Incident Sequence Model
10.4 Why Investigate?
10.5 Costs
10.6 Legal Requirements
10.7 Other Benefits of Accident/ Incident Investigation
10.8 What should be Investigated?
10.9 Who should Investigate?
10.10 Reporting of Accidents/ Incidents
10.11 Investigation Preparation
10.12 Investigation Process
11.0 Right to Refuse Unsafe Work
12.0 Return to Work Policy and Procedures

Waste Management Plan/ Hazardous Waste Management Plan

In several of the Developers responses (responses to conformity review by individual agencies, such as AANDC, and the Tuktoyaktuk-Inuvik Working Group), the Developer committed to preparing a waste management plan, which typically includes a hazardous waste management plan, as part of an overall Environmental Management Plan.

There are no specific guidelines for preparing a waste management plan in the ISR; however, the GNWT ENR recommends that a waste management plan clearly state

- The nature and volume of waste and hazardous waste generated,
- How waste will be stored, and transported, as well as,
- The types of facilities they will be transported to.

The hazardous waste section will provide a detailed list of the types of hazardous waste generated. A short list of hazardous waste typically associated with road construction may be,

- Hydrocarbon contaminated soils / snow / water
- Contaminated sorbent material (e.g., rags, filters, pads, floor dry, etc.)
- Batteries
- Used oil
- Waste fuel

- Solvents
- Aerosol cans
- Other compressed gas cylinders (propane tanks, etc.)
- Other wastes specific to the project.

According to the Mackenzie Valley Land and Water Board's[2] (2011) Guidelines for Developing a Waste Management Plan, a waste management plan may contain the following components:

1.0 Introduction
2.0 Identification of Waste Types
3.0 Management of Each Waste Type
4.0 Infrastructure Required for Waste Management

Erosion and Sediment Control Plan

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

As indicated in Section 4.2.4.2 (Water Quality and Quantity – Project Design and Mitigation Measures), "In recognition of the potential adverse effects of sediment, an environmental management plan (EMP) will be prepared prior to construction and submitted to regulators for approval, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment."

There is no standard erosion and sediment control plan for projects in the Northwest Territories. However, the Department of Fisheries and Oceans has standard operating procedures that relate to issues surrounding erosion and sedimentation. Therefore, the erosion and sediment control plans to be developed by the prime ITH construction contractors will refer to appropriate erosion and sediment control guidelines, GNWT erosion and sediment control best management practices (currently being prepared in coordination with DFO), and measures outlined in DFO's[3] (1993) Land Development Guidelines for the Protection of Aquatic Habitat.

Copies of the Erosion and Sediment Control Plan and Drainage Report used by the contractor during construction of the Tuktoyaktuk to Source 177 Road are provided as Attachment 2 of this document.

[2] http://www.mvlwb.ca/WGDocs/MVLWB_Guidelines_Developing_Waste_Mgmt_Plan-Mar2011.pdf
[3] http://www.dfo-mpo.gc.ca/Library/165353.pdf

The following lists the components of a typical erosion and sediment control plan.

1.0 Introduction
- 1.1 Objectives
- 1.2 Regulatory Requirements

2.0 Project Description
- 2.1 Project Activities and Schedule
- 2.2 Construction Equipment
- 2.3 Critical Areas

3.0 Responsibilities and Accountability

4.0 Best Management Practices Selection and Design
- 4.1 Procedural Best Management Practices
  - 4.1.1 Site Access Management
  - 4.1.2 Stockpile Management
  - 4.1.3 Dust Management
  - 4.1.4 Fisheries Considerations
- 4.2 Highway Construction
  - 4.2.1 Water Management
  - 4.2.2 Erosion Control
  - 4.2.3 Sediment Control
- 4.3 Bridge Construction
  - 4.3.1 Water Management
  - 4.3.2 Erosion Control
  - 4.3.3 Sediment Control
- 4.4 Culvert Installation
  - 4.4.1 Water Management
  - 4.4.2 Erosion Control
  - 4.4.3 Sediment Control
- 4.5 Borrow Sources
  - 4.5.1 Water Management
  - 4.5.2 Erosion Control
  - 4.5.3 Sediment Control

5.0 Monitoring, Inspection and Maintenance
- 5.1 Water Quality Monitoring
- 5.2 Inspections
- 5.3 Maintenance

6.0 Contingency Plan

Fish and Fish Habitat Protection Plan

A Fish and Fish Habitat Protection Plan is also known as a Construction Monitoring Plan. A Construction Monitoring Plan typically identifies site-specific mitigation and monitoring measures for each stream crossing with a bridge or large culvert and is used in combination with an Erosion and Sediment Control Plan.

DFO[4] states that Construction Monitoring Plans are typically included as conditions of *Fisheries Act* authorizations. According to DFO, "construction monitoring is conducted to minimize impacts to fish and fish habitat during construction activities. Construction monitoring typically includes oversight of works conducted in and around water by a trained professional to ensure that identified mitigation measures are being appropriately applied and environmental emergencies are responded to should they arise. Construction monitors also assess the effectiveness of the mitigation measures applied and confirm the project footprint and impact." Monitoring plans should include the following components:

- objectives of the monitoring program;
- the schedule (frequency) of monitoring activities for various project components;
- documentation and reporting procedures; and
- the qualifications and experience of the environmental monitor.

Wildlife and Wildlife Habitat Protection Plan

A Wildlife and Wildlife Habitat Protection Plan is also known as a Wildlife Management and Monitoring Plan.

The GNWT is proposing changes to the *Wildlife Act* that would potentially result in provisions for wildlife management and monitoring plans for some projects. The draft *Wildlife Act* (March 2012), Section 96(1) states:

A developer or other person or body may be required, in accordance with the regulations, to prepare a wildlife management and monitoring plan for approval by the Minister, and to adhere to the approved plan, if the Minister is satisfied that a development, proposed development, or other activity is likely to:

(a) result in a significant disturbance to big game or other prescribed wildlife;

(b) substantially alter, damage or destroy habitat; or

(c) pose a threat of serious harm to wildlife or habitat.

According to the draft document, this means that:

the Minister can require these types of projects to have a plan that identifies:

- *how the project might affect big game or other wildlife listed in the regulations and its habitat;*

[4] http://www.pac.dfo-mpo.gc.ca/habitat/steps/authorization/additional-auth-eng.htm#monitoring

- *how the impacts will be reduced or repaired;*
- *how the developers will monitor any impacts and whether the measures to reduce the impacts are working; or,*
- *other requirements that are in the regulations.*

There will be regulations to identify what kinds of projects would need a wildlife management and monitoring plan.

A Wildlife Protection Plan should be developed with and approved by agencies that have responsibility for management of wildlife and their habitat, including:

- Inuvialuit Game Council
- Wildlife Management Advisory Council (NWT)
- GNWT Environment and Natural Resources
- Fisheries and Oceans Canada (fish habitat and stream crossings)
- Environment Canada - Canadian Wildlife Service (migratory birds and species at risk)

Appendix E-3 of the EIS included a copy of the Wildlife Management Plan submitted to the Environmental Impact Screening Committee for the Tuktoyaktuk to Granular Source 177 Access Road. This plan provides an example of a wildlife and wildlife habitat management/protection plan.

The Table of Contents is as follows:

1.0 Introduction
- 1.1 Purpose
- 1.2 Objectives
- 1.3 Scope of the Plan
- 1.4 Definition of Terms

2.0 Regulatory Responsibilities
- 2.1 Federal
- 2.2 Territorial
- 2.3 Inuvialuit

3.0 Project Activities, Schedule, and Location

4.0 Wildlife and Wildlife Habitat Protection Planning
- 4.1 Critical Wildlife Periods
- 4.2 Critical Wildlife Habitat Locations
- 4.3 Project Design Mitigation Measures
- 4.4 Mitigation Measures for Species at Risk
- 4.5 Environmental Contingency Planning

5.0 Monitoring

6.0 Reporting and Notification
- 6.1 Internal Reporting Requirements
- 6.2 External Reporting Requirements

7.0 Documentation

8.0 Employee Training and Awareness

Archaeological Site(s) Protection Plan

As stated in Section 4.3.9 of the EIS, archaeological resources are protected through various federal, territorial and Inuvialuit legislation and regulations.

The *Northwest Territories Archaeological Sites Regulations*, pursuant to the *Northwest Territories Act,* applies throughout the Territories and states:

> 4. No person shall search for archaeological sites or archaeological artifacts, or survey an archaeological site, without a Class 1 or Class 2 permit.
>
> 5. No person shall excavate, alter or otherwise disturb an archaeological site, or remove an archaeological artifact from an archaeological site without a Class 2 permit.

Within the Inuvialuit Settlement Region, the *Territorial Land Use Regulations*, pursuant to the *Territorial Lands Act,* applies to federal crown lands. Two sections are relevant to archaeological sites:

> 10(a) No permittee shall, unless expressly authorized in his permit or expressly authorized in writing by an inspector conduct a land use operation within 30 metres of a known monument or a known or suspected archaeological site or burial ground; and
>
> 16 Where, in the course of a land use operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the permittee shall immediately
>
> (a) suspend the land use operation on the site; and
>
> (b) notify the engineer or an inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

On Inuvialuit private lands, the Inuvialuit Lands Administration Rules and Procedures apply. One section is relevant to the protection of archaeological sites:

> 19(9) Where in the course of an operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the Holder shall immediately:
>
> (a) suspend the operation on the site; and
>
> (b) notify the Administrator or an Inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

The *Historical Resources Act* (Territorial) pertains to Commissioner's Land within the ISR. Protection of sites in these areas is afforded by the following Section:

> 9(1) Whenever, in the opinion of the Commissioner, any prehistoric or historic remains, whether or not designated as an historic place under this ordinance or under the *Historic Sites and Monuments Act* of Canada is threatened with destruction by reason of commercial, industrial, mining, mineral exploration or other activity, the Commissioner may order the persons undertaking the activity to provide for adequate investigation, recording and salvage of prehistoric or historic objects threatened with destruction.

On the recommendation of the contract archaeologist in the field the Developer shall implement avoidance or mitigation measures to protect archaeological sites or to salvage the information they

contain through excavation, analysis, and report writing, subject to the approval by the Prince of Wales Northern Heritage Centre (PWNHC).

According to the PWNHC, an archaeological site(s) protection plan will facilitate the continued protection and management of archaeological resources during the construction phase of the Project. A typical plan includes:

- detailed procedures for information flow between relevant agencies,
- how minor route realignments during construction will be assessed for archaeological impacts, and
- how this information will be communicated in a timely manner.

Mitigation measures will be designed on an individual basis, and require prior approval by the Prince of Wales Northern Heritage Centre. Mitigation measures may include avoidance (the preferred mitigation), temporary site protection, or systematic data recovery. It is expected that most archaeological sites found will be small and could be readily avoided with a minor Project realignment or footprint adjustment.

In the unlikely event that Project relocation is not feasible and a site will be affected, recommended site mitigation will likely comprise detailed mapping, recording and excavation of a sufficient number of units to ensure a representative sample of the site contents is obtained.

An example table of contents for an Archaeological Protection Plan is as follows:

1.0 Introduction

2.0 Regulatory Compliance

3.0 Types of Heritage Resource Sites

4.0 Recognizing Archaeological Remains

- 4.1 Burial Places
- 4.2 Archaeological Deposits

5.0 Archaeological Specifications

- 5.1 Preconstruction Planning
- 5.2 Construction Monitoring and Archaeological Assessment
- 5.3 Effect Management Procedures
  - 5.3.1 Human Remains
  - 5.3.2 Archaeological Deposits
  - 5.3.3 Isolated Artifact Finds
  - 5.3.4 Historical Remains
  - 5.3.5 Historical Artifacts
  - 5.3.6 Emergency Contacts

Pit Development Plan

For borrow sources on Inuvialuit-owned land, the pit development plan will conform to the ILA's *Granular Management Plan* and requirements for a Quarry Permit. For borrow sources on Crown-lands, the pit development plan will conform to INAC's[5] (2010) *Northern Land Use Guidelines Access: Pits and Quarries,* TAC's (2010) guide for *Development and Management of Transportation Infrastructure in Permafrost Regions,* and the pit/quarry development plan requirements.

According to INAC (2010), a typical pit development plan includes the following topics:

1. 1:5000 scale site map.
2. Description of proposed mitigation measures to address all identified environmental concerns.
3. Site Conditions:
    - Full delineation of granular material resource;
    - Contours, elevations and drainage features;
    - Environmentally sensitive areas (e.g. streams, wildlife habitat);
    - Extent of permafrost and ground ice;
    - Adjacent land uses.
4. Site Design and Development:
    - Adequate room for all activities;
    - Topsoil, overburden and granular pile locations;
    - Proposed site development techniques (e.g. clearing trees, windrowing brush);
    - Proposed or existing access routes;
    - Proposed or existing infrastructure (e.g. camps, refuelling areas);
    - Design for water management and erosion control; and
    - Design for progressive reclamation.
5. Operations:
    - Resource extraction and processing techniques;
    - Single-season or multi-year operation;
    - Spill contingency plan;
    - Monitoring and maintenance plans; and
    - Contingencies if changes to the original development scenario are required.

[5] http://www.aadnc-aandc.gc.ca/eng/1100100023585

6. Reclamation:
    - Closure objectives;
    - Removal of all garbage, debris, equipment and buildings;
    - Overburden replacement for site contouring;
    - Re-establishment of natural drainage;
    - Replacement of all salvaged topsoil;
    - Revegetation activities; and
    - Reclamation of access roads.

Directive 4:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will provide the information requested regarding permafrost, ground ice, climate change and the use of granular resources (quality, quantity and location), as set out in the attached IRs as soon as possible.

Developer Response 4:

The Developer submitted a response to the information requests outlined in Directive 4 on June 11, 2012.

Directive 5:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will update the socio-economic impact assessment with 2011 Canadian census data and any new information available from the GNWT Bureau of Statistics and the IRC. The Developer will identify where any impact predictions and proposed mitigation measures have changed as a result and provide any necessary explanations.

Developer Response 5:

The Developer submitted a response to Directive 5 on June 7, 2012.

Directive 6:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will re-evaluate the impacts and proposed mitigation for any valued socio-economic component based on the information gathered and provided in the Traditional Knowledge and Traditional Land Use report. The Developer will also re-evaluate the impacts and proposed mitigation for any valued socio-economic component that would be affected by changes to the biological components where baseline information will only become available in August 2012.

Developer Response 6:

Traditional Knowledge and Traditional Land Use (TK/TLU) studies have become an integral part of the environmental assessment process under the Inuvialuit Final Agreement (IFA). The project is currently undergoing a substituted panel review by the Environmental Impact Review Board (EIRB) pursuant to the IFA and Canadian Environmental Assessment Act. The Terms of Reference for the project's Environmental Impact Statement require that "*The Developer is expected to demonstrate how TK was used to influence the planning, design and implementation phases of the proposed development. This should include details of how the Developer and TK holders have worked together to share knowledge and gain insight into creating a better development proposal. The Developer shall identify where TK and scientific knowledge differed and how these differences were resolved for the EIS and overall project planning."*

Although the Developer provided a significant amount of Traditional Knowledge and Traditional Land Use information in the Environmental Impact Statement, comments received during the conformity review indicated a need for a focused review of the alignment in a Project-specific study. The compilation of Traditional Knowledge was conducted in two phases. The first phase was a review of published Traditional Knowledge for the Inuvik to Tuktoyaktuk Highway Program and surrounding area. The second phase included two Traditional Knowledge workshops, one in Inuvik and one in Tuktoyaktuk. Both final reports were submitted to the EIRB on July 5, 2012 and are available on the EIRB's registry.

The final report for phase one is entitled "Summary of Existing Traditional Knowledge for the Inuvik to Tuktoyaktuk Highway Study Area" (KAVIK-STANTEC May 2012). The report provides a review of life history as well as traditional use patterns of wildlife including migratory birds and fish. This report was prepared from publicly available documents and is not confidential.

The Developer notes that the Department of Fisheries and Oceans (DFO) have provided significant substantiating information in Information Responses in its work with Hunters and Trappers Associations in Inuvik and Tuktoyaktuk communities. Some additional information was filed by the Developer in a DFO report entitled "Socioeconomic Literature Review of the Impact of Linear Developments in the Northwest Territories" (Nichols Applied Management and Knopp 2010).

Although the Terms of Reference suggest only the Developer has a responsibility for engaging with Traditional Knowledge holders, it is clear from Information Request Responses from many ISR bodies, that the process is a broader approach to sharing information on issues, mitigations and management. These processes have been applied over the past few years in the routing of the alignment as well as providing mitigations in the EIS. As stated in the EIS, mitigations and monitoring will be further refined in forthcoming plans, such as the Fish and Fish Habitat Protection Plan.

Phase two included conducting Traditional Knowledge workshops in Tuktoyaktuk and Inuvik with a select group of elders and harvesters familiar with the Program area. The first workshop was held in Tuktoyaktuk on February 7 and 8, 2012. The second workshop was held in Inuvik on February 9 and 10, 2012. The Community Corporations and Hunters and Trappers Committees selected eleven elders and harvesters for each community, respectively.

A questionnaire was developed for the workshops to be used as a guide and to maintain focus of the purpose and geographic scope of the workshops but was not followed directly question by question. The questionnaire is found in Appendix B of the final report.

The workshop results were submitted to the EIRB in a final report entitled "Inuvik to Tuktoyaktuk Highway Traditional Knowledge Workshop Results: Inuvik and Tuktoyaktuk, February 2012" (KAVIK-STANTEC May 2012). The results in this report are presented in five environmental and three non-environmental categories. Environmental categories include the general environment, vegetation, mammals, birds, and fish. The remaining three categories include cabins, graves and spiritual areas as one category, and general comments and recommendations as the remaining two categories.

Tuktoyaktuk workshop participants felt more comfortable discussing the northern half of the project area while Inuvik participants preferred discussing the southern portion as these were the areas the respective communities use the most and, therefore, have the greatest knowledge about.

Directive #6 asks the Developer to:

- re-evaluate the impacts and proposed mitigation for any valued socio-economic component based on the information gathered and provided in the Traditional Knowledge and Traditional Land Use report, and
- re-evaluate the impacts and proposed mitigation for any valued socio-economic component that would be affected by changes to the biological components where baseline information will only become available in August 2012.

In response to the Directive, the following discussion briefly reviews the workshop items raised and indicates which have been incorporated into the planning approach as discussed in the EIS, additional reports filed with the EIRB, responses and other submissions filed with the EIRB or new mitigations that were identified.

General Environment

Tuktoyaktuk

General observations were made regarding slumping and permafrost. The Developer is keenly aware of these issues as these matters are critical to the construction and maintenance of the Highway. The two key construction techniques to address these matters are no "cut and fill" and winter construction.

The importance of gravel areas for wildlife denning and water quality of Husky Lakes were raised as well as gravel sources for community use. The Developer is working with GNWT Environment and Natural Resources to address wildlife protection including minimizing the number of gravel sources and footprint, determining mitigation techniques for winter denning grizzly bears, and implementing general construction and site specific mitigations included in a Sediment and Erosion Control Plan. Granular sources for communities has been discussed in the response provided to Directive #4. Community granular resource planning is a key consideration of the GNWT Departments of Public Works and Services and Municipal and Community Affairs.

Inuvik

General observations were made regarding changes in climate and effects on timing of grizzly bear denning. Other concerns were identified in relation to land slumping and pipeline effects on the land. Additional comments on water and differences in freezing of water during winter were made.

The Developer shares the concern for the effects of climate warming. One reason for construction of the Highway relates to the dependency on winter ice roads and the potential for climate change. Construction techniques for each water crossing will be considered during the Fish and Fish Habitat Protection plan. This plan will include the expert advice of DFO and the Inuvik-Tuktoyaktuk Working Group organized under the Fisheries Joint Management Committee.

Cabins, Graves and Spiritual Areas

Tuktoyaktuk

No known graves sites or spiritual areas were identified. The Developer is also conducting Archaeological Surveys for the Highway alignment and borrow sites. A report entitled "Archaeological Impact Assessment of the Inuvik to Tuktoyaktuk Highway" (IMG-Golder Corporation December 2011) was filed by the Developer with the EIRB. This report was submitted "in confidence" at the request of the Prince of Wales Northern Heritage Centre (PWNHC).

Although this report did not identify any new archaeological or burial sites along the Highway alignment, the Developer, at the request of the PWNHC, subsequently conducted a predictive mapping of the area using the LiDAR imagery and terrain mapping. The Developer will complete more detailed review of gravel sources in early July 2012. The Inuvialuit Land Administration cabin location provided in the EIS was confirmed.

Inuvik

The primary issue discussed was cabin locations and concerns over the number and location of cabins. Participants identified the Inuvialuit Land Administration as the primary party responsible for managing this concern. Potential gravesites were mentioned but are not within the Project footprint. However, the Developer, through its formal Archaeological Surveys and in following advice from the PWNHC, is making every effort to avoid impacts on known or potential areas. As discussed above, field surveys are a key to identifying specific sites of concern and the Archaeological Impact Assessment is the method of determining site-specific mitigations should sites be found. The PWNHC has been fully engaged with the Developer to ensure appropriate surveys are conducted.

Vegetation

Tuktoyaktuk

Participants provided information on specific plants used for food and medicine. Many species are widespread. No concerns were raised or areas identified with significant abundance of particular species.

Inuvik

Participants discussed the importance of lake edges and creeks for berries. No concerns were raised or areas identified with significant abundance of particular species.

Caribou

Tuktoyaktuk

Participants identified caribou as an important food. Some participants felt the [Cape] Bathurst are part of the Bluenose West herd. While the largest number of caribou use the area in fall and spring, a small number of animals remain in the area all year. Participants thought a Highway may have an initial effect but over time the caribou would eventually habituate to it, but with large herds moving across there would likely be some effects. Caribou have adapted to the Dempster Highway and are using their usual routes, but they tend to act nervous and will avoid the area when large machinery is in the area for construction or maintenance.

Caribou appear to like the current 177 access road in the spring because the road provides good footing. However, caribou have stopped passing through some areas. They have changed their routes (they do that every 30 years or so), and have not been in this area for 15 to 20 years. Participants noted that caribou are not moving around as much. They are staying in the area near Husky Lakes possibly because there is no hunting allowed there. About 2,000 caribou were seen crossing Husky Lake recently (during the first week of February 2012).

Concerns were raised regarding increased hunting from the road. Participants felt more or improved by-laws related to harvesting would be needed and regulatory agencies would have to

"step up" and enforce the regulations. The timing of construction was seen as a trade-off between what is good for the land and what is good for the caribou. Summer construction would be better for caribou but would cause greater impact to the land. Participants concurred that the best time for construction is the winter. Using monitors during construction might help, but that caribou will change their route during that time. This could be okay if the hunters are aware of the change and can predict it.

Participants felt that more caribou than any other species would be killed by road traffic. However, since the road (such as the 177 access road) will be so crooked, the traffic will only be able to go about 50 km an hour. Wildlife kills on the highway are expected to be few because there are no trees to obscure the view of people driving or of the animals passing. South of Parsons there are some trees that could obscure the view.

Inuvik

Residents have changed harvesting areas as few caribou are in the southern part of the project area. People used to hunt in the study area as well as along the coast, but now there are none too few caribou in the study area. Hunters now travel east to Sitidgi Lake and Miner River. Woodland caribou are harvested east of these areas. Caribou numbers are said to be quite cyclic and the health of the caribou is improving, so that last year the caribou were healthy.

If the caribou return to the study area and the road is constructed, caribou may stay away from the area due to noise from construction, but that they may return. Some may stay away for 10 years before coming back. Participants suggested that to keep caribou from moving away, construction should be stopped while caribou are migrating through the project area. Caribou numbers may also be affected due the potential of increased harvesting and road traffic. Participants suggested moving the caribou harvesting area further south and revising the caribou management plans if the road is constructed.

Wolves

Tuktoyaktuk

Wolves generally follow the caribou. They move into the area in October and November and migrate back east in February and March, although some wolves spend all year in the study area. The wolf population was considered to be healthy.

Workshop participants did not think the Inuvik to Tuktoyaktuk highway would have much effect on wolves. Wolves would be most sensitive when denning and it was recommended that construction activities should stay at least one mile from den sites. Dens are generally found in quieter areas, and in high, dry places along rivers and stream banks. Participants stated that wolves will most-likely stay away from the road as they prefer to move and den in quiet places.

The main impact to wolves will be from easier hunting access. Windrows and snowbanks created by snowplows might affect the good hunting spots for traditional hunters, and there is some concern that people will come into established trapping areas.

Inuvik

There appear to be more wolves, especially in the delta. Wolves move dependent on food availability. People see wolves on the Dempster Highway and it provides easier access for hunting wolves. Wolves used to be in packs of 20 to 30 but now are normally in groups of 3 to 4 animals.

Grizzly Bears

Tuktoyaktuk

There appear to be more grizzly bears than 15 years ago, and numbers have been increasing particularly in the last few years. There are now many grizzly bears in the spring around Husky Lakes and east of the study area.

Grizzly bears den in the banks along rivers, in high ridges, or grassy areas. Dens usually face south; for warmth from the sun in the spring. Some of the gravel sources are potential denning sites, but not many. Bears emerge from dens in April but may come out during really warm weather. Husky Lakes area has a high concentration of grizzly bear dens. Bear hunting is generally during September or in the spring when they first come out from hibernation.

Concerns were that noise during construction may force bears from their dens. Bears may also not want to den close to the road because of traffic. There was a concern about increased bear attacks on people berry picking off the Highway, and that any nuisance bears shot come of the harvest quota, thereby reducing the quota available to the community.

Inuvik

There are more bears seen in the delta and lots of dens on Richards Island. Grizzly bears den on the south side of creek banks, with steep slopes, often protected by willows or trees. Dens are located where it is easy to dig a stable den. Bears will return to their dens more than once.

Bear populations may decline after the Highway is constructed due to increased hunting pressure related to easier access. Some participants thought that the grizzly bears will likely move away from the road while others thought bears may use the road for hunting when the caribou are around.

Black Bears

Tuktoyaktuk

There are no black bears around Tuktoyaktuk; they are located closer to Inuvik, near the treeline.

Inuvik

Participants do not see as many black bears as before. They are mostly seen around the road and dump.

Wolverine

Tuktoyaktuk

There appear to be more wolverine now. They live in both treed and tundra habitats. Some follow the caribou but others remain in the area. The dens are in high dry places along banks of lakes and streams. They are harvested from December to April.

Generally it was thought that the highway would cause no long-term effects to wolverine and that population numbers appear to be stable. It was mentioned that the highway may lead to some increased harvesting of wolverine. Some thought that wolverine numbers in the study area might increase if people were hunting along the highway, since the wolverine would scavenge the remains of kills.

Inuvik

Wolverine numbers appear to be higher. They are considered shy animals and normally try and stay away from humans. They like deep snow as they can tunnel into the snow. Wolverine den in the same types of areas as grizzly bears (hilly areas) and these areas should be protected. They are harvested from November to April.

Workshop participants thought that the highway may lead to increase harvesting of the wolverine. Wolverines will also be affected if there are impacts on caribou and reindeer.

Moose

Tuktoyaktuk

Moose are found farther south but appear to be extending their range northward.

Inuvik

Moose are found throughout the study area including the Hans Creek area. However, moose are more abundant in the delta..

Muskrat

Tuktoyaktuk

Muskrat are found all along the proposed Highway route in small lakes or small bays of larger lakes. The Highway is not expected to have any effect on populations. There are more now possibly because they are not trapped as much as before

Inuvik

Some participants thought muskrat populations were declining and the populations are becoming sick.

Beaver

Tuktoyaktuk

Beaver appear to be moving north. They are not trapped as much as before. Beavers could affect the Highway by damming streams and creeks.

Inuvik

People see more beaver now. Damming of creeks is spoiling some fishing areas.

Other Furbearers

Tuktoyaktuk

Participants briefly mentioned lynx, fox, rabbits, otter, mink and ground squirrels. Lynx prefer treed areas. Fox numbers seem to be up lately and foxes are likely to adapt well. Ground squirrels are all over and populations will not be affected.

Several traplines run near Parsons Lake, but there are few serious trappers now. Some people still trap for recreation. Where there is trapping, it tends to be along the bay – outside of the study area. Some trappers will like the increased access created by the highway and may trap more as a result. Martens and weasels are not trapped much anymore.

Inuvik

Lynx are found wherever there are rabbits. The southern portion of the Project area from Noell Lake has lots of lynx. The Highway may bother them at first, but over time, they would probably get used to the Highway and the associated noise. Black and red foxes are also abundant in the study area. Overall, the road will not impact the foxes but they may travel up and down the road looking for garbage.

Otters and fishers are moving northward. The road may bother these animals at first as they would not be used to the noise but over time would probably get used to the road.

Martens are seldom seen and it has been a long time since a weasel has been seen. A porcupine was seen several years ago. One participant noted that coyotes are coming further north now.

Waterfowl (geese, ducks, swans and loons)

Tuktoyaktuk

Husky Lakes area is an important area for harvesting geese. Areas often used for geese hunting include Hans Bay, Face Point, Zed Lake and anywhere along the shore of Husky Lakes. Some geese will nest in the study area, such as yellowlegs and Canada geese, but only in small groups. Seagulls, swans, ducks and likely ptarmigan also nest along the road. Snow geese do not nest in the program area but nest further north. Workshop participants reported seeing more geese and ducks now.

They speculated whether this was related to the reduced helicopter traffic in the area. The amount of air traffic might decrease with the road because people will use the road instead.

Goose hunting in the spring it is mostly along the coast. Before the oil companies came there was more hunting near Husky Lakes, too. Geese hunting in the highway corridor is mainly the end of April and the first half of May.

The sensitive times that people should consider along the highway (other than spring hunting and nesting) are fledging times (June – about a week after hatching).

Fall hunting requires that they go north by boat. If the people coming up on the highway do not have a boat, they cannot go that far. The highway is not expected to change the fall hunting in the corridor because there is not much of that anyway (the birds are all on the coast or up north)

Swans nest in lakes throughout the area with small numbers on larger lakes and single pairs on small lakes. Ducks and loons can be found in almost any lake.

If the highway is constructed during the winter then there should be no effect on waterfowl, apart from the indirect effects of construction equipment noise, which will temporarily scare off the geese. If some construction were to occur in the spring, summer or fall then it should be conducted at times to avoid bird migrations and moulting. If a bird is disturbed while moulting it would move to the next lake to avoid the disturbance..

The road might not have much effect except that the waterfowl will nest farther away from the road. The road will increase access for hunting geese, and there might be a lot of hunting along the highway generally, once it goes in. This will be difficult to control.

Inuvik

Geese are now migrating more east. Used to hunt on Mackenzie River but now hunt along Husky Lakes or east. Ducks [mallards, American widgeons, pintails, long-tail duck and black ducks] are found throughout the area. Swans nest on many of the lakes. Geese hunting in the 500 Lakes area occurs from the end of April to the middle of May. While hunting geese, ptarmigan, ducks (mallards, Goldeneye, Teal, canvasback, and eider) and swans will also be harvested at the same time.

Birds of Prey (eagles, hawks, falcons and owls)

Tuktoyaktuk

In general more birds of prey, including bald and golden eagles, are now seen; however, workshop participants say they do not see eagles nesting in the study area. Eagles seem to prefer high places such as trees to nest in. Falcons are seen around Husky Lakes. Falcons also need high places to nest. Snowy owls are sometimes seen in the study area but are normally found only north of Tuktoyaktuk, not near the route. Snowy owls nest along the coast on the top of knolls or areas with gravel. Peregrine falcons nest in abandoned buildings and cliffs, but their specific nest locations are not known. Yaegers (3 types) pass through in large numbers (up to 200 at a time) in the spring, and nest far north.

Birds of prey can be sensitive and any human activity may result in birds of prey moving further away from the highway. If owls or other birds of prey are nesting at a gravel site, any disturbance may cause them to leave that site. Also, if there are any effects on food sources such as mice or lemmings this could affect birds of prey numbers.

Inuvik

Bald eagles are common and seem to be increasing. Eagles nest in high trees and mostly in the delta. Falcons can be seen around the Airport and Campbell Lakes. Some species, like jaegers, arrive later, in late July. Populations of falcons and owls remain about the same. Owls are more seen in the west side of the delta, with some owls found close to Inuvik. The occasional snowy owl is seen but not in the past couple of years. Short-eared owls and great-horned owls have also been seen.

Other Birds (ptarmigan, raves, cranes, songbirds)

Tuktoyaktuk

Cranes, ptarmigan, and ravens are seen all over. Ravens gather in large flocks in fall and fly between Inuvik and Tuktoyaktuk. A number of smaller birds are seen, possibly blown in from distant areas.

Inuvik

There has been no noticeable change in songbirds.

Fish

Tuktoyaktuk

Fish are fragile and important among the species being discussed. Fish meat is the main source of food, moreso than birds - whereas caribou is the most important for some other reasons. Along the road, and in the study area, you can catch trout and many other species.

Any lake or stream with a connection to Husky Lakes or the coast will have fish using them. There is likely spawning potential in most lakes and lakes that are deep enough would provide overwintering habitat. Common fish species in the lakes include grayling, crookedback, lake and broad whitefish, herring (ciscoes), lake trout, burbot, jackfish, northern pike, and loche. Freshwater shrimp are also in some lakes.

Hans Bay is good for fishing. East and West Hans Lakes contain mainly whitefish. Parsons Lake is a common fishing place, but there are not too many fish are there (numbers and species). It is shallow, with about 8 feet of ice, so there is not a lot of water for fish to overwinter. Ikinilik [?] is also a fishing area. It is very popular and sometimes there are so many people it is difficult to fish. Fish go up Jimmy, Parsons, Hans, and other creeks. Fish populations are considered healthy but can fluctuate from year to year. Fish migrations are changing by 1-2 weeks in spring and fall due to the warmer weather.

The Tiktaliktuk Lake fish population is declining with the increased access to the lake from the access road to gravel source 177. With increased access from the Highway there is a concern there could be long-term impacts on fish populations due to overfishing. Currently there is limited access to many of these lakes during parts of the year.

People travel to fish-bearing lakes with skidoos during winter and sometimes with all-wheelers during the summer. There are different trails that are used at different times of the year.

Bridges are better than culverts for the fish in the creeks. Construction timing is important because at least once culverts were used rather than bridges because it was too late in the season (the ground was not favourable) to construct the bridge.

The road will make access to the lakes very easy and fishing will increase.

Inuvik

Important areas for fishing within the project area include Husky and Jimmy lakes, the creeks in the areas around Husky Lakes and on the skidoo route from Inuvik to Husky Lakes. Noell and Jimmy lakes have whitefish, jackfish (northern pike) and lake trout. Noell Lake also has arctic grayling. The mouth of Hans Creek has lake trout and arctic grayling. Peter Lake and Husky Lakes have lake trout. There are fish in both West and East Hans Lakes. Workshop participants were not sure where spawning areas were located, but some suggested in all the creeks including those north of Sitidgi Lake. Workshop participants indicated they did not did not fish in Parsons Lake, and did not travel north of Parsons Lake when fishing.

Fishing in Noell and Husky Lakes occurs in the spring from the end of April to the middle of May, and in the fall in October and part of November, when the ice is thin (6-12" thick). It was noted by workshop participants that some people will fly up to Noell and Husky Lakes in the summer to fish, while some people fish year-round. Fish will overwinter in lakes and creeks that do not freeze right to the bottom.

People will use the Highway to fish in Husky Lakes. More fish surveys were required in waterbodies and creeks including those that drain beyond the Project area. Quarry site #2.45 is close to a fish bearing lake and stream. If the quarry is used, slumping may occur and slumping material may end up in the lake or creek and affect fish habitat.

Several workshop participants mentioned that it may not be good to eat fish from Noell Lake because of pollution or higher contaminant levels. Other Workshop participants have mentioned that they have found several lakes, including Noell and Jimmy Lakes, to be overpopulated because people are worried about contaminants and will not eat the fish from them as some people are getting sick from them. Fish from Husky Lakes, however, are considered okay to eat.

General Comments

Tuktoyaktuk

- All want an all-weather road however it needs to be built the best way possible.
- There are different types of costs, not just money such as the cost to people and the environment.
- Cost of losing a species and loss of subsistence harvesting outweighs the costs of the highway.
- Some problems will come with the road but it will be used and overall be a benefit to the community.
- Our children and grand-children should have the same ability to use and experience Husky Lakes like we do now. If the road is built too close to Husky Lakes our grandchildren will not have this opportunity.
- No one wants their kids to come back and say that the people participating today made a mess of the process and deprived them of their traditional hunting areas.
- People are not listening to elders
- A report was prepared for the government that said the Tuktoyaktuk people were in favor of the road they're proposing right now. But the people didn't want this, they were really against this road, they are in favor of the upland road or the Elders' Road. Husky Lake is sacred to a lot of people, and they're trying to protect it.
- The upland route, it's all on top of the hill, there's no creeks to cross and it's all gravel.
- Different people, organizations talking differently
- Sometimes cheaper ways cost more in the long-run
- Creek crossings are very important - many creek crossings should be bridges rather than culverts
- How much will it cost to maintain the road and who pays?
- Is the road going to be the same kind of gravel? If you look at that existing road that's been made, it seems like it's sinking into the ground.
- Concerns related to mining the gravel are minimal.
- The gravel sites will have to be left in a well-managed way so that it does not create another lake where they have taken the gravel out. They cannot just leave it because it will create ponds and small lakes because the drainage is not good. They need drainage or a slope or to cover it up so the permafrost does not melt and create these ponds.
- There are few or no traplines in the corridor, although [name removed] still traps occasionally from Kitti Creek to Parsons.
- More daylight has been noted. The sun is higher now compared to years ago.
- Moon used to come up [water?] creek, and when it went down it was on the south side. Now it comes up on the south side. It has changed position – the earth is tilting.

- Sun used to come up at 9 a.m. and set at 6 p.m. ; those times have changed. The sun comes earlier in the year also (January 6 vs. January 10).
- Sunspots and northern lights are changing. There are more northern lights.
- There is a concern that there be some return for the surface rights. Relates to discussion about surface rights and subsurface rights on private lands vs. Crown lands.

Inuvik

- There is general support for the road but it requires to be constructed in an environmentally sound way.
- Culverts tend to freeze-up and cause problems during break-up.
- Concern that people will leave garbage along the road or near Husky Lakes. Even if access to Husky Lakes is restricted, if the road is close people will find a way to access this area.
- There is a need to protect the land and its resources.
- If the road is not built properly it will negatively affect younger generations' use of the area and its resources.
- Once the highway is completed people will take advantage (use) of it.
- With an all-year highway boot-legging of liquor may then occur all year long instead of only when the ice road is in.
- Supplies may now come by ship to Tuktoyaktuk and then sent south to Inuvik by the highway.
- There will be benefits to tourism and businesses because of the highway.
- Probably more trapping for wolves, fox and wolverine after the road is built

Recommendations

Tuktoyaktuk

- Move Highway west further away from Husky Lakes
- Community wants road but it needs to be built in an environmentally friendly way to preserve wildlife resources
- There should be a gathering of all interested parties and people to know how decisions are made, understanding of the road route, construction etc. Should include organizations like IRC, IGC, HTCs, co-management committees, governments, etc.
- Post signage on Highway for areas of trap lines or where people cross over a lot
- ENR and DFO will need to step-up to monitor and enforce regulations etc.
- DFO and ENR must ensure road is constructed properly (in terms of environment)
- Save sources of gravel close to the community for community use
- Do not take gravel close to Husky Lakes

- Take extra care when working around camps/cabins
- Use lessons learned from access road to source 177 when constructing road Problems with culvert blocking fish movements
- The access road to 177 should be widened
- There should be no construction between April to mid-June and between November and December
- Consider harvest times when planning construction
- Listen to elders – use elders' route
- Recover areas where gravel is taken to prevent permafrost from melting
- Complete construction in a timely manner, if late the company should be penalized
- There should be a good grizzly bear denning study (by ENR or Fish and Wildlife) to check for dens. There was a quick survey last year, but the person was from Inuvik and might not know all the sites. Someone local should do this study
- When blasting the gravel out of the quarries, it should be done away from the bear dens
- With all these sites, when they do make the highways, somewhere down the road they will have a problem with nuisance bears. Monitoring or compensation to HTC should be considered to help manage this problem. Protocol for bear encounters should also be in place
- A vegetation survey (plant study) should be done along the corridor to check those areas for rare and special plants. Trees are even starting to come out along the route
- They have to make sure they have enough money to finish that highway in a period of time, rather than temporary solutions over 3 or 4 years. Whatever contractors are working on the highway need to finish in the time scheduled and using the gravel sources they need
- Parts of the route near 177 need to be wider. It is not safe because it is not finished properly
- There should be studies on some of the lakes and creeks and monitoring after the highway is built to check how the fish are doing, especially during the summer when people are not actively fishing there
- Maintenance plan in place to make sure the highway is safe. Resources should be in place: money, gravel, people. There should be more monitoring once the road is built
- The communities should always have information about what is going on.

Inuvik

- There should be a meeting with all interested parties together including the, communities of Inuvik and Tuktoyaktuk, DOT, and government regulators.
- When constructing the road, keep the overburden wherever possible to prevent damage to the permafrost
- Do not take too much gravel from any one source as this may cause permafrost to melt and slumping to occur.
- Creeks around Parsons Lake area and Valley creek should have bridges for the stream crossings.
- ENR will need to do more patrols when road is open.
- Revise caribou plan to reflect effects of the Highway
- Fishing plans relevant to area should be revised
- Take lessons learned from constructing and maintaining the Dempster Highway and apply them to the Inuvik to Tuktoyaktuk Highway.
- Concerns of road need to be brought-up with the HTCs and at the AGM. There is a need to talk to regulators regarding monitoring and enforcement requirements for the Highway.
- During important periods of migrations (e.g. caribou migrations) more conservation officers should patrol the road as is done in the Yukon.
- Same rules that apply for the Dempster regarding hunting should also apply for this Highway.
- Inuvialuit need to get together to determine cabin issues (how many, where) for Husky Lakes.
- People need a say on how the Highway is built. It is our land.
- Should stop construction to allow the caribou to migrate through the southern end of the program area, for the last 2 weeks in September and the first week of October – but because they change routes so much it would be better to conduct surveys to determine when or if the caribou would come through the area.

Developer Conclusions

The Developer has re-evaluated the potential effects and proposed mitigation for the valued socio-economic component based on the information provided in the Traditional Knowledge (TK) and Traditional Land Use report. The potential effects and mitigation measures identified in the Environmental Impact Statement (EIS) and subsequently submitted supporting documents address the issues raised in the TK report. For example, the Developer has provided the planning and mitigation processes to address the key issues raised regarding grizzly bear and barren-ground caribou, and habitat concerns for wolves and wolverine. The Developer's construction season will avoid many issues related to migratory birds. As indicated by participants, short-term wildlife behavioural responses are expected, but species are generally expected to habituate to the road.

Other issues, such as potential increased harvesting and increased access to the land, were identified in the EIS and are the responsibility of the parties identified by the participants.

Furthermore, the Developer does not anticipate its additional field work to require a re-evaluation of socio-economic impacts related to biological components.

Directive 7:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will provide evidence and records of discussions with the affected community and community organizations that confirms that the use of these Category E lands for the ITH is acceptable. Failure to provide this information could force the Review Board to ask the Developer to provide information on an alternative routing that would avoid the Category E lands along the current preferred ITH alignment.

Developer Response 7:

It is important to note that Inuvialuit interests identified Alternative 3 (2010 Minor Realignment) in 2010, and the Developer has incorporated this input into the route options presented. The GNWT is currently in negotiations with the ILA to attain land for the Highway right-of-way.

Furthermore, the GNWT is anticipating that a letter from the IRC regarding use of the Category E lands is forthcoming.

Directive 8:

Source: **Environmental Impact Review Board**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

The Developer will provide a cross reference of the existing Draft EIS and all supplementary information filed to date, and any new information filed in response to this Directive, with the requirements of the Terms of Reference for the EIS, and also clearly demonstrate/justify how the Terms of Reference have been satisfied by the information.

Developer Response 8:

The EIS Concordance Table (Table E) has been updated to reflect the various addendum, conformity and information request submissions to the EIRB.

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
4.0	**Executive Summary**	Executive Summary	Sect. 3.0 #1				
5.0	**Introduction**	1.0					
5.1	**Introduction to the Developer**, Consultants, Contractors and key personnel that prepared the EIS. Contact information and record of the environmental performance.	1.1, 1.1.1, 1.1.2					
5.2	**Contextual Summary of the Development** Brief summary of the development, location, components, phases, spatial extent, temporal extent, workforce, and equipment, associated activities, schedule, and cost.	1.2					
5.3	**Purpose and Justification**, including any regional and national interests.	1.3					
5.4	**Development Setting** General overview of the geographic, ecological, social, economic and cultural setting and similar information for all considered alternatives.	1.4	Sect. 3.0 #2		8, 18.1		
5.5	**Permits and Authorizations** and all land-tenure requirements (including area and ownership), and on any non-regulatory requirements that may be needed for the development to proceed.	1.5	Sect. 2.0 #1			142.1	
5.6	**Study Strategy and Methodology** Steps in EIS Preparation. Approach, strategy, and methodology and justification. Guidance documents or BMPs used or modified for proposed construction and operation – Plus, justification for modifications. How EIRB Goals and Principles were incorporated into the EIS Methodology.	1.6	Sect. 2.0 #2			143.6	
5.6.1	**Traditional Knowledge**		Sect. 2.0 #12		9.5, 46.2	144.2	
	How TK influenced assessment results and overall Project design. Includes, details of how the Developer and TK holders have worked together; where TK and scientific knowledge differed and how these differences were resolved; TK Study methodology; How TK was gathered and verified. Summary of issues, concerns, and recommendations arising from TK studies. Discusses how, issues, concerns, and recommendations were responded to.	1.6.1, 1.6.3, 1.6.5, 3.1.2, 3.1.9, 3.1.9, 3.1.10, 3.1.10, 4.1.2, 4.3.9, 6.0					
5.6.2	**Engagement and Consultation**				22.2, 46.2, 51.1, 51.2, 51.3, 55.1	118.1, 143.4, 144.3	
	Issues and concerns raised by potentially affected parties, including communities, regulators and other reviewers. How these issues and concerns have been or will be addressed.	1.6.2					
	Summary of the public engagement process in the EIS, including the following: Community, competent authority or Party contacted; Contact names; Dates of contact; Communication/consultation format ; and Reason(s) for communication/consultation, and topic(s) of discussion, including the issues and concerns that were raised, and how the issues and concerns were responded to and/or resolved.	1.5, 1.5.1, 1.5.7, 1.5.2, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 3.2.8, 3.2.9, 4.3.5, 4.3.6, 4.3.7, 5.3, Appendix B					
	Any commitments made by the Developer as a result of the communication/ consultation.	1.6.1, 1.6.2, 1.6.4, 4.4.3					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	How the planning, design and/or implementation of the proposed development was influenced and/or changed as a result of consultation and by any issues and concerns raised.	1.6.5, 2.1.1, 2.1.2, 2.1.2, 2.2.1, 2.2.4, 2.2.7,4.4.5, 6.0					
5.6.3	**Recognition of IFA and CPP**				55.1	111.1, 143.4, 146.1, 146.2	
	Potential development effects on the various land categories identified in applicable community's CCP. Demonstration that Developer has reviewed applicable CPPs and consulted with appropriate communities and organizations about any potential conflicts. Mitigation measures and commitments to eliminate potential impacts potentially caused by the development to identified category lands and waters. Environmental Management Integration Plan: demonstration of how information and guidelines from CCPs and other regional plans will be adhered to and complied with.	1.5, 1.6.2, 1.6.3, 3.0, 4.0, 6.0					
5.6.4	**Sustainability Goals**					143.4	
	Summary of how the principles of sustainability were incorporated into the Project and how sustainability goals have been achieved.	1.6.4					
	Provides a methodology and list of indicators used.	1.6.4					
	The extent to which the development makes a positive overall contribution towards environmental, social, cultural and economic sustainability – locally, regionally, territorially, and nationally.	1.6.4, 4.0, 5.3, 5.4					
	How the planning and design of the development have considered how it affects achieving sustainable development.	1.6.4, 2.0, 4.0					
	How monitoring, management and reporting systems have incorporated indicators of sustainability.	1.6.4, 4.0, 6.0, 7.0					
	How the public and communities have been given opportunity to participate in and contribute to the planning and design of the development and that their views have been considered in the review process.	1.6.2, 2.0, Appendix B					
5.6.5	**Precautionary Principle**						
	Identifies which Project components may warrant a precautionary approach. Discusses the potential for serious or irreversible adverse impact to the environment as a result of the Project and how they can be avoided. Describes ways to reduce the risk to the environment, including a discussion of Project design and available technology with respect to effectiveness and cost.	1.6.5, 2.2, 3.0, 4.0, 5.0, 6.0	Sect. 2.0 #3				
6	**Detailed Project Description**						
	Plus, required management plans, and management related activities.	1.5, 2.0, 4.0, 6.0, 7.0, Appendix E		2c	1.1, 1.2, 62.1,62.2, 62.4, 67.5	90.1, 90.2, 93.1, 130.1, 132.1, 132.2, 135.1, 143.5, 144.1, 144.3	148.1
6.1	**Alignment Alternatives**		Sect. 2.0 #4		13.1, 13.2, 13.2		
	Information on the preferred alignment and the alternatives considered.	2.1, 2.2					
	Plus, information on the nature and rationale for any changes since the Project Description submission.	1.6.2, 2.0, 2.1, 2.2					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
6.2	**Scope of Project Components and Activities**					90.1, 90.2, 92.1, 92.2, 92.3, 93.1, 94.1, 94.2, 94.3, 94.4, 96.4, 98.1, 99.1, 103.1, 104.1, 107.1, 108.1, 133.1, 134.1, 136.2, 137.1, 138.1, 138.2, 138.3, 139.2, 139.3, 139.4, 141.1, 141.3, 146.1, 146.2	147.1, 147.2, 149.2, 150.1, 151.1, 151.2, 151.3,
	Description of Project components, their timing, and location.	2.0, 2.6	Sect 3.0 #3		4.1, 14.1, 14.2, 14.3, 14.4		
	Description of related Project activities, their timing and location.	2.0, 2.6, 4.0, 7.0					
	Including as applicable: Construction, operation and maintenance; Closure, decommissioning and restoration; Modification; and Abandonment of permanent and temporary structures.	2.6					
6.3	**Development Phases and Schedule**						
	Location, spatial and temporal extent of Project components and activities as they relate to workforce, roles and responsibilities of governing agencies; and costs.	2.7	Sect. 2.0 #5		40.1, 40.2, 40.3, 63.1	104.2, 106.1	
6.3.1	**New Work and Additional Field Studies Required**		Table 2, 2.7.7		15.1, 22.1, 22.2, 25.1, 36.3	114.3, 131.1, 132.2, 135.1	148.1, 148.2, 148.3, 151.3
	Discussion of field work conducted, since filing the Project Description, and any additional field work proposed to be conducted, including a schedule and how results may affect the environmental review and the final decision on the development. Explanation of why this work wasn't included in the current development submission.	2.7.7					
6.4	**Life of the Project**						
	How this development fits with the overall goals, objectives, and long term planning of the Government of the Northwest Territories (GNWT) for Territorial Highways. Including: responsible governing bodies, funding sources, anticipated use, government response to increased use, contribution of the Project to the objectives of the Government of Canada.	2.7.5, 2.8	Sect. 2.0 #6		39.1, 39.2, 39.3, 42.1		
6.4.1	**Other Parties**						
	Roles and responsibilities of the Hamlet of Tuktoyaktuk and the Town of Inuvik to support and promote this development proposal, including long-term management.	2.7.5			11.1, 11.2, 11.3		
7	**Consideration of Alternatives**						
7.1	**Alternative Means of Carrying out the Project**		Sect. 2.0 #7		3.1, 3.2		
	Discussion and analysis of alternative technical and economical options, their feasibility, environmental effects, and how they contribute to sustainable development in the ISR.	1.6.2, 2.1, 2.2, 2.3, 2.4, 2.5, 4.0					
	Evaluation of relationships and interactions among the various components of the ecosystem, including affected communities.	2.2, 4.0					
	Discussion of environmental effects, and technical and economic feasibility for the preferred option and comparison to alternatives.	2.2, 4.0, Appendix F					
	Criteria and/or constraints used to identify any alternative means as acceptable or unacceptable, and how these criteria and/or constraints were applied.	1.6.2, 2.1, 2.2, 3.0, 4.0					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Rationale for selection of route and rejection of alternatives. Identification of the environmental effects of the various route alternatives.	1.6.2, 2.2.6, 2.2.7, 4.2					
7.2	**Alternative Route Options**		Sect. 2.0 #8		2.1, 2.2, 3.1, 3.2, 18.1, 18.2, 18.3	130.1	
	A description of each alternative route considered and the criteria for selecting them.	1.6.2, 2.1.2, 2.2					
	Environmental assessment of the alternatives to substantiate their inclusion as viable alternatives.	2.2, 4.2					
	How or why they are not environmentally, technically and/or economically feasible (constraints), and the rationale for rejecting any alternatives that are excluded from further assessment.	2.1, 2.2, 2.3, 2.7.6					
	How community engagement/consultation, TK and valued components (from the impact assessment) have influenced these determinations.	1.6.1, 1.6.2, 1.6.3					
	Answers to the following safety questions: What makes the preferred alignment safer than the alternative routes? Which parts of the alternate routes are dangerous and why? How many dangerous areas are present in each of the three routes? How much additional risk is posed by these dangerous features, compared to the preferred alignment? What mitigations can be put in place to alleviate these additional risks? What is the cost of these additional risk mitigation features? What sources of information were used in these determinations?	2.1, 2.2, 2.3, 2.4, 2.7					
8.0	**Key Issues and Study Area Boundaries**						
8.1	**Key Issues**		Sect. 3.0 #4				
	Identification of VCs, for which effects have been predicted, and justification of the methods used to select them.	4.1, 4.1.2					
8.2	**Study Boundaries**						
8.2.1	**Spatial Boundaries**		Sect. 3.0 #5				
	Description of the boundaries used to assess each biophysical or socio-economic element, for all components of the development.	4.1.3					
	Justification and rationale for all of the study area boundaries.	4.1.3					
	Description of the boundaries in a regional context showing existing and planned future land use, surface disturbance, and any current infrastructure.	3.2.9, 4.1.3					
8.2.2	**Temporal Boundaries**						
	Description of temporal boundaries for construction, operation, maintenance, and where relevant, closure, decommissioning and restoration of the sites affected by the development.	2.6, 2.7, 4.1.3	Sect. 2.0 #9				
	Discussion of seasonal and annual variations of environmental components, as applicable, in relation to each phase of the development.	2.6, 2.7, 4.1.3					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
9	**Existing Environment and Baseline Information**				15.1		
	Identification of all potential direct and indirect biological, physical and human elements which could be affected by the proposed development, focusing on relevant issues and considering historical conditions.	3.0					
	List of Elements and Goal statements, plus any additional elements identified by the developer. Justification for any deviation from the elements used in the EIRB goals.	4.0					
	Details on any data manipulation, including accuracy assessments, confidence intervals, and margins of error.	3.0					
9.1	**Biophysical Environment**		Sect. 2.0 #10	2b	17.1, 17.2, 17.3		
	Demonstration of the Developer's understanding of the biophysical environment of the proposed development area, through the presentation of appropriate and current data on the following:	3.1					
	Terrain, Geology, Soils and Permafrost;	3.1.1			18.2, 18.3	91.1, 94.1, 94.2, 100.1, 130.1, 131.1, 132.1, 132.2, 133.1, 135.1, 136.1, 136.2, 136.3, 136.4, 137.1, 138.1, 139.1, 141.1, 141.2, 141.3	148.1, 148.2, 148.3, 149.1
	Climate;	3.1.2			19.1, 19.2, 19.3, 20.1, 20.2	95.1	
	Air Quality;	3.1.3			21.1, 30.1		
	Noise;	3.1.4			6.1, 6.2		
	Water Quality and Quantity;	3.1.5, 3.1.6				104.1, 104.2, 134.1	
	Fish and Fish Habitat;	3.1.7			25.1	104.1, 104.2,	
	Wildlife and Wildlife Habitat;	3.1.9			19.1, 36.3	114.3	
	Birds and Bird Habitat; and	3.1.10					
	Vegetation.	3.1.8			19.1, 22.2		
9.2	**Human Environment**		Sect. 3.0 #6		46.1, 46.2		152.1, 152.2, 152.3, 152.4, 152.5
	Demonstration of the Developer's understanding of the Human environment of the proposed development area, through the presentation of appropriate and current data on the following:	3.2					
	Demographics;	3.2.2			27.1		
	Regional and Local Economies;	3.2.3			28.1		
	Education, Training and Skills;	3.2.4			40.1, 40.2, 40.3, 41.1, 41.2, 41.3, 41.4, 41.5		
	Infrastructure and Institutional Capacity;	3.2.5			28.1		
	Human Health and Community Wellness;	3.2.6					
	Socio-cultural Patterns;	3.2.7					
	Harvesting;	3.2.8					
	Land Use; and	3.2.9			46.1, 46.2		
	Heritage Resources.	3.2.10					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
10	**Impact Assessment**				4.2, 5.1, 10.1, 10.2, 13.1, 13.2, 15.1, 48.1, 55.1, 56.1, 64.1		
	Methods used for the environmental effects assessment, in sufficient detail so the reviewers can understand the rationale, logic, assessment process, and how conclusions were reached.	4.1, 4.2, 4.3, 4.4, 4.5					
	Description of environmental effects of all development components over all phases of the development, including long-term operations and maintenance, including: Direct, indirect, reversible, irreversible, short-term, long-term, and cumulative;	4.0, 5.0					
	The location, extent, and duration of affected elements and their overall impact;	4.1, 4.2, 4.3					
	Focus on the biophysical and socio-economic elements (valued components) identified for the development;	4.0					
	Reference of impacts to elements and goal statements;	4.0					
	Quantified confidence levels for impact predictions that can be used in follow monitoring programs to verify predictions; and	4.0, 5.4.1					
	Consideration of the historic biophysical and human environment conditions in impact assessment and mitigation/ reclamation plans.	1.6.2, 3.0, 4.0, 5.0, 6.0					
10.1	**Biophysical Components**		Sect. 2.0 #1	2b, 2c		95.1	
	Potential impacts of the Project on physical environment VECs.	4.2					
	Assessment of the Areas of Concern.	4.0					
	The nature of potential impacts and how conclusions were reached, for each VEC.	4.2, 5.4.1					
	Clear description of the path from the baseline (current) conditions, to potential impacts, mitigation, residual impacts and determination of significance.	4.2					
	Consider how natural variation or events (e.g., Climate Change) could affect the descriptions of Project impacts.	2.6, 3.1.2, 4.5					
10.1.1	**Terrain, Geology, Soils, and Permafrost**		Sect. 2.0 #1		1.1, 1.2	90.1, 91.1, 91.2, 99.1, 99.2, 130.1, 131.1, 133.1, 135.1, 138.1, 139.2 139.3	
	Potential impacts of the Project on terrain, geology, soils and permafrost, including a consideration of:	4.2.1					
	Slope and soil stability;	4.2.1					
	Erosion on overland low angle sloping terrain;	4.2.1					
	Subsidence;	4.2.1					
	Granular resource extraction areas (include quantity and quality of granular resources);	4.2.1					
	Thaw slumps and compaction of organic peatlands and potential for melt of ice-rich ground;	4.2.1, 4.2.6					
	Drainage beside and beneath the road;	4.2.1, 4.2.4					
	Channelization and non-channelization flow; and	4.2.1, 4.2.4					
	Consideration of mitigation to prevent degradation of permafrost.	2.6, 4.2.1					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	With respect to potential impacts of the Project on permafrost, include the consideration of: Permafrost as a design feature in the road bed; failure modes analysis and associated contingency plans; Thermal condition, active layer thickness, thaw depth, distribution and Stability; Ice rich soils (thaw settlement, thermokarst) permafrost thaw and related settlement; Frost heave of frost susceptible soils in thin permafrost as well as seasonally frozen soils; Thaw or settlement-related impacts on drainage and surface hydrology; and Shorelines, channels, taliks.	2.6, 4.2.1, 4.2.4					
	Combined impacts of the Project and tundra fires.	4.5.4					
10.1.2	**Air Quality**		Sect. 2.0 #1		13.3, 21.1, 21.2, 31.1, 92.5	127.1, 128.1	
	Potential impacts of the Project on air quality including a consideration of: the Project activities and components which would be sources of air emissions;	4.2.2					
	Emissions of concern by source for each Project phase, including quantity, timing and duration, normal operation conditions and upsets;	4.2.2					
	If appropriate, secondary particulate matter, diesel particulate matter, and air pollutants on the List of Toxic Substances in Schedule 1 of CEPA Registry;	4.2.2					
	Air quality parameters that could be affected by these emissions;	4.2.2					
	Acid deposition;	4.2.2					
	How changes in air quality could impact humans, wildlife and vegetation (short-term and long-term over the Project lifespan);	4.2.2, 4.2.6, 4.2.7					
	Ice fog, visibility; and	4.2.2					
	Terrain.	4.2.2					
	Also includes: Discussion of relevant territorial, provincial and federal air quality standards or guidelines, including their purpose and use in relation to the Project phases; Consideration of the CCME's guidance document (CI and KCAC); and Discussion and evaluation of dust suppression techniques.	3.1.3, 4.2.2					
10.1.3	**Noise**		Sect. 2.0 #1		39.1, 39.2, 39.3, 42.1, 6.1, 7.1, 7.2, 13.3	115.1, 115.2, 129.1	
	Potential impacts of Project-related noise, including a consideration of: Project components or activities that could produce noise levels of concern, including source location, timing and duration;	4.2.3					
	Terrain and weather;	4.2.3					
	Disturbance to fish, wildlife and birds including barren-ground caribou and grizzly bear;	4.2.3, 4.2.5, 4.2.7					
	Disturbance of harvest and recreational activities, including tourism;	4.2.3					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Potential impacts to harvesting activities;	4.2.3					
	Impacts to communities;	4.2.3					
	Discussion of relevant territorial, provincial and federal noise standards or guidelines, including their purpose and use in relation to the Project phases;	3.1.4, 4.2.3					
	Comparison of anticipated noise levels along the highway with current industrial, municipal or ambient noise levels;	3.1.4, 4.2.3					
	Assessment of the potential health impacts related to Project-related changes in noise levels, including potential impacts of sleep disturbance and annoyance; and	4.2.3					
	Description of the proximity of the Project to sensitive receptors and environmental elements.	4.2.3					
10.1.4	**Water Quality and Quantity**		Sect. 2.0 #1		21.3, 92.4	97.1, 101.1, 104.1, 104.2, 106.1, 106.2, 108.1, 108.2, 109.1, 109.2, 109.3, 109.4, 109.5, 109.6, 140.1, 140.2, 142.1	
	Potential impacts of the Project on water quality and quantity, including a consideration of: Changes to surface drainage patterns and surface water hydrology including changes caused by Project-related impacts on terrain, soils and permafrost;	4.2.4					
	Hydrogeological resources;	3.1.6, 4.2.4					
	Drinking water quality for humans and wildlife;	3.1.5, 4.2.4					
	Recreational water quality;	3.1.5, 4.2.4					
	Discharge or seepage of wastewater effluent, contaminants, chemical additives;	4.2.4, 4.3.4, 4.4.3					
	In-stream activities (e.g. watercourse crossings);	4.2.4					
	Changes to water quality at water crossings (bridges, culverts and other wetted areas);	4.2.4					
	Changes to water quality due to thaw slumps;	4.2.4					
	Erosion, sediment deposition, sediment re-suspension;	4.2.4					
	Dust and dust suppression;	4.2.4			21.3		
	Increased turbidity;	4.2.4					
	Subsidence;	4.2.4					
	Slope stability;	4.2.4					
	Flow or water levels including the formation of frost bulbs and related icings at watercourse crossings;	4.2.4					
	Water withdrawal and volume of withdrawal; and	1.5.1, 4.2.4					
	Gravel extraction.	1.5.1, 4.2.4					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
10.1.5	**Species of Concern**		Sect. 2.0 #1		22.1, 22.2, 22.3, 23.1, 23.2, 24.1	117.1, 117.2	
	Consideration of any change that the Project may cause to a listed wildlife species, its critical habitat, or the residences of individuals of that species, as outlined in subsection 2(1) of SARA.	4.2.7					
	Discussion of the potential impacts of the Project on species of concern and proposed mitigation in relation to applicable legislation, policy, management plans, recovery strategies, action plans or land use planning initiatives.	4.2.7					
10.1.6	**Fish and Fish Habitat**		Sect. 2.0 #1		1.1, 21.3, 25.1, 32.4, 59.1, 59.2, 59.3, 59.4	103.1, 104.1, 104.2, 106.2, 107.1, 108.1, 108.2, 110.1, 111.1, 112.1, 112.2 143.1, 145.1	
	Potential impacts of the Project on VECs related to fish and fish habitat, including: Proposed watercourse crossings and temporary vehicle crossing methods;	4.2.4, 4.2.5			5.1		
	Standards or guidelines related to watercourse crossings that would be applied;	1.5.1, 4.2.4, 4.2.5					
	Relevant policies, management plans or other measures to protect or enhance fish and fish habitat, including timing restrictions, protected areas or regulations;	1.5.1, 4.2.4, 4.2.5					
	Disruption of sensitive life stages or habitat including loss of substrate habitat, known sensitive or important sites;	4.2.4, 4.2.5					
	Features such as in-stream structure, riparian zones, water quality and flow regimes;	3.1.5, 3.1.6, 3.1.7, 4.2.4, 4.2.5					
	Impacts on food resources;	4.2.5,4.3.7					
	Impacts on water quality or quantity;	4.2.4, 4.2.5					
	Distribution or abundance;	4.2.5					
	Sensitive or important areas or habitat;	4.2.5					
	Contaminant levels in harvested species that could be changed by the Project, if applicable;	4.2.5					
	Fish health and condition;	4.2.5					
	Blockages to movement;	4.2.5					
	Blasting (if required);	4.2.5					
	Dredging or disposal of sediments;	4.2.5	Sect. 2.0 #1				
	Underwater noise associated with Project activities;	4.2.5					
	Water withdrawal;	1.5.1, 4.2.5					
	How Project-related changes in harvest pressures could impact the resource;	4.2.5, 4.3.7					
	Effects to fish populations and harvest activities;	4.2.5					
	Description of any works that may result in potential impacts to fish and fish habitat that cannot be avoided or mitigated, and that may result in harmful alteration, disruption, or destruction (HADD) on fish habitat;	4.2.5					
	The condition(s) to which the ROW (instream and riparian) and temporary work areas would be reclaimed or restored, and maintained once construction has been completed;	4.2.5					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Criteria for evaluating the success of mitigation or reclamation measures, and indicate when and how this evaluation would be conducted; and	4.2.5, 5.4.1, 6.0, 7.0					
	The monitoring program for fish and habitat resources of waterbodies along the highway corridor.	4.2.5, 7.0					
10.1.7	**Wildlife and Wildlife Habitat**		Sect. 2.0 #1		23.1, 23.2, 24.1, 29.1, 29.2, 33.1, 33.2, 33.3, 34.1, 34.2, 34.3, 34.4, 34.5, 35.1, 35.2, 35.3, 36.1, 36.2, 36.3, 36.4, 37.1, 37.2, 38.1, 38.2, 51.1, 51.2, 51.3, 92.6	117.1, 117.2	
	Potential impacts of the Project on VECs related to wildlife or wildlife habitat, including a consideration of: Direct and indirect alteration of habitat including Project footprint impact;	4.2.7					
	Visual or auditory disturbance, including habitat avoidance and effective habitat loss in relation to Project facilities or activities;	4.2.7					
	Wildlife mortality due to harvesting and vehicle collisions;	4.2.7					
	Disruption of sensitive life stages or habitat;	4.2.7					
	Wildlife movement patterns, home ranges, distribution and abundance;	4.2.7					
	Sensitive or important areas or habitat;	4.2.7					
	Population cycles;	4.2.7					
	Predatory-prey relationships;	4.2.7					
	Increased human-wildlife interactions;	4.2.7					
	How Project-related changes in harvest pressures could impact the resource;	4.2.7, 4.3.7					
	Contaminant levels in harvested species that could be changed by the Project;	3.1.9, 4.2.7					
	Wildlife health and condition; and	4.2.7					
	Discussion on the duration and geographic extent of potential impacts in relation to how wildlife populations and harvest activities could be affected.	4.2.7, 4.3.7					
10.1.8	**Birds and Bird Habitat**		Sect. 2.0 #1		26.1, 51.1, 51.2, 51.3	116.1, 116.2, 116.3	
	Potential impacts of the Project on VECs related to birds and bird habitat, including a consideration of: Disruption of sensitive life stages or habitat;	4.2.7					
	Direct and indirect alteration of habitat including footprint;	4.2.7					
	Sensitive or important areas or habitat;	4.2.7					
	Visual or auditory disturbance, including habitat avoidance in relation to Project facilities or activities and light disturbance;	4.2.7					
	Bird distribution or abundance;	4.2.7					
	Contaminant levels in harvested species that could be changed by the Project;	4.2.7					
	Bird health and condition;	4.2.7					
	How Project-related changes in harvest pressures could impact the resource;	4.2.7					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Project-induced subsidence;	4.2.7					
	Highway maintenance;	4.2.7					
	Attraction of predators of birds and bird eggs to the Project, or the provision of nesting or denning habitat for predators and scavengers;	4.2.7					
	Potential mortality from collisions with temporary or permanent tall structures or wires;	4.2.7					
	Potential mortality from vehicle collisions.	4.2.7					
10.1.9	**Vegetation**		Sect. 2.0 #1		22.1, 22.2, 22.3, 31.1		
	Potential impacts of the Project on vegetation, including consideration of: Alteration or loss of species, or vegetation assemblages that are rare, valued, protected or designated sensitive or important areas or habitat;	4.2.6					
	Sensitive or important areas;	4.2.6					
	Introduction of non-native and/or invasive species;	4.2.6					
	How road dust might impact vegetation and surface albedo near highway;	4.2.6					
	How changes might impact permafrost and the highway itself;	4.2.6					
	Changes to the soil, hydrological or permafrost regimes;	4.2.1, 4.2.4, 4.2.6					
	Re-establishment of vegetation and reclamation of borrow sites and other disturbances;	2.6.8, 4.2.6					
	How Project-related changes in harvest pressures could impact vegetation resources;	4.2.6, 4.3.6, 4.3.7, 4.3.8					
	Changes in contaminant levels in harvested species that could be changed by the Project, including parts of plants such as roots, leaves and berries; and	4.2.6					
	Vegetation control.	4.2.6					
10.1.10	**Biodiversity**		Sect. 2.0 #1		22.1, 22.2, 22.3, 23.1, 23.2, 24.1, 26.1, 29.1, 29.2, 33.1, 33.2, 33.3, 34.1, 34.2, 35.1, 35.2, 35.3, 36.1, 36.2, 36.4, 37.1, 37.2, 51.1, 51.2, 51.3, 55.1, 58.1, 58.2, 61	117.1, 117.2, 146.1, 146.2	
	Discussion about changes to the biodiversity of the Study Area(s) during construction, operations and any post-reclamation and the significance of these changes in a local and regional context. Description of how the Project could result in changes to biodiversity, including a consideration of: Ecosystem and habitat loss;	4.2.2, 4.2.5, 4.2.6, 4.2.7					
	Habitat fragmentation/ barriers to movement and gene flow;	3.1.9, 4.2.7					
	Ability of habitat or species to recover;	4.2.6,4.2.7					
	Response to edge effects;	4.2.7					
	Species distribution and abundance;	4.2.6, 4.2.7					
	Invasive/non-native species;	4.2.6					
	Changes to special management areas;	4.3.8					
	Pollution – spills, runoff, water and emissions to air;	4.2.2, 4.2.4, 4.4					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Species of special management concern;	3.1.7, 3.1.8, 3.1.9, 3.1.10, 4.2.6, 4.2.7					
	Project-related changes in harvest levels; and	4.2.7, 4.3.7					
	Changes to important habitat areas.	4.2.7					
10.1.11	**Country Foods**		Sect. 2.0 #1		45.1, 45.2, 46.1	143.1	
	Linkages and related sources of contaminants and other impacts in relation to the potential for contamination of country foods.	3.1.9, 3.2.6, 4.3.7					
	Identification of which country foods are consumed, or expected to be consumed, contaminants of concern, and an indication of whether transport pathways of contaminants into country foods will result from the proposed Project and associated activities.	3.1.9, 3.2.6, 4.3.7					
10.2	**Human Environment Components**		Sect. 2.0 #12	2b, 2c	8.1, 8.2, 9.1, 9.2, 9.3, 65.1, 65.2	143.3	
10.2.1	**General**		Sect. 2.0 #12				
	Positive and negative impacts of the Project on the VCs selected for the human environment.	4.3, 5.4.1					
	Potential changes to social, cultural, and economic conditions that may occur as a result of Project-related biophysical impacts.	1.6.2, 4.3, 4.4.5, Appendix F					
	Social, cultural, and economic impacts, both positive and negative, of year-round access between Tuktoyaktuk and Inuvik, and opened access to harvesting areas and areas of ecological and cultural importance.	1.6.2, 4.3, Appendix F					
	Direct and indirect impacts of the Project that may enhance and/or impair the current social, cultural, and economic ways of life in the communities, and community aspirations for the future.	1.6.2, 3.2.10, 4.3, Appendix F					
	The needs and interests of various segments of the local populations (e.g. youth, Elders, women, harvesters), and how the Project may affect each of them.	1.6.2, 3.2.4, 4.3					
	Possible reactions to Project-related effects, as well as the capacity of local residents, communities, and institutions to respond to the Project.	1.6.2, 4.3					
	How people, communities, institutions, and governments might be expected to adapt to Project-induced changes to the human and biophysical environments.	4.3	Sect. 2.0 #12				
	Local residents' perceptions of impacts and how these are grounded in their culture, social organization, and historical experience.	1.6.2, 4.3					
	The limitations of this study in identifying any of the potential effects.	4.3					
	How mitigation would address impacts experienced by residents: by age group, gender and ethnicity (where appropriate).	4.3, 5.4.1, 6.0					
	How Inuvialuit organizations will be involved in the development, application and ongoing evaluation of mitigation measures. Parties responsible for the implementation of mitigation measures and how a lack of resources and/or information may have the potential the effectiveness of mitigation measures.	1.5.1, 4.2, 4.3, 6.0	2.7.7.11		4.2, 11.1, 11.2, 11.3, 12.1, 12.2, 23.2, 32.1, 51.1, 51.3, 54.1, 54.3, 55.2, 60.1, 60.2, 60.3, 61, 63.2, 66.1, 67.2, 67.3	144.3, 145.2	

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
10.2.2	**Demographics**		Sect. 2.0 #12				
	Potential impacts of the Project on demographics and mobility, including a consideration of:	4.3.1					
	Age and gender;	4.3.1, 4.3.2					
	Residence patterns; and	4.3.1					
	In/out migration, by community and for the Inuvialuit Settlement Region (ISR).	4.3.1					
10.2.3	**Regional and Local Economies**		Sect. 2.0 #12		39.1, 39.2, 39.3, 42.1		
	Potential impacts of the Project on local, regional (ISR), and territorial economies, including consideration of: Project contribution to the GDP - direct, indirect, and induced economic activities for the regional (to the extent possible), provincial, territorial, and national economies;	4.3.2, Appendix F					
	Direct taxes (estimated) for business and persons;	4.3.2, Appendix F					
	Employment and income for every year of construction and operation;	4.3.2, Appendix F					
	The extent to which the skills of the available workers match the job requirements;	4.3.2					
	The level of interest in Project-related work;	1.6.2, 4.3.2					
	Commuting arrangements for workers;	2.6.9					
	How any unionized labour could impact employment and income;	4.3					
	Hiring opportunities, priority hiring practices;	2.7.3, 2.7.4, 4.3.2					
	Skill or certification requirements;	2.7.4, 3.2.4, 4.3.2					
	The equitable distribution of benefits to residents and communities in the Project area;	1.6.2, 2.2.4, 2.6.8, 4.3.2, 4.3.8					
	Competition for labour between the Project and existing businesses, government institutions and traditional activities and related wage and salary impacts;	1.3, 4.3.2, 4.3.7					
	Community income and household economics, including subsistence activities and the sustainability of traditional economies;	3.2.3, 3.2.4, 3.2.8, 4.3.2, 4.3.7					
	Local consumer prices, inflation and costs of living, particularly with regard to food, transportation, utilities, and shelter; and	3.2.3, 3.2.4, 3.2.8, 4.3.2, 4.3.5, 4.3.7					
	How Project-related impacts on harvested resources or harvest activities (both positive and negative) affect community income and household economies, and sustainability of traditional economies.	4.3.7, 4.3.8, 4.4.5, 5.4.1					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
10.2.4	**Education, Training and Skills**		Sect. 2.0 #12		40.1, 40.2, 40.3, 41.1, 41.2, 41.3, 41.4, 41.5		
	Describe and evaluate the potential impacts of the Project on education, training and skills, including a consideration of: Participation in education and training, by age, gender and ethnicity;	4.3.3					
	Educational achievement and attainment;	4.3.3					
	Literacy levels (English and Inuvialuktun);	4.3.3					
	Education and training programs required for Project-related construction and operation employment, including: Local and regional training opportunities available to local people;	3.2.4, 4.3.3			1.1		
	Timing and duration of programs, in relation to the Project schedule;	2.7.2, 3.2.4, 4.3.3					
	Which skills and experience gained in the Project workforce that could be applied to other available projects or sectors; and	2.7.4, 4.2.7, 4.3.3					
	Programs that would be provided by, or sponsored by, the Proponents.	1.1.2, 2.7.4, 4.2.7, 4.3.3					
10.2.5	**Infrastructure and Institutional Capacity**		Sect. 2.0 #12		44.1		152.2, 152.3, 152.4, 152.5
	Describe and evaluate the potential impacts of the Project on infrastructure and institutional capacity, including a consideration of: Temporary and permanent changes to infrastructure and services and the capacity of institutions and organizations to deliver those services identified in the baseline description;	1.3, 4.3.1, 4.3.4					
	Changes in the capacity of the service industries to provide local goods and services;	1.3, 4.3.1, 4.3.4					
	Changes in the availability, quality and affordability of housing in communities, including factors that influence accessibility to housing (e.g. age, gender); and	4.3.4			28.1, 28.2		
	Measures to address any changes in the level of demand for infrastructure and institutional capacity and an estimate of incremental costs to municipal, regional, territorial, and federal governments resulting from the Project.	4.3.2, 4.3.4					
10.2.6	**Human Health and Community Wellness**		Sect. 2.0 #12		43.1, 43.2	127.1, 128.1, 129.1	
	Potential impacts of the Project on human health and community wellness, including a consideration of: Local perceptions of physical, mental and social health and changes in the quality of life, including differences or similarities in perceptions within and between Inuvik and Tuktoyaktuk;	1.6.2, 4.3.5, 4.3.6, 4.3.7					
	Measures of mortality and morbidity, and of social pathology and dysfunction such as teen pregnancies, sexually transmitted infections, communicable diseases, substance abuse, family violence, and crime; and	3.2.2, 3.2.6, 4.3.5					
	Changes in diet and use of country food.	1.6.2, 3.2.6, 3.2.8, 4.3.5, 4.3.7					
	How Project-related changes in the quality of country food affect health, including possible sources of contaminants, exposure pathways and consumption patterns (i.e., age group, sex).	1.6.2, 3.1.9, 3.2.6, 4.3.5, 4.3.7					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	How Project-related impacts on harvested resources or harvest activities affect health and wellness.	1.6.2, 4.3.5, 4.3.6, 4.3.7					
	Describe and evaluate potential impacts that may arise from changes in: Water quality and air quality;	4.2.4, 4.2.5, 4.3.5, 4.4					
	Poverty and homelessness;	3.2.4, 4.3.5					
	Literacy skills and education levels; and	3.2.4, 4.3.3					
	The presence or absence of support systems and programs, regionally and locally and their capacity to address human health and community wellness.	3.2.6, 3.2.7, 4.3.6					
10.2.7	**Socio-cultural Patterns**		Sect. 2.0 #12		39.1, 39.2, 39.3, 42.1, 46.1, 46.2, 47.1	143.1	
	Describe and evaluate the potential impacts of the Project on social and cultural patterns and cohesion, including: How Project-related impacts on harvested resources or harvest activities affect social and cultural patterns and cohesion;	1.6.2, 4.3.6, 4.3.7					
	Traditional lifestyles, values and culture;	3.2.7, 4.3.6, 4.3.7, 4.3.8, 4.4.5					
	Cultural and spiritual life of the communities, including language loss or retention;	3.2.7, 4.3.3, 4.3.6, 4.3.8, 4.4.5					
	Patterns of social organization at the household and community level, including the organization of work, mutual aid and sharing;	3.2.7, 4.3.6					
	Family dynamics or structure, including child and elder care;	1.6.2, 3.2.5, 3.2.7, 4.3.5, 4.3.6					
	How the influx of tourists, and potential influx of Project-related employees for future projects and workers could impact communities;	1.6.2, 4.3.1, 4.3.2, 4.3.4, 4.3.6, 4.3.8					
	Social relations between residents and non-residents, and between Aboriginal and non-Aboriginal persons; and	1.6.2, 3.2.7, 4.3.1, 4.3.2, 4.3.6, 4.3.8					
	Programs that could support cultural patterns and cohesion.	3.2.5, 3.2.7, 4.3.3, 4.3.6					
10.2.8	**Harvesting**		Sect. 2.0 #12		34.2, 34.3, 34.4, 34.5, 45.1, 45.2, 46.1, 46.2, 51.1, 51.2, 51.3	112.1, 143.1, 144.2	
	Potential impacts of the Project, for the preferred and alternate routes, on harvesting during both construction and operation including a consideration of: Changes in access, including increased access to the land and surrounding lakes, as well as increased access to an environmentally and culturally sensitive area (Husky Lakes);	4.3.7, 4.3.8					
	Changes in the abundance and distribution of harvested resources, including wildlife, birds, fish and vegetation that would negatively affect harvesting;	4.2.5, 4.2.6, 4.2.7, 4.3.7					
	Disturbance of harvest patterns, or loss or alteration of high-value harvest areas;	4.2.7, 4.3.7, 4.3.8, 4.4.5					
	Changes in the quality of harvested species (including contamination) that would negatively affect their consumption or sale;	3.1.9, 4.2.5, 4.2.6, 4.2.7, 4.3.7, 4.4.5					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Measures to avoid or minimize changes in the abundance, distribution, or quality of harvested species, or mitigate the consequences of such changes;	4.2.5, 4.2.6, 4.2.7, 4.3.7					
	Mechanisms to control Project workforce-related hunting, fishing, or harassment of wildlife; and	4.2.5, 4.2.7, 4.3.7, 6.0					
	Mechanisms of resource management agencies and other parties to control hunting, fishing, or harassment of wildlife.	3.1.9, 3.2.8, 4.2.5, 4.2.7, 4.3.7, 6.0					
10.2.9	**Land Use**		Sect. 2.0 #12		39.1, 39.2, 39.3, 42.1, 46.1, 46.2, 47.1, 54.1, 54.2, 54.3	111.2, 143.1	
	Potential impacts of the Project on land use, including a consideration of various land uses, including: Traditional use; Tourism and changes in tourism access; Industrial use and changes in access;	3.2.9, 4.3.8					
	Patterns of use and changes in these patterns; and	3.2.9, 4.3.8					
	Impacts on particular sites or features.	3.2.9, 4.3.8					
	Conformity of proposed Project-related land uses with designated land use management areas as described in approved and draft management plans, community conservation plan, and proposed land use designations and identification of discrepancies.	3.2.9, 4.3.8					
	An evaluation of the potential impacts of the Project on protected areas and special management areas, including a consideration of the following: Community conservation plans; Regional land use plans; Existing and proposed protected areas; Special management areas; Other proposed special management areas such as parks, sanctuaries or preserves; and Implementation of plans, action plans, strategies and guidelines.	3.2.9, 4.3.8					
10.2.10	**Heritage Resources**		Sect. 2.0 #12				
	Describe and evaluate the potential impacts of the Project on cultural heritage and special management areas, including a consideration of the following: Historic, archaeological, paleontological, cultural and heritage resources/ sites/ trails;	3.2.10, 4.3.9					
	Resource potential;	3.2.10, 4.3.9					
	Encounter of resources during Project activities; and	3.2.10, 4.3.9					
	Valued visual and aesthetic locations and their attributes.	3.2.9, 4.3.8					
10.3	**Potential Accidents and Malfunctions**			2c	67.1, 69.1, 69.2, 69.3, 69.4, 69.5, 69.6, 69.7		
	Possible accidents or malfunctions, their probable and potential effects on the environment, including impacts on social, economic, and cultural elements of the environment and human health to people in close proximity of accidents or malfunctions, including spills of contaminants for the life of the Project.	4.4					
	The process for the implementation of any mitigation measures or contingency plans.	4.4.5					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Discussion of the developer's commitment to having an Environmental Protection Plan (EPP) and Emergency Response Plan (ERP) that would address potential accidents and malfunctions for the life of the Project.	4.0, 4.4, 6.0, Appendix E			55.1		
	Sensitive elements, including those identified in the IFA and CPPs, of the environment that could be affected in the event of an accident or malfunction over the life of the Project.	4.4					
	The probability of impacts, taking into account weather or extreme external events that present contributing factors.	4.4, 4.5					
	For each Project phase, the potential accidents or malfunctions that may occur as a result of the Project.	4.4					
10.4	**Effects of the Environment on the Project**				1.1, 1.2, 68.1, 68.2	91.1, 95.1, 96.1, 96.2, 96.3, 96.4, 133.1, 134.1, 137.1	
	The effects of the environment on the Project.	4.5					
	How the Project is engineered and designed to integrate into its environmental surroundings and operate safely and reliably over its life.	4.5					
	How physical and biological changes in the environment could have implications for the Project.	2.4, 4.5					
10.5	**Determination of Significance**			2c	10.1, 10.2		
	Approaches used to determine the significance of effects for each biophysical or socio-economic element assessed	4.1					
	Definition of impacts in terms of magnitude, geographic extent, duration, and frequency.	4.0, 4.1					
	Justification and rationale for thresholds relating to the impacts criteria and how the impacts criteria inform the assessment about the significance of impacts, under the assumption that mitigation measures will be implemented successfully.	4.1, 4.2, 4.3, 5.4.1					
	Positive and negative impacts.	4.1, 4.2, 4.3, 5.4.1					
11	**Cumulative Effects**			2c	48.2, 48.3, 49.1, 49.2, 50.1, 51.1, 51.2, 51.3, 52.1, 52.2, 52.3, 52.4,, 53.1, 53.2, 54.1, 54.2, 54.3	113.1, 113.2, 114.1, 114.2	152.2, 152.3, 152.4, 152.5
	Assessment of cumulative effects, showing that long-term cumulative effects are adequately considered and can be successfully mitigated.	5.0					
	Discussion of the incremental contribution of all projects or activities (including operation of the hwy) in the delineated Study Area(s), and of the Project alone, to the total cumulative effect on the VEC or VSC over the life of the Project.	5.0					
	Spatial and temporal boundaries for the cumulative effect assessment for each VEC selected.	5.1, 5.2					
	Analysis of impacts of Project activities when they are combined with the impacts of other past, present, and future projects and activities.	5.3, 5.4					
	Different types of potential impacts, different forms of effects, such as synergistic, additive, induced and spatial or temporal overlap; and impact pathways and trends.	5.0, 5.4.1					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Rationale for the process chosen to carry out the cumulative effects assessment; and description of, and rationale for, the approach and methods used to identify and assess cumulative effect; and the approach of the assessment in the context of the IFA and updated CCPs.	5.0					
	Identification and justification of (VECs or VSCs) for all Project components involved in the cumulative effects assessment, including those for alternative routes.	4.1, 5.4					
	Evaluation of the potential for this Project to catalyze future projects and the effects these potential projects and the associated loss of remoteness.	1.3, 2.8, 3.2.8, 4.3.2, 5.3, 5.4.1, Appendix F					
	Contribution of the Project to a total potential cumulative effect.	5.3, 5.4					
	Potential cumulative Project effects in a regional context, considering regional plans, community conservation plans, species recovery plans, management plans, objectives and/or.	5.3, 5.4					
	Identification of any changes in the original environmental effects and significance predictions for the Project.	5.4					
	Effectiveness of the proposed mitigation and/or other restitution measures, the response to such changes, and implications for monitoring and follow-up programs.	4.0, 5.4, 6.0, 7.0					
	Proposed management tool(s) for cumulative effects resulting from the proposed Project.	4.0, 5.4, 6.0					
12	**Mitigation, Mitigative and Remedial Measures, and Worst Case Scenario**		Table 1	2b, 2c	12.1, 12.2, 16.1, 16.2, 16.3, 36.4, 43.2, 48.1, 55.1, 55.2, 58.1, 58.2, 64.1, 65.1, 69.1, 70.2	103.1, 108.2	
	Examination of all mitigation measures, identified during the impact assessment to identify development impacts that could affect wildlife harvesting, from a worst case scenario perspective.	4.2.7, 4.3.7, 4.3.8, 4.4.5					
	Discussion and conclusions reached in this chapter are necessary to address the specific requirements of the IFA and have been requested for liability/compensations purposes.	4.4.5					
12.1	**Mitigation**						
	Summary table of detailed mitigation commitments of the Developer, including: measures, implementation methods, identified impacts and VCs.	4.2, 4.3, 6.0			21.2, 32.3, 32.5, 34.4, 51.1, 54.3, 59.3, 61, 62.2, 65.3	143.5	
12.2	**Mitigation and Remedial Measures**						
	Mitigative and remedial measures designed to reduce or eliminate negative impact to wildlife, wildlife habitat and wildlife harvesting in the EIS.	4.2, 4.3, 6.0			5.2, 22.3, 32.1, 32.3, 32.5, 34.2, 34.3, 34.4, 34.5, 36.4, 38.1, 38.2, 43.2, 44.1, 51.1, 51.2, 51.3, 52.3, 52.4, 53.1, 53.2, 54.3, 56.1, 57.1, 58.1, 58.2, 59.3, 59.4, 60.1, 60.2, 60.3, 61, 62.1, 62.2, 62.3, 62.4, 65.3, 65.4, 70.1, 70.2	91.1, 92.4, 92.5, 92.6, 93.2, 97.1, 99.2, 101.1, 103.1, 106.2, 108.2, 143.5, 143.6, 144.1, 144.3, 145.2	

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
12.2.2	**What Developers Shall Consider**				See section TOR 12 and TOR 12.2.	See section TOR 12 and TOR 12.2.	
	A description of any potential impacts to the biophysical and human environment, wildlife, wildlife habitat, and wildlife harvesting activities.	4.2, 4.3, 5.4, 6.0					
	A description of the proposed mitigation to reduce or eliminate potential impacts.	4.2, 4.3, 6.0					
	Measures to address sensory disturbances to wildlife, particularly barren-ground caribou and grizzly bear.	4.2.7, 6.0					
	An outline of emergency response plans and any management and monitoring plans proposed and/or required for the development to proceed.	4.0, 4.4, 6.0, Appendix E					
	Where appropriate, a clear indication of the party responsible for implementing the mitigation.	2.7.5, 4.0, 6.0					
	Mitigation to reduce the potential negative effects of a development.	4.2, 4.3, 6.0					
	Measures that are built into the design of the development can be included in the discussion of development activities.	1.6.2, 2.6, 3.0, 4.0					
	Rationale for mitigation measures and examples of where these measures have been used effectively.	2.6.1, 4.2, 4.3, 6.0					
12.3	**Worst Case Scenario**						
	Worst case scenario estimate for negative impacts to wildlife, wildlife habitat and wildlife harvesting, as a result of the proposed development.	4.4.5			9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 69.1, 69.2, 69.3, 69.4, 69.5, 69.6, 69.7		
12.3.1 12.3.2 12.3.3	**Wildlife Compensation, Liability and Worst Case Scenario**				See TOR 12.3		
	The Developer's potential Liability, based on worst case scenario. If there is a possibility that damage to wildlife or wildlife habitat may occur as a result of the Project, the EIRB must recommend terms and conditions relating to mitigative and remedial measures that are necessary to minimize the negative impact of a proposed development on wildlife harvesting. The Worst Case Scenario will be used to calculate a security amount to be held by the federal Minister.	4.4.5					
12.3.4	**Wildlife Habitat Restoration**				See TOR 12.3		
	Restoration includes post-development measures that would enhance recovery of harvested populations to pre-development levels. Determining the practicality and potential costs of restoration resulting from a "worst case scenario".	4.4.5					

TABLE E: CONCORDANCE TABLE							
ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
13	**Follow-up and Monitoring**						
	"Follow-up" program for verifying the accuracy of the environmental assessment of the Project, and determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the Project, including: Regulatory and non-regulatory monitoring requirements for the life of the Project; Purpose of each program, responsibilities for data collection, analysis and dissemination, and how results will be used in an adaptive management process; and How Project-specific monitoring will be compatible with the NWT CIMP or other regional monitoring programs.	4.0, 7.0		2c	11.1, 11.2, 11.3, 12.1, 12.2, 15.2, 21.2, 48.1, 51.1, 51.2, 51.3, 52.1, 52.4, 56.1, 57.1, 60.1, 60.2, 60.3, 61.1, 61.2, 61.3, 65.1, 65.2, 65.3, 65.4, 67.4, 67.5	93.2, 97.1, 102.1, 102.2, 102.3, 102.4, 105.1, 108.2, 109.1, 109.2, 109.3, 109.4, 109.5, 109.6, 110.1, 145.2	
13.1	**Environmental and Socio-Economic Effects Monitoring**						
	Table with effects monitoring requirements, including: effects, indicators and parameters for each effect or concern; and the target or management goal.	7.0	Sect. 2.0 #13	2b	16.1, 16.2, 16.3, 22.1, 61, 64.1, 66.1, 66.2, 67.2, 70.1, 70.2,	91.2, 93.2, 97.1, 102.1, 102.2, 102.3, 102.4, 105.1, 112.2, 143.2, 143.3, 144.1, 144.3	
13.2	**Compliance Monitoring**						
	Environmental Monitoring Inspection Requirements Table, that includes: Current conditions of any applicable permits, licenses and approvals; The frequency, nature, and period of time of inspections; and Demonstrates how the terms and conditions set out in regulatory approvals, licenses and permits, and in the commitments submitted by the Developer will be adhered to and met and will be used by the environmental monitoring to verify and report the work being done.	7.0	Sect. 2.0 #14	2b	21.2, 61, 63.2, 64.1, 67.3, 67.4, 70.2	102.1, 102.2, 102.3, 102.4, 105.1, 108.2, 110.1, 143.2, 143.3, 144.3	
13.3	**Environmental Management Plans**						
	Environmental management plans for specific areas of concern to meet environmental goals for life of the Project, including: Methods for the implementation of mitigation measures; Methods for the monitoring of mitigation effectiveness; Reporting mechanism on goals; and Incorporation of plans identified by the Developer in the EIS as being required and other plans deemed necessary.	4.2, 4.3, 6.0, 7.0, Appendix E	2.7.7.10	2b	32.1, 32.2, 32.3, 32.5, 36.4, 56.1, 57.1, 61, 62.1, 62.2, 62.3, 62.4, 63.1, 63.2, 64.1, 66.1, 66.2, 67.1, 67.5, 70.2	102.3, 102.4, 105.1, 110.1, 111.1, 111.2, 144.1, 144.3, 145.2	
13.4	**Socio-economic and Cultural Effects Management, Policies, and Commitments**				55.1, 67.1	112.1, 105.1, 111.2, 143.6, 145.2	
	Management plans, policies, commitments, and arrangements directed at promoting beneficial or mitigating negative impacts to social, cultural, or economic conditions where they have been presented as a form of mitigation. Discuss any requirements for contractors and sub-contractors to comply with these policies.	4.0, 4.3.2, 6.0, 7.2			44.1, 44.2/3		
	Recruitment, training, hiring, pay equity and employment policies, including those policies specifically for Aboriginal and local candidates, and those promoting participation.	1.3, 1.6.2, 4.2.7, 4.3.2, 4.3.3, 7.2					
	Contracting and procurement policies, including those which promote local sourcing, and participation of local businesses and how this will be accomplished.	1.3, 1.6.2, 2.2.4, 2.2.6, 4.3.2					

TABLE E: CONCORDANCE TABLE

ToR Section	Information Requested	EIS Location	Addendum	Conformity (2b and 2c)	IR Round 1	IR Round 2	IR Round 3
	Employment policies, including policies on alcohol and drugs on the job site, harassment policies, firearms policies, work and pay schedules, and any policies related to worker access to harvesting areas.	4.3.8, 7.2			1.1, 44.2/3		
	Commuting and work rotation of workers and contractors.	2.6.9, 4.3					
	Policies to managing hunting, fishing and gathering on, or from, the work site by non-Inuvialuit employees and contractors, while respecting the harvest rights of Aboriginal employees and contractors.	3.1.9, 3.2.8, 3.2.9, 4.2.7, 4.3.7, 4.3.8, 6.0					
	Occupational health and safety and related training, and emergency response plans for workplace accidents.	4.2, 4.4 Appendix E			1.1, 67.1		
	Scheduling of construction activities to accommodate needs of Aboriginal harvesters (employees, contractors, and non-employees).	4.3.8					
	Scheduling of work activities to accommodate needs of Aboriginal employees and contractors to pursue other traditional activities.	4.3.8					
	Promoting activities and programs that increase community stability and wellness.	1.6, 3.2.6, 4.3					
14	**References**						
	Information used to prepare the EIS, including: primary, peer-reviewed literature, government and consultant reports, personal communications, guidelines and best practices.	References					

ATTACHMENT 1

Tuktoyaktuk to Source 177 Access Road

Pre-Construction Safety Meeting and Orientation Presentation

TUKTOYAKTUK TO SOURCE 177 ACCESS ROAD

Pre- Construction

Safety Meeting and Orientation

Introductions

- Management Team
- Russell Newmark – C.E.O.
- Doug Saunders – Operations Manager
- Darren Klippenstein – Project Superintendent
- Ryan Yakelaya – Day Shift Foreman
- Andy Surinak – Night Shift Const. Foreman
- Garfield Meissner – Night Shift Foreman
- Shaun Lundrigan – Shop Foreman
- Randy Hein – Safety Supervisor

PROJECT OVERVIEW

- Permit ILA08TF021
- Ice Road Construction
- Quarry Preparation
- ROW Preparation – Clearing Snow
- Installation of Geotextile Material
- Material Placement
- Culvert Installation
- Leveling Material
- Compact Material
- Cleanup

SAFETY MATTERS

PREVENTION OF ACCIDENTS IS EVERYBODIES BUSINESS

Hazard Assessments

- **Purpose** - To identify and control hazards throughout all phases of work in to eliminate injury and damage.
- **Policy** - Prior to the commencement of work on any EGT project the project supervisor must ensure that a hazard assessment has been completed.
- A hazard is any circumstance or condition that poses the risk of an incident to either man or machine.
- A hazard assessment is a thorough examination of a project or operation for the purpose of identifying what actual or potential hazards exist.

Hazard Assessments

- There are Near Miss/Hazard ID cards available, which can be used to report both safety concerns and to the acknowledge safe work practices of those who demonstrate safety leadership.
- There will be a weekly draw for an award valued at approximately $50.00.
- There will be a draw for a laptop computer at the end of the season. All those who submitted cards will have their name entered.

Tuk Camp Rules

- All personnel should familiarize themselves with the camp layout and the facilities available, and familiarize themselves with the emergency exits. If everyone does their part to keep the camp clean and in good condition it will ensure continued availability of the various amenities.
- Smoking is permitted in one area of the camp. The TV room located on the second floor is the selected designated smoking area. Otherwise, smoking is strictly prohibited in the rest of the camp.

Tuk Camp Rules

- The consumption and/or possession of alcohol or non-prescription drugs is strictly forbidden in the camp or on E. Gruben's Transport Ltd. property. A zero tolerance policy is in effect regarding these items and failure to comply may result in immediate removal from the camp.
- Coveralls, hard hats, work boots and other work clothing are to be left in the mudroom. Hats may not be worn in the dining room. Bare feet are not permitted outside of the bedrooms or recreational areas.

Tuk Camp Rules

- Please use courtesy and common sense in regards to activity and noise levels in the camp at all times.
- Do not tamper with the fire/smoke alarms and do not use the fire exits except in the case of an emergency.
- Please make yourself familiar with the fire exits in the building. In the event of a fire please ensure the safety of yourself and others by calmly proceeding to your designated fire exit.

Operation of Vehicles

Operation of Vehicles

- **Company Vehicle Policy**
- **Purpose** - To reduce injury and property damage due to use of company vehicles.
- **Policy** - EGT realizes driving is one of the most hazardous tasks workers perform. It is the only task that is completed frequently that has the potential for severe personal injury even if everything reasonable has been done prior to starting the task. All personnel operating a EGT vehicle (owned, leased or rented) and subcontractors will do so in accordance with all applicable laws, regulations and EGT's safety policy. To assist in the prevention of driving related incidents the following guidelines will be followed:

Operation of Vehicles

- Heavy equipment have right-of-way.
- All traffic to come to a complete stop at intersections.
- Speed limits are in effect for everyone's safety be prepared for speed limits of 50 km on the ice road with maximum speeds of 25 km on curves and ice bridges.
- Use courtesy, no racing, no unnecessary passing, yield ROW, drive defensively.

Operation of Vehicles

- Do not tailgate another vehicle as two vehicles act as a single load which increases stress on the ice road.
- Make a mental note of kilometre markers as you travel in the event of an emergency.
- Do not discard foreign materials on ice.
- Slow down if roads are rough
- Keep your vehicles clean and in good condition

Driving and Speed Limits

- Any employee operating a licensed vehicle on or off right of way must possess a valid driver's license of proper class. Any changes to status of driver's license must be reported immediately to the EGT Supervisor.
- Employees will ensure vehicles, which have been assigned to them, are operated in accordance with this program, including the drug and alcohol policy, in accordance to driving regulations and are only used for approved company business. **Employees will be financially responsible for any traffic violations.** Workers receiving, and failing to report any known traffic violations, will be subject to disciplinary action, up to and including dismissal.
- Workers are to ensure that the driver of any vehicle they are a passenger in, is fit and able to operate the vehicle in accordance with this policy.

Driving and Speed Limits

- All commercial company vehicles will be equipped with proper safety equipment in accordance with highway and worksite rules and regulations. Each vehicle will have, as a minimum, a fire extinguisher, first aid kit, reflective triangles.
- Workers will secure vehicle loads, as per legislative and company requirements, prior to moving the vehicle. Loose objects must not be transported in the crew compartment of the vehicle.
- Heavy vehicle operators will meet the requirements of the national safety code (NSC), including the completion of an "hours of service" logbook. The logbooks will be completed as per NSC Guidelines and handed into the applicable division office.

Driving and Speed Limits

- All company vehicles will be driven with their headlights **on** at all times, to ensure that vehicles, both on-coming and following, have a greater chance of awareness of their presence.
- Workers will ensure vehicles are in good repair and clean condition. Only personnel authorized to complete repairs are allowed to complete maintenance on vehicles.
- Drivers of company vehicles, are responsible for reporting all accidents or damage to their supervisor immediately, and ensure any injured person receives prompt medical attention. The drivers are also responsible to report the accident to all applicable authorities as directed by regulation.

Incidents and Accidents

- Driving accounts for the majority of all workplace accidents and incidents.
- Speed limits will be posted at 50 KMH on the Big Lake; however worksite conditions will require operators to reduce speeds on the ROW and other access Roads.
- REMEMBER!!! End Dumps are by design very unstable when the box is lifted. Ensure your truck and trailer are on stable and level ground BEFORE dumping your load.

Care of Trucks and Equipment

- **Equipment & Vehicle "Walk-Around" – Pre-Trip Inspections**
- Daily pre-trip equipment and vehicle walk-around inspections are to be done prior to commencing daily work duties to monitor any wear and tear.
- If there is more than one operator, assign who will be responsible for equipment and vehicle walk-around inspection.
- Critical checks would include fluid levels, belts, hoses and electrical connections.
- Required emergency survival gear will also be checked

Care of Trucks and Equipment

- **Company Inspection Checklist**
- Standard checklist ensures nothing is missed.
- Checklists provide a detailed record of the inspection findings.
- Checklists provide a detailed record of corrective measures needed.
- Include monthly inspections of shop and yard.
- On-going inspections of work practices and work site conditions.

Care of Trucks and Equipment

- **Government and ILA Inspections**
- Inspect to ensure company meets Regulatory Requirements.
- These inspections may assess records, plans, policies, equipment and/or work procedures.
- The inspectors may interview anyone on the work site.
- They have the right to remove any item from the work site they need to inspect further.
- Anyone on site at the time of the inspection must co-operate with the inspector.
- Stop work orders can be given if Life-Threatening conditions are discovered.
- Lesser violations will attract orders to correct the violations or deficiencies.

Defensive and Off-Road Driving

- Driving, especially off-road, is an activity which presents numerous hazards which must be managed effectively to prevent injuries and fatalities. Speed is a major contributing factor in most injury and fatal accidents. EGT employees are to observe all speed limits and use a common sense approach in assessing driving conditions. Drive at speeds appropriate to road and weather conditions.

Wildlife

Wildlife

Wildlife and Environment

- This project is located on Inuvialuit Land
- We have ILA Monitors on this project to ensure the environment and the wildlife are respected
- The Wildlife Monitor is on site for two main purposes to protect the animals from us and to protect us from the animals
- The Environmental Monitor is on site to ensure we abide by the Land Use Permit
- We will also have ILA Gravel Haul Monitors checking and counting loads

Wildlife

Wildlife and Environment

- We must all do our work in a manner that respects the land and the environment
- The guiding principle is to do everything possible to prevent damage.
- All spills need to be reported, cleaned up and documented.
- Garbage must be pick up and disposed of properly. If everyone does their part we will have no negative impact on the environment or wildlife. Garbage attracts wildlife, which is not good for them or us.

Ice Road Safety

Ice Road Safety

- An ice road is a difficult and challenging driving area to begin with. Vehicle breakdowns and sudden changes in the weather can compound the hazard to a critically unsafe condition for ill-prepared personnel. Prevention is the KEY!
- Dress adequately for the weather and ensure that each person in the vehicle has arctic clothing sufficient to wait out an extended period of time in an unheated vehicle.
- You may be required to wear safety glasses while traveling and proper winter foot-wear will be compulsory when walking on the ice road.
- Food and water should be taken along when traveling the ice road in case of a breakdown and a delay in being picked up.

Ice Road Safety

- Be sure to inform someone of your travel plans on the ice road and include your estimated arrival time.
- Carry communications in the form of a radio and/or telephone, or travel in convoy with vehicles possessing communication equipment.
- Single persons should not venture onto the ice when there is no help at hand.
- Keep all unnecessary communication off the radio. Absolutely no swearing or profanity is allowed during any radio communication.

Ice Road Safety

- All vehicles are required to carry the following items when traveling on ice roads:
- Always begin your journey with a full tank of fuel.
- Portable or fixed drip liner must be used when the vehicle is parked for any length of time on the ice road.
- Snow shovel and tow rope should be carried.
- Working headlights, horn, heater and windshield wipers.
- Survival gear, food and water.
- First Aid kit.
- Reflective triangles.
- Fire Extinguisher.

Defensive and Off-Road Driving

- SUPERVISORS AND EMPLOYEES SHARE IN THE RESPONSIBILITY THAT ENSURES THAT VEHICLES ARE PROPERLY MAINTAINED AND EQUIPPED FOR THE CONDITIONS THAT WILL BE ENCOUNTERED EN-ROUTE.
- EGT HAS AN ABANDONED VEHICLE PROTOCOL , WHICH IS SET OUT IN THE ORIENTATION PACKAGE.
- ABANDONED VEHICLES MUST BE REPORTED IMMEDIATELY TO SUPERVISOR, PULLED TO THE EXTREME RIGHT AND CLEARLY MARKED WITH REFLECTIVE TRIANGLES .

Fueling Procedure

- **Do:**
- Ensure stationary storage fuel tanks are vented and kept clear of buildings, and if not buried, should be grounded.
- Carry gasoline in a closed container, which is adequately vented.
- Inspect the tanks daily for leaks and ensure that the static chain is attached.

Fueling Procedure

- Keep the metal fill nozzle in contact with the lip of the tank to eliminate any static accumulation.
- Take care not to over fill any equipment tanks
- Use three point system when climbing on or off equipment

Fueling Procedure

- **Do Not:**
- Smoke while fuelling is in progress.
- Allow open fires, welding, etc. in the fuelling zones.
- Fuel equipment before it is shut off.
- Overfill any equipment fuel tanks.

Fueling Procedure

- Climb on equipment until it has been shut off.
- Leave fuel pumping unattended
- Work on equipment over 3 meters without proper fall protection

Fueling Procedure

- All employees will be aware of the spill response procedure which includes:
- Stopping work, shut down equipment
- Move personnel to safe area
- Identify the substance spill, refer to MSDS
- Conduct a hazard assessment and implement controls
- Notify supervisor and sound alarm
- Contain and clean up spill when safe to do so

Fueling Procedure

- When approaching equipment for refuelling ensure both the Swamper and Operator see you and signal you to enter area.
- Drive close to equipment to be fuelled.
- Shut off fuel truck if not required to run pump.
- Have Operator shut off equipment and set attachment to rest.

Fueling Procedure

- Insure proper grounding of fuel truck and equipment.
- Place a spill catch tray under area where fuel will be dispensed.
- Turn on fuel pump and remove nozzle.
- If helper is available climb onto equip and have some one hand you the nozzle.

Fueling Procedure

- If no one around attach rope to nozzle climb onto equipment and pull nozzle up with rope.
- Remove fuel cap, insert nozzle and squeeze trigger, wait till tank is full release trigger.
- Ether hand nozzle down or lower with rope.
- Climb off equipment, shut off pump store nozzle.

Journey Management

- **Journey management** requires that operators of EGT vehicles plan ahead and ensure that they and their passengers are prepared for the conditions which may be encountered. It is recommended that operators check and make provisions for both local and en-route weather conditions and ensure that they have an adequate fuel supply. Operators must check that their vehicle(s) is properly equipped and in good conditions- and that there is proper clothing and supplies onboard in the case of unforeseen circumstances or an emergency.
- Be on time. Rides will leave a precise times.

Warning Signs

- Signs are posted as a warning device and are a method of controlling or mitigating hazards.
- They are placed for your protection.
- Signs help us to read the environment, so we are better able to understand the hazards.
- Failure to take the signs seriously could endanger your very survival.
- Eagles see the big picture, but a mouse only what is in front of his nose. So decide how you will be perceived.

See the Big Picture

Intersections

- Recent crash data show that approximately 25 percent of all road users died in collisions at intersections.
- The same data indicates that 57 percent of all road users who were seriously injured were involved in intersection collisions.
- Always be fully prepared to stop at all intersections no matter, who might have the ROW.
- SLOW DOWN AND DRIVE DEFENSIVELY

Traffic Control

- An adequate number of Flag persons shall be placed when applicable for the purpose of warning and directing traffic while construction operations are being conducted.
- Flag persons shall be trained, instructed and posted on the worksite.
- Public traffic will be safely accommodated at all times with no unnecessary delay.

Blasting and Quarry Operations

Blasting and Quarry Operations

- The blasting contractor will take every reasonable measure and precaution to protect the health and safety of employees and other persons at the worksite.
- All personnel working with or near explosives will be familiar with the applicable safe work practices being utilized at the worksite.
- The contractor will adhere to the Mine Safety Act and the Explosive Regulations.

Blasting and Quarry Operations

- The worksite where explosives are being used will be under the control of the certified blasting supervisor, who has been deemed competent.
- Before the detonation of an explosive the certified blaster will ensure that all safety precautions set out in the permit are in place.
- Prior to the detonation of an explosive the certified blaster will sound an audible warning at a reasonable time before the detonation.

Blasting and Quarry Operations

- The certified blaster will ensure that all avenues of approach to the site have been guarded.
- They will ensure that all workers and other persons near the site of the explosion have reached a place of safety. At the Source 177 site the ILA Monitors will check the area for both human and animal presence prior to any detonation to ensure the area is clear.
- The certified blaster will shout “Fire” immediately before detonating the explosive.

Blasting and Quarry Operations

- After any detonation of explosives the certified blaster will make an immediate inspection of the worksite.
- They will not permit any person to return to the site until the inspection has been completed and they have given the "All Clear" signal.
- The ILA Monitors will recheck the surrounding area to ensure no wildlife, such as bears have been disturbed.

Blasting and Quarry Operations

- There is absolutely no smoking or open flames allowed within 20 meters of any blast pattern or explosive material.
- All explosive material must be handled with care .

Overview

- Review of Safe Work Policies and Practices
- Questions and Discussion

Conclusions

- All workplace incidents and accidents are preventable; however it takes commitment and cooperation at all levels.

Safety Matters

ATTACHMENT 2

Tuktoyaktuk to Pit 177 Access Road

Erosion and Sediment Control Plan
&
Drainage Report

Tuktoyaktuk to Pit 177 Access Road

Erosion and Sediment Control Plan

Revision 1

Project # 2008-1191
March 23, 2010

Prepared for:

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Prepared by:

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1 Erosion and Sediment Control (ESC) Plan

1.1 BACKGROUND INFORMATION

This Erosion and Sediment Control plan address specifically the requirements of the control of erosion and sediment for 4 stream crossings identified as either being fish bearing, or contributing to fish habitat.

This plan supplements the March 12, 2010 Drainage Report for the same project.

1.2 CROSSING 4

1.2.1 Location maps and property lines

Crossing 4 is located at station 12+015 on the Tuktoyaktuk to Pit 177 access road.

The location chosen for this crossing is on a narrow bridge of land, approximately 65 m wide, between two lakes. Given the topography of the land and the location of the lakes in this area, there is no reasonable alternative other than to cross at this location

See drawings CSK01-04 and CSK01-10 in Appendix A.

1.2.2 Limits of disturbance

The disturbance associated with construction of this crossing will largely be constrained to the footprint of the road embankment itself. The winter construction methodology using winter roads constructed on the frozen ground adjacent to the roadway prevents damage and disturbance to the existing vegetated surface adjacent to the roadway itself.

In addition, there is no cutting of the existing ground surface, as the entire roadway is constructed of material from embankment.

Any disturbance to the environment comes as a result of the run off from the road embankment itself.

1.2.3 Existing site information

There is no existing site infrastructure at this location.

1.2.4 Proposed Site grading

As noted previously, there is no grading of the existing ground carried out in construction of this crossing.

1.2.5 Stockpiles

There will be no stockpiles of material on site at any point during in construction of this crossing.

1.2.6 Construction schedule

This crossing is scheduled for completion May 1, 2010. This is before the spring freshet at this location, which occurs typically in June.

1.2.7 Construction Methodology

The entire construction period of this crossing will take place in winter construction (frozen) conditions.

The location of the proposed culvert will be graded to provide a straight path from inlet to outfall. Following that site grading, non-woven geotextile fabric will be placed continuously through the location of the culvert. The culvert will be placed directly on the geotextile, with bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline. Bedding gravel will then be placed and compacted up to the invert of the culvert, and road embankment material placed and compacted on either side of the culvert.

The remaining bedding gravel will placed and compacted over the culvert as shown in the detailed installation drawings. The remainder of the road embankment at this location will then be placed and compacted.

Following completion of the embankment, the bank stabilization material will be placed, with biodegradable matting placed as shown on the Erosion Control and

Stabilization Drawing, and rip rap placed around the culvert ends and apron as shown in the installation detailed drawings.

It is anticipated that there will be no run off from the site during construction.

Any erodable material spilled during construction will be removed following completion of the installation of this crossing and of it's associated control measures.

1.2.8 Control measure details

To minimize the short term potential for erosion due to uncontrolled run off from causing siltation of the stream channel and adjacent water bodies at the crossing location during and following spring freshette, silt fencing is proposed to be place across the across the drainage path from the embankment toe (i.e. parallel to the existing ground contours at the crossing location).

A fundamental component of the Erosion Control system is based upon the fact that the existing tundra vegetation layer has not been damaged or removed in the construction of this roadway. Any erodable material on the project is in the roadway embankment itself. Thus, should any run off from the road embankment to the tundra occur, that sediment will be trapped and contained within the existing tundra vegetation. As such, any significant runoff of sediment into the streams of interest in this project is anticipated to be of no consequence.

1.2.9 Stabilization details

To minimize the longterm potential for damage to the waterway at this crossing, we propose to:

1. Armour the side slope of the road and the stream apron immediately above and below the culvert ends with rip rap

2. Place silt fencing across the drainage path from the embankment toe, upstream and downstream, up chainage and down chainage, to minimize any eroded material passing into the waterway.

3. Protect the road side slope 30 m on either side of the crossing for 10 out from the embankment toe, upstream and downstream, with biodegradable matting, pre-seeded with perennial grasses to stabilize the embankment adjacent to the waterway.

1.3 CROSSING 5

1.3.1 Location maps and property lines

Crossing 5 is located at station 8+700 on the Tuktoyaktuk to Pit 177 access road.

It is located at the outflow of a marshy area adjacent to the outlet of a small lake, which itself drains a slightly larger basin to the east of the crossing. The downstream extent of the stream travels 400 m before it drains into a chain of lakes.

See drawings CSK01-03 and CSK01-09 in Appendix A.

1.3.2 Limits of disturbance

The disturbance associated with construction of this crossing will largely be constrained to the footprint of the road embankment itself. The winter construction methodology using winter roads constructed on the frozen ground adjacent to the roadway prevents damage and disturbance to the existing vegetated surface adjacent to the roadway itself.

In addition, there is no cutting of the existing ground surface, as the entire roadway is constructed of material from embankment.

Any disturbance to the environment comes as a result of the run off from the road embankment itself.

1.3.3 Existing site information

There is no existing site infrastructure at this location.

1.3.4 Proposed Site grading

As noted previously, there is no grading of the existing ground carried out in construction of this crossing.

1.3.5 Stockpiles

There will be no stockpiles of material on site at any point during in construction of this crossing.

1.3.6 Construction schedule

This crossing is scheduled for completion May 1, 2010. This is before the spring freshet at this location, which occurs typically in June.

1.3.7 Construction Methodology

The entire construction period of this crossing will take place in winter construction (frozen) conditions.

The location of the proposed culvert will be graded to provide a straight path from inlet to outfall. Following that site grading, non-woven geotextile fabric will be placed continuously through the location of the culvert. The culvert will be placed directly on the geotextile, with bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline. Bedding gravel will then be placed and compacted up to the invert of the culvert, and road embankment material placed and compacted on either side of the culvert.

The remaining bedding gravel will placed and compacted over the culvert as shown in the detailed installation drawings. The remainder of the road embankment at this location will then be placed and compacted.

Following completion of the embankment, the bank stabilization material will be placed, with biodegradeable matting placed as shown on the Erosion Control and

Stabilization Drawing, and rip rap placed around the culvert ends and apron as shown in the installation detailed drawings.

It is anticipated that there will be no run off from the site during construction.

Any erodable material spilled during construction will be removed following completion of the installation of this crossing and of it's associated control measures.

1.3.8 Control measure details

To minimize the short term potential for erosion due to uncontrolled run off from causing siltation of the stream channel and adjacent water bodies at the crossing location during and following spring freshette, silt fencing is proposed to be place across the across the drainage path from the embankment toe (ie parallel to the existing ground contours at the crossing location).

A fundamental component of the Erosion Control system is based upon the fact that the existing tundra vegetation layer has not been damaged or removed in the construction of this roadway. Any erodable material on the project is in the roadway embankment itself. Thus, should any run off from the road embankment to the tundra occur, that sediment will be trapped and contained within the existing tundra vegetation. As such, any significant runoff of sediment into the streams of interest in this project is anticipated to be of no consequence.

1.3.9 Stabilization details

To minimize the longterm potential for damage to the waterway at this crossing, we propose to:

4. Armour the side slope of the road and the stream apron immediately above and below the culvert ends with rip rap

5. Place silt fencing across the drainage path from the embankment toe, upstream and downstream, up chainage and down chainage, to minimize any eroded material passing into the waterway.

6. Protect the road side slope 30 m on either side of the crossing for 10 out from the embankment toe, upstream and downstream, with biodegradable matting, pre-seeded with perennial grasses to stabilize the embankment adjacent to the waterway.

1.4 CROSSING 6

1.4.1 Location maps and property lines

Crossing 6 is located at station 7+390 on the Tuktoyaktuk to Pit 177 access road.

The location chosen for this crossing is on an 850 m long stream connecting two small lakes, which drain a fairly large basin to the west of the crossing. The routing for the roadway needs to be within this 850 long section, and there is no apparent difference from a fisheries impact perspective on crossing locations either up or downstream of the chosen location, as the stream is of similar character throughout it's length. Within 500 mm downstream there is no change of width, flow, water depth or tides anticipated. Approximately 210 mm upstream there is a small lake, approximately 400 m x 80 m in size. That upstream lake is part of the drainage collection system which drains through crossing 6.

See drawings CSK01-02 and CSK01-08 in Appendix A.

1.4.2 Limits of disturbance

The disturbance associated with construction of this crossing will largely be constrained to the footprint of the road embankment itself. The winter construction methodology using winter roads constructed on the frozen ground adjacent to the roadway prevents damage and disturbance to the existing vegetated surface adjacent to the roadway itself.

Cutting of the existing ground surface, is limited to the location of the new culvert at this crossing, together with the construction of a short connection to the adjacent tundra pond.

Any disturbance to the environment comes as a result of the run off from the road embankment itself.

1.4.3 Existing site information

There is no existing site infrastructure at this location.

1.4.4 Proposed Site grading

As noted previously, there is no grading of the existing ground carried out in construction of this crossing.

1.4.5 Stockpiles

There will be no stockpiles of material on site at any point during in construction of this crossing.

1.4.6 Construction schedule

This crossing is scheduled for completion May 1, 2010. This is before the spring freshet at this location, which occurs typically in June.

1.4.7 Construction Methodology

The entire construction period of this crossing will take place in winter construction (frozen) conditions.

The location of the proposed culvert will be graded to provide a straight path from inlet to outfall. Following that site grading, non-woven geotextile fabric will be placed continuously through the location of the culvert. The culvert will be placed directly on the geotextile, with bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline. Bedding gravel will then be placed and compacted up to the invert of the culvert, and road embankment material placed and compacted on

either side of the culvert.

The remaining bedding gravel will placed and compacted over the culvert as shown in the detailed installation drawings. The remainder of the road embankment at this location will then be placed and compacted.

Following completion of the embankment, the bank stabilization material will be placed, with biodegradeable matting placed as shown on the Erosion Control and Stabilization Drawing, and rip rap placed around the culvert ends and apron as shown in the installation detailed drawings.

It is anticipated that there will be no run off from the site during construction.

Any erodable material spilled during construction will be removed following completion of the installation of this crossing and of it's associated control measures.

1.4.8 Control measure details

To minimize the short term potential for erosion due to uncontrolled run off from causing siltation of the stream channel and adjacent water bodies at the crossing location during and following spring freshette, silt fencing is proposed to be place across the across the drainage path from the embankment toe (ie parallel to the existing ground contours at the crossing location).

A fundamental component of the Erosion Control system is based upon the fact that the existing tundra vegetation layer has not been damaged or removed in the construction of this roadway. Any erodable material on the project is in the roadway embankment itself. Thus, should any run off from the road embankment to the tundra occur, that sediment will be trapped and contained within the existing tundra vegetation. As such, any significant runoff of sediment into the streams of interest in this project is anticipated to be of no consequence.

1.4.9 Stabilization details

To minimize the longterm potential for damage to the waterway at this crossing, we propose to:

7. Armour the side slope of the road and the stream apron immediately above and below the culvert ends with rip rap

8. Place silt fencing across the drainage path from the embankment toe, upstream and downstream, up chainage and down chainage, to minimize any eroded material passing into the waterway.

9. Protect the road side slope 30 m on either side of the crossing for 10 out from the embankment toe, upstream and downstream, with biodegradable matting, pre-seeded with perennial grasses to stabilize the embankment adjacent to the waterway.

1.5 CROSSING 7B

1.5.1 Location maps and property lines

Crossing 7B is located at station 5+833 on the Tuktoyaktuk to Pit 177 access road.

It is located some 3.5 m higher than the nearby culvert 16, a non fish bearing drainage culvert which drains the nearest small lake from west to east. Crossing 7B drains a small (100 x 100 m) marshy of ice rich polygonal terrain south of that lake..

See drawings CSK01-02 and CSK01-07 in Appendix A.

1.5.2 Limits of disturbance

The disturbance associated with construction of this crossing will largely be constrained to the footprint of the road embankment itself. The winter construction methodology using winter roads constructed on the frozen ground adjacent to the roadway prevents damage and disturbance to the existing vegetated surface adjacent to the roadway itself.

In addition, there is no cutting of the existing ground surface, as the entire roadway is constructed of material from embankment.

Any disturbance to the environment comes as a result of the run off from the road embankment itself.

1.5.3 Existing site information

There is no existing site infrastructure at this location.

1.5.4 Proposed Site grading

As noted previously, there is no grading of the existing ground carried out in construction of this crossing.

1.5.5 Stockpiles

There will be no stockpiles of material on site at any point during in construction of this crossing.

1.5.6 Construction schedule

This crossing is scheduled for completion May 1, 2010. This is before the spring freshet at this location, which occurs typically in June.

1.5.7 Construction Methodology

The entire construction period of this crossing will take place in winter construction (frozen) conditions.

The location of the proposed culvert will be graded to provide a straight path from inlet to outfall. Following that site grading, non-woven geotextile fabric will be placed continuously through the location of the culvert. The culvert will be placed directly on the geotextile, with bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline. Bedding gravel will then be placed and compacted up to the invert of the culvert, and road embankment material placed and compacted on either side of the culvert.

The remaining bedding gravel will placed and compacted over the culvert as shown in the detailed installation drawings. The remainder of the road embankment at this location will then be placed and compacted.

Following completion of the embankment, the bank stabilization material will be placed, with biodegradeable matting placed as shown on the Erosion Control and

Stabilization Drawing, and rip rap placed around the culvert ends and apron as shown in the installation detailed drawings.

It is anticipated that there will be no run off from the site during construction.

Any erodable material spilled during construction will be removed following completion of the installation of this crossing and of it's associated control measures.

1.5.8 Control measure details

To minimize the short term potential for erosion due to uncontrolled run off from causing siltation of the stream channel and adjacent water bodies at the crossing location during and following spring freshette, silt fencing is proposed to be place across the across the drainage path from the embankment toe (ie parallel to the existing ground contours at the crossing location).

A fundamental component of the Erosion Control system is based upon the fact that the existing tundra vegetation layer has not been damaged or removed in the construction of this roadway. Any erodable material on the project is in the roadway embankment itself. Thus, should any run off from the road embankment to the tundra occur, that sediment will be trapped and contained within the existing tundra vegetation. As such, any significant runoff of sediment into the streams of interest in this project is anticipated to be of no consequence.

1.5.9 Stabilization details

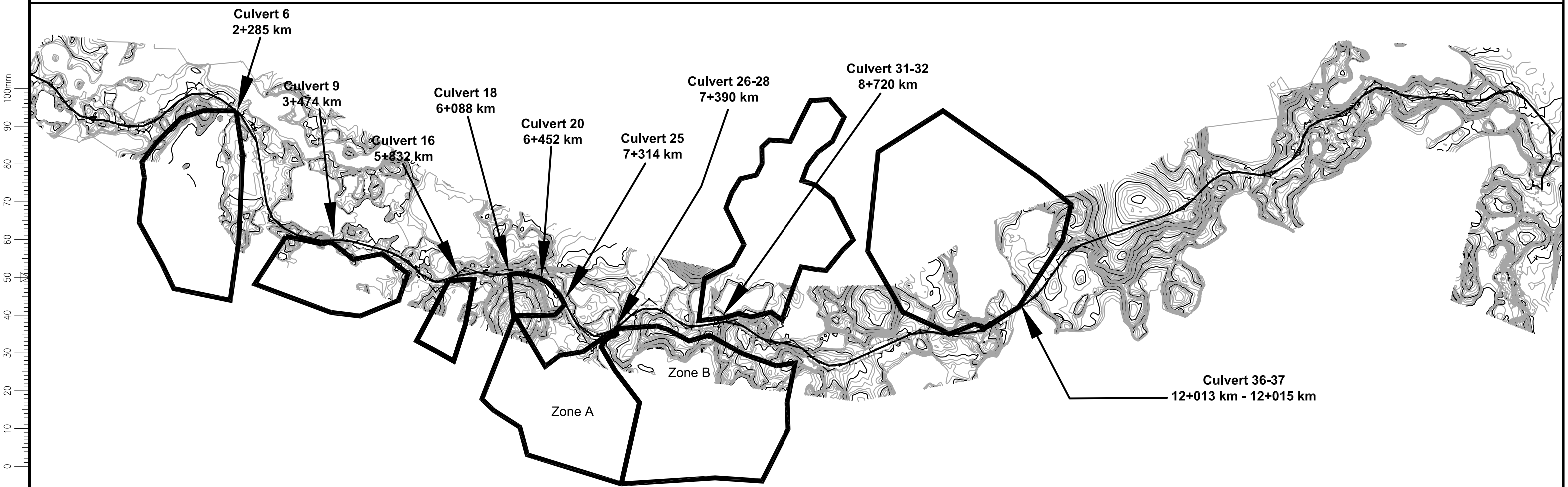
To minimize the longterm potential for damage to the waterway at this crossing, we propose to:

10. Armour the side slope of the road and the stream apron immediately above and below the culvert ends with rip rap

11. Place silt fencing across the drainage path from the embankment toe, upstream and downstream, up chainage and down chainage, to minimize any eroded material passing into the waterway.

12. Protect the road side slope 30 m on either side of the crossing for 10 out from the embankment toe, upstream and downstream, with biodegradable matting, pre-seeded with perennial grasses to stabilize the embankment adjacent to the waterway.

2 Appendix A – Culvert Location and Detail Drawings



PROJECT TITLE

TUKTOYAKTUK GRAVEL SOURCE ACCESS ROAD

FSC
ARCHITECTS & ENGINEERS
4910 - 53rd Street, P.O. Box 1777
Yellowknife, NT, X1A 2P4, Canada
T 867.920.2882 | F 867.920.4319

LOCATION: TUKTOYAKTUK, NT

DRAWING TITLE

CULVERT LOCATION & AREA BOUNDARY

CLIENT PROJECT NO.	FSC PROJECT NO.
-	2008-1191
DRAWN BY: FG / OA	CHECKED BY:
SCALE: N.T.S	DATE: FEBRUARY 15, 2010
DRAWING NO.	OF ___

FSC – ANSI-B_L – 11x17

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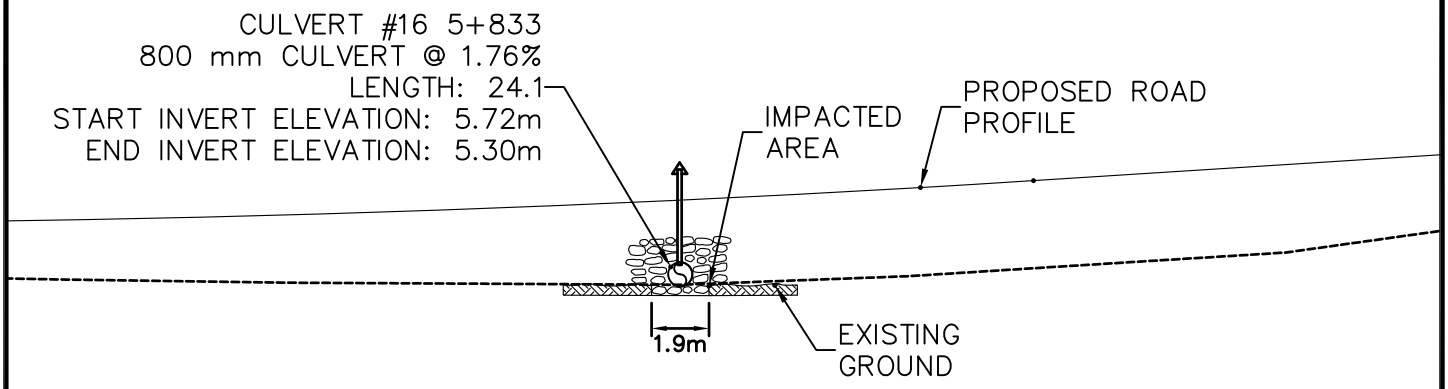
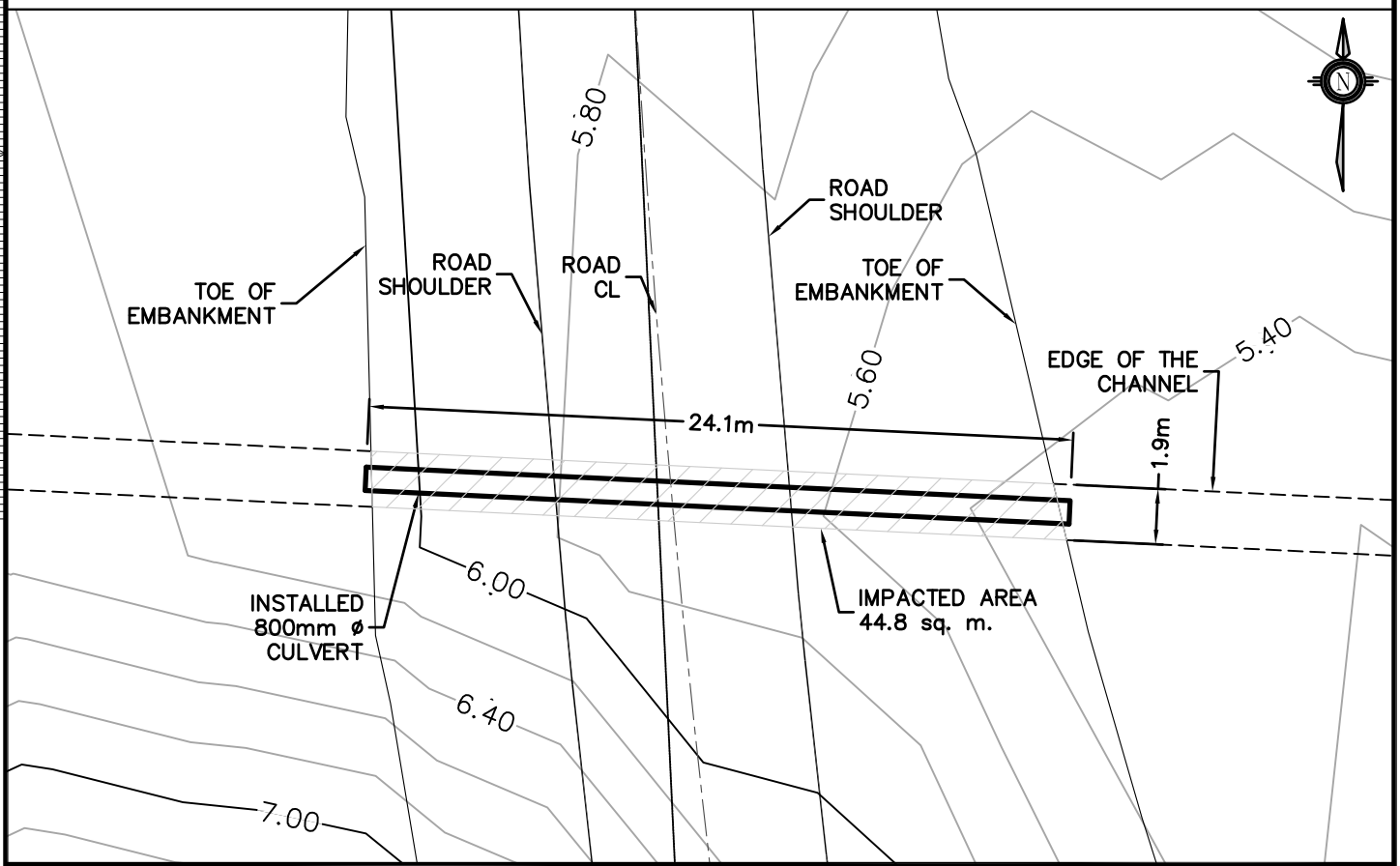


NOTE: THIS LOCATION DOES NOT HAVE A CLEARLY DEFINED OWHL OR NORMAL FLOW CHANNEL. IMPACTED AREA IS BASED UPON GOLDER FIELD REPORT OBSERVATIONS OF FLOW WIDTH 30 JUNE 2009.



PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 7B STATION 5+833	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-01	OF 06

FSC – ANSI–A – 8.5x11

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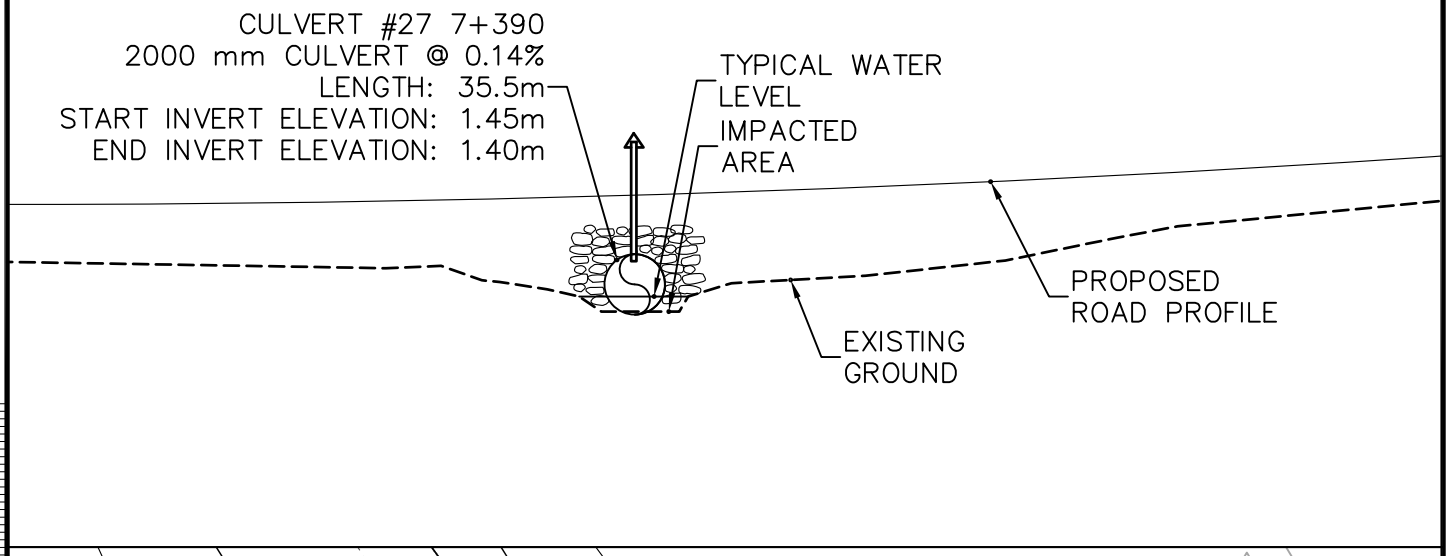
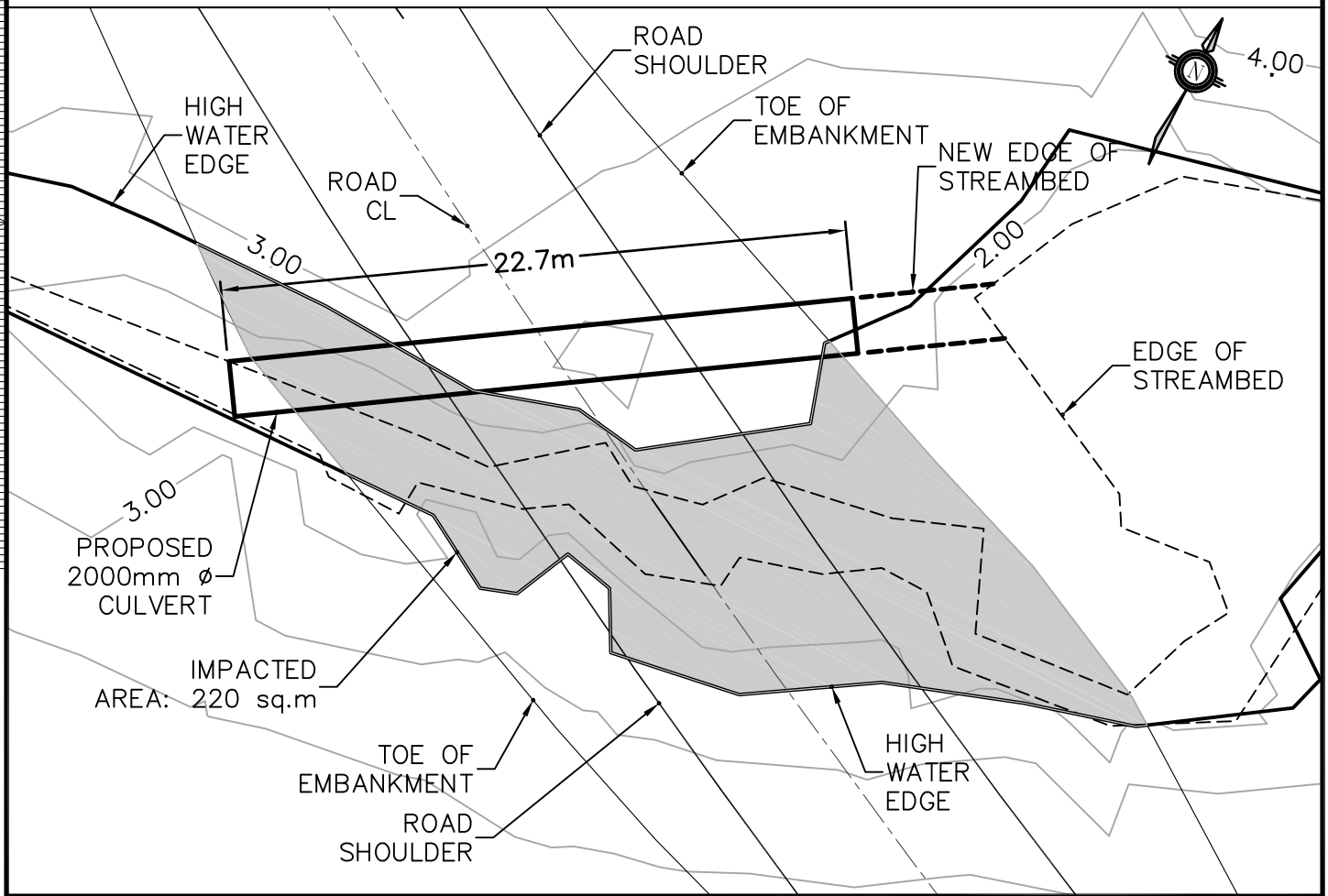




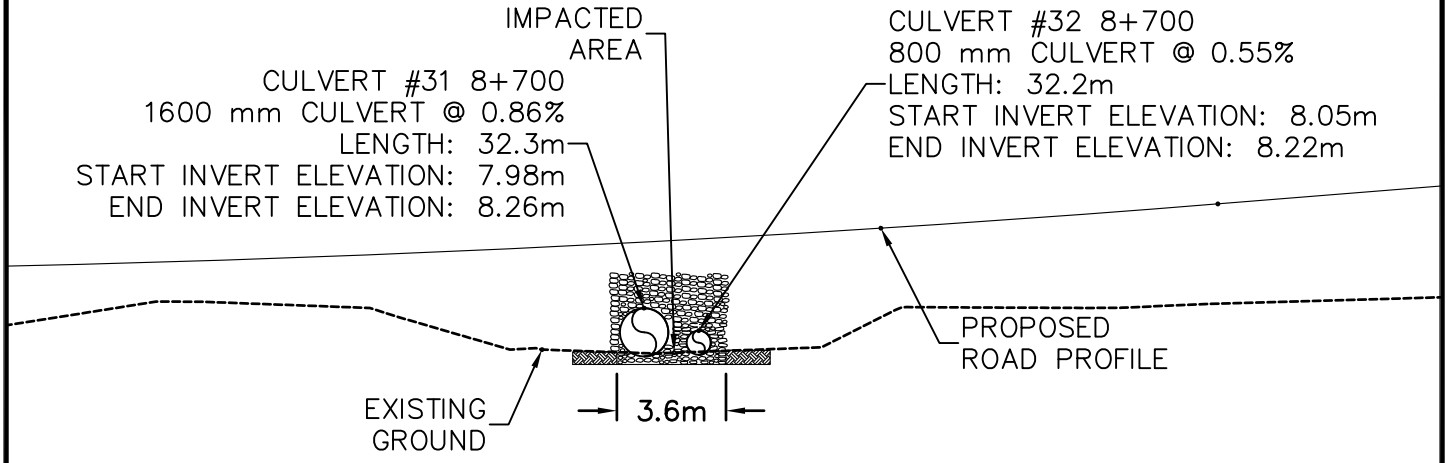
PROJECT TITLE

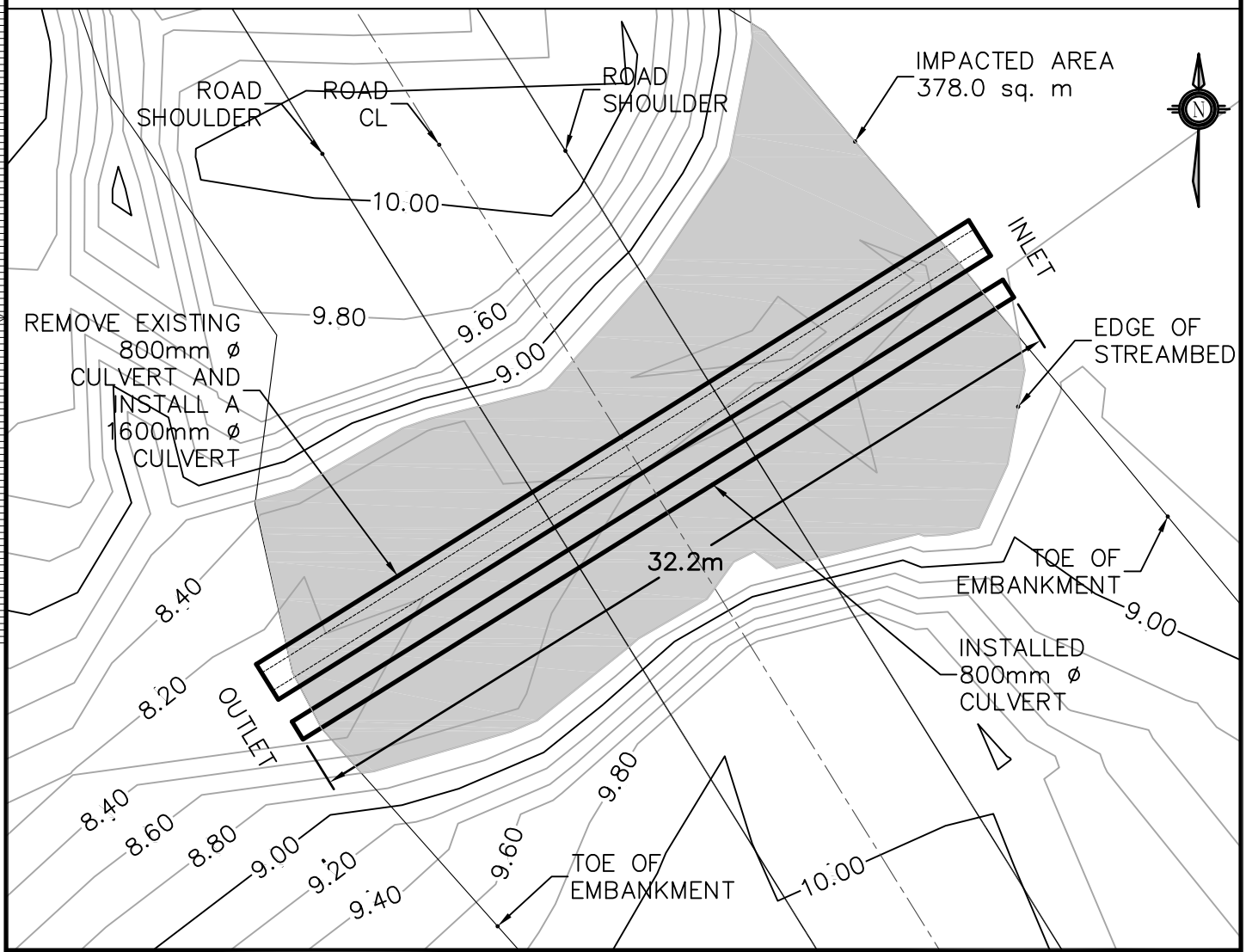
ACCESS TO BORROW SOURCE 177

CLIENT PROJECT NO.	FSC PROJECT NO.
-	2008-1191
LOCATION	DRAWN BY / CHECKED BY
TUKTOYAKTUK, NWT	FG / WO
DRAWING TITLE	SCALE / DATE
CROSSING 6 STA 7+390	1:250 / 2010/03/12
	DRAWING NO.
	CSK01-02 OF 06

FSC ARCHITECTS & ENGINEERS
4910 - 53rd Street, P.O. Box 1777
Yellowknife, NT, X1A 2P4, Canada
T 867.920.2882 | F 867.920.4319

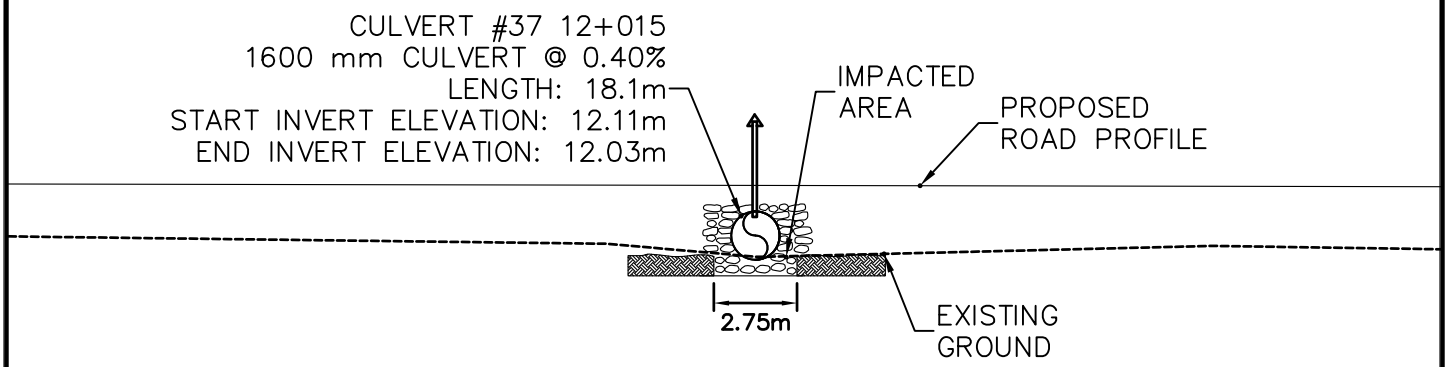
FSC – ANSI–A – 8.5x11



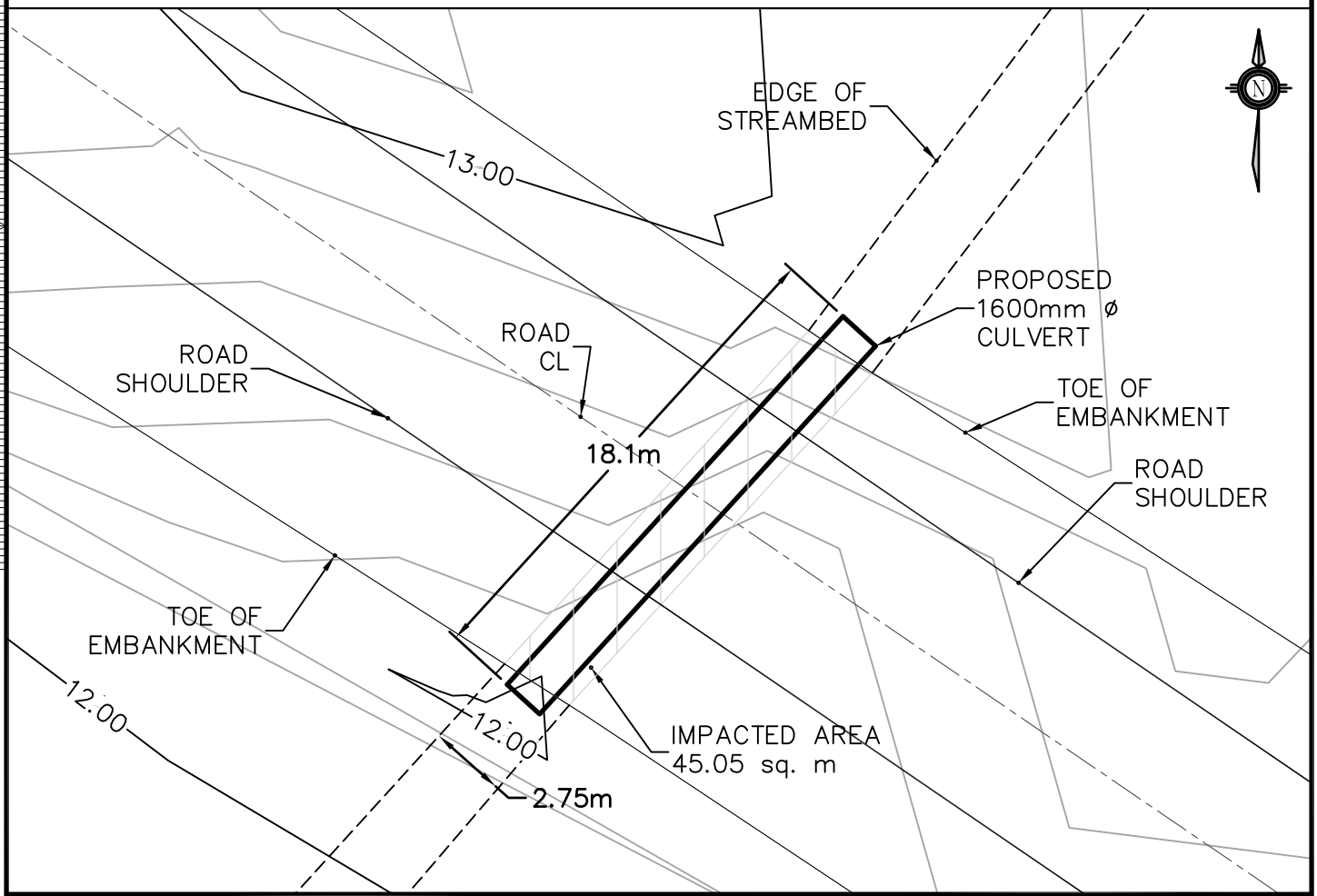


PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 5 STATION 8+700	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-03	OF 06

FSC – ANSI–A – 8.5x11



NOTE: THIS LOCATION DOES NOT HAVE A CLEARLY DEFINED OWHL OR NORMAL FLOW CHANNEL. IMPACTED AREA IS BASED UPON GOLDER FIELD REPORT OBSERVATIONS OF FLOW WIDTH 30 JUNE 2009.



PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 4 STATION 12+015	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-04	OF 06

FSC – ANSI–A – 8.5x11

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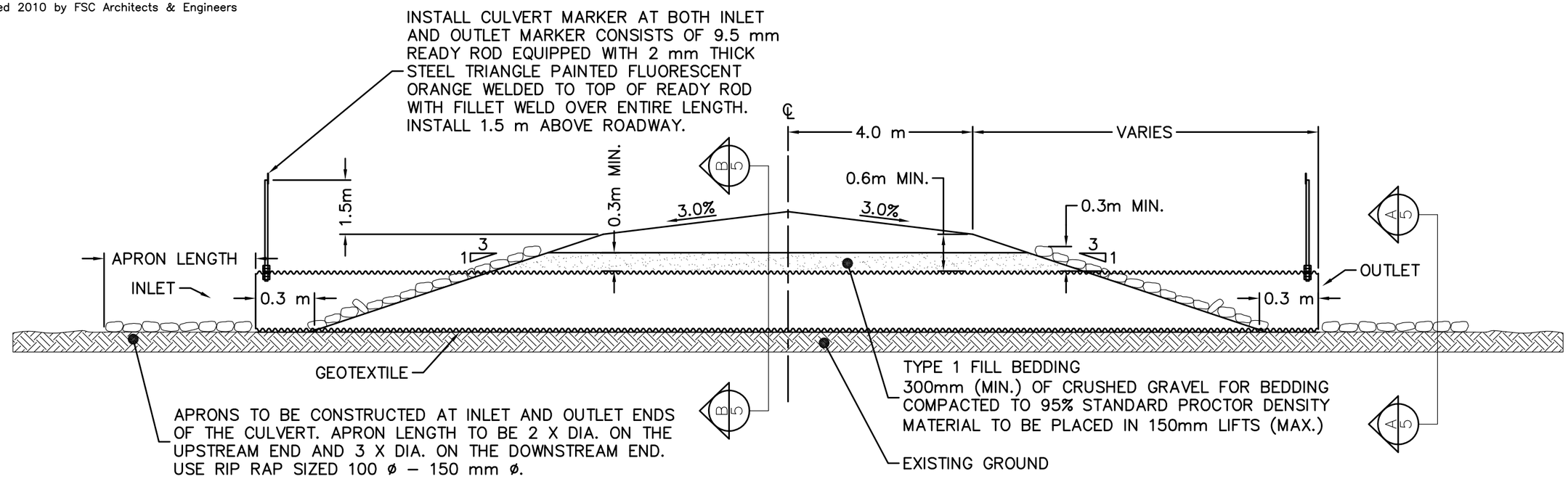
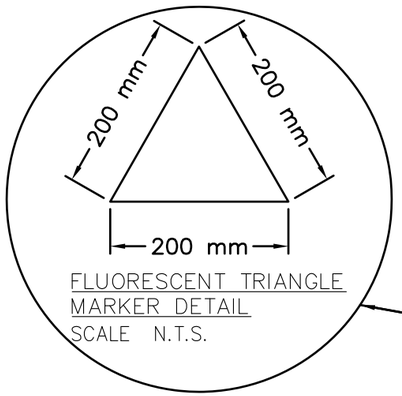
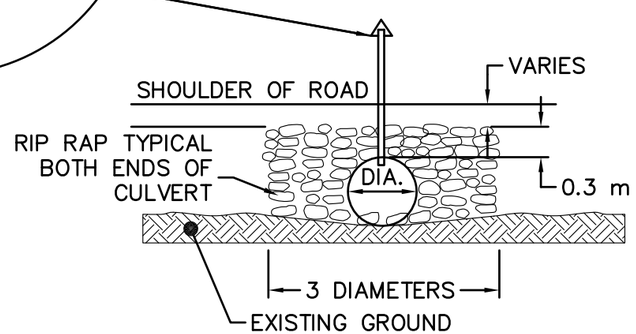


NOTES:
1– 100 mm MIN. GRADE BETWEEN UPSTREAM INLET TO DOWNSTREAM OUTLET.
2– GRADES TO BE SET AS SHOWN.
3– LENGTH AS SHOWN ON DRAWINGS.

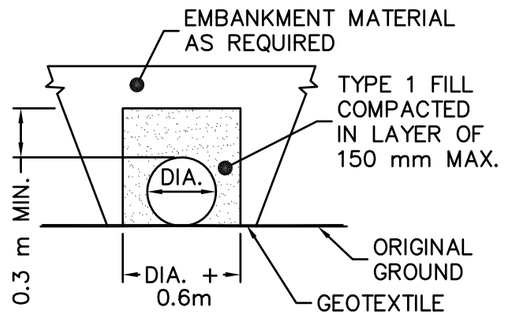
TYPICAL ROADWAY CULVERT DETAIL 1/5
SCALE N.T.S.



FLUORESCENT TRIANGLE MARKER DETAIL
SCALE N.T.S.

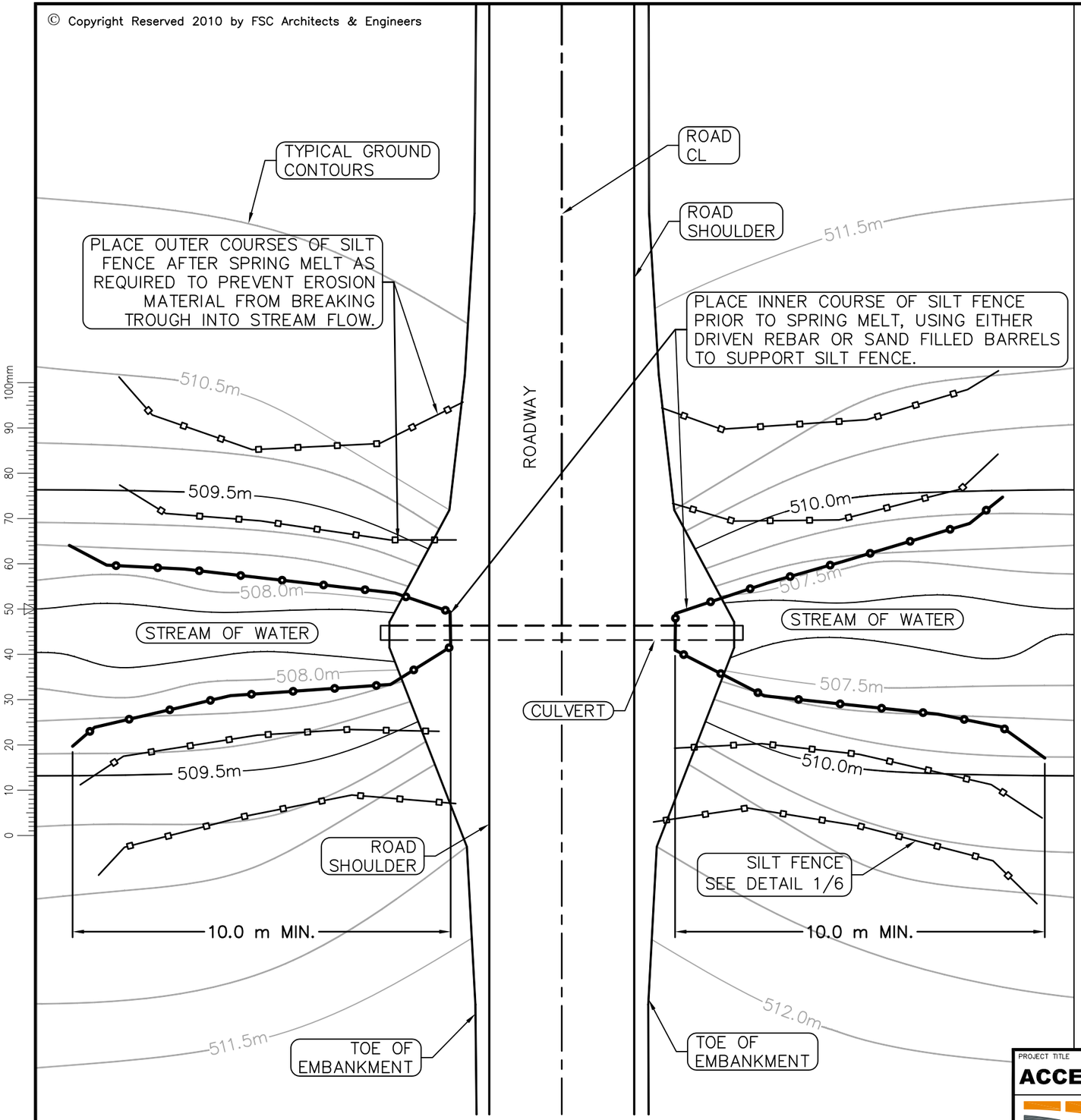


CULVERT ELEVATION VIEW A/5
SCALE N.T.S.

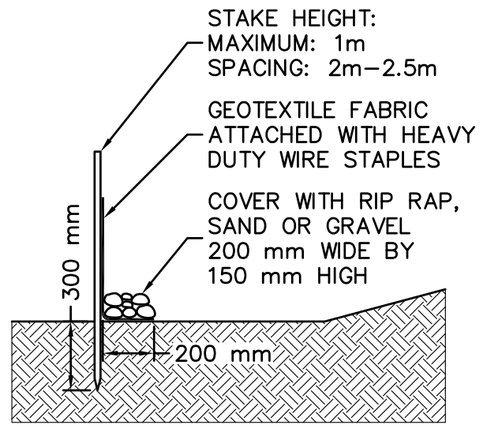


TYPICAL CULVERT BEDDING B/5
SCALE N.T.S.

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CULVERT DETAILS	SCALE: N.T.S.	DATE: 2010/03/12
		DRAWING NO.: CSK01-05 OF 06	



TYPICAL SILT FENCE INSTALLATION 1/6
SCALE N.T.S.



TYPICAL SILT FENCE INSTALLTION 1/6
SCALE N.T.S.

SILT FENCE NOTES:
- INSTALL BEFORE LAND IS DISTURBED
- INSTALL ON DOWN SLOPE SIDE OF SITE PARALLEL TO CONTOUR OF THE LAND
- STAKE POSTS ON DOWNHILL SIDE
- EXTENDED ENDS UP SLOPE ENOUGH TO ALLOW WATER TO POND BEHIND FENCE
- TURN ENDS OF FENCE UPHILL
- COVER 200 mm OF FABRIC AT THE BOTTOM WITH RIP RAP, SAND, OR GRAVEL LEAVE NO GAPS.
- OVERLAP SECTIONS OF SILT FENCE, OR TWIST ENDS OF SILT FENCE TOGETHER.
- INSPECT AND REPAIR ONCE A WEEK AND AFTER EVERY RAIN. REMOVE SEDIMENT IF DEPOSITS REACH HALF THE FENCE HEIGHT
- MAINTAIN UNTIL A VEGETATION IS ESTABLISHED

PROJECT TITLE
ACCESS TO BORROW SOURCE 177

CLIENT PROJECT NO.: -
FSC PROJECT NO.: 2008-1191

FSC ARCHITECTS & ENGINEERS
4910 - 53rd Street, P.O. Box 1777
Yellowknife, NT, X1A 2P4, Canada
T 867.920.2882 | F 867.920.4319

LOCATION: TUKTOYAKTUK, NT
DRAWN BY: FG
CHECKED BY: WO
DRAWING TITLE: SILT FENCE DETAILS AT POTENTIALY FISH BEARING CROSSING
SCALE: N.T.S.
DATE: 2010/03/12
DRAWING NO.: CSK01-06 OF 06

PLACE INNER COURSE OF SILT FENCE PRIOR TO SPRING MELT, USING EITHER DRIVEN REBAR OR SAND FILLED BARRELS TO SUPPORT SILT FENCE.

PLACE OPTIONAL OUTER COURSES OF SILT FENCE AFTER SPRING MELT AS REQUIRED TO PREVENT EROSION MATERIAL FROM BREAKING THROUGH INTO STREAM FLOW.

TOPOGRAPHIC SURVEY LIMIT

EDGE OF CHANNEL

ROAD SHOULDER

TOE OF EMBANKMENT

CULVERT

20m MIN. TYPICAL

10m TYPICAL

10m MIN. TYPICAL

8.50

7.50

6.00

4.50

5.00

7.50

10.00

12.50

6.50

10m

7.50

10.00

12.50

CL

ROAD SHOULDER

TOE OF EMBANKMENT

RIP RAP AROUND CULVERT END

TOPOGRAPHIC SURVEY LIMIT

EROSION CONTROL MATTING TO BE BIODEGRADABLE MATERIALS ONLY, STRAW OR COCONUT FIBER WITH JUTE OR COTTON NETTING. TOTAL WEIGHT TO BE A MINIMUM OF 0.27 Kg/sq. m. MATTING TO BE FASTENED FROM SHOULDER OF ROAD TO 10m FROM ROAD TOE OF SLOPE, FOR 10m UP AND DOWN CHAINAGE FROM CULVERT LOCATION

0 10 20 30 40 50 60 70 80 90 100mm

PROJECT TITLE **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO. -	FSC PROJECT NO. 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION TUKTOYAKTUK, NT	DRAWN BY FG	CHECKED BY WO
	DRAWING TITLE SILT FENCE DETAIL AT CROSSING 7B STATION 5+833	SCALE 1:500	DATE 2010/03/22
		DRAWING NO. CSK01-07	OF 10

FSC – ANSI–B_L – 11x17

X:\CIVIL\20081191 Construction Phase Tuk Highway\DWG\Construction\Fisherie Report\20081191 Tuk Hwy - 2010-03-18.dwg , CSK01-07, LastSaved: 3/23/2010 5:06:28 PM, Plotted: 3/24/2010 9:35:55 AM, ANSI B (11.00 x 17.00 Inches), 1:1

PLACE INNER COURSE OF SILT FENCE PRIOR TO SPRING MELT, USING EITHER DRIVEN REBAR OR SAND FILLED BARRELS TO SUPPORT SILT FENCE.

TOPOGRAPHIC SURVEY LIMIT

ROAD SHOULDER

TOE OF EMBANKMENT

5.00

4.50

4.50

20m MIN. TYPICAL

10m TYPICAL

NEW EDGE OF STREAMBED

EDGE OF STREAMBED

2.50

2.50

PLACE OPTIONAL OUTER COURSES OF SILT FENCE AFTER SPRING MELT AS REQUIRED TO PREVENT EROSION MATERIAL FROM BREAKING THROUGH INTO STREAM FLOW.

10m TYPICAL

3.00

CULVERT

HIGH WATER EDGE

2.50

RIP RAP AROUND CULVERT END

3.50

10m MIN. TYPICAL

CL

5.00

5.50

6.00

7.50

6.50

TOE OF EMBANKMENT

7.50

ROAD SHOULDER

CONTROL MATTING TO BE BIODEGRADABLE MATERIALS ONLY, STRAW OR COCONUT FIBER WITH JUTE OR COTTON NETTING. TOTAL WEIGHT TO BE A MIN. 0.27 Kg/sq. m. MATTING TO BE FASTENED FROM SHOULDER OF ROAD TO 1m FROM ROAD TOE OF SLOPE, FOR 10m UP AND DOWN CHAINAGE FROM CULVERT LOCATION

TOPOGRAPHIC SURVEY LIMIT

0 10 20 30 40 50 60 70 80 90 100mm

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**	CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NT	DRAWN BY: FG / CHECKED BY: WO
	DRAWING TITLE: SILT FENCE DETAIL AT CROSSING 6 STA 7+390	SCALE: 1:500 / DATE: 2010/03/22
		DRAWING NO.: CSK01-08 OF 10

FSC – ANSI–B_L – 11x17

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ROAD SHOULDER

TOE OF EMBANKMENT

PLACE OPTIONAL OUTER COURSES OF SILT FENCE AFTER SPRING MELT AS REQUIRED TO PREVENT EROSION MATERIAL FROM BREAKING THROUGH INTO STREAM FLOW.

ROAD SHOULDER

TOE OF EMBANKMENT

10.00

9.00

APPROXIMATE EDGE OF CHANNEL

CL

10m MIN. TYPICAL

20m MIN. TYPICAL

PLACE INNER COURSE OF SILT FENCE PRIOR TO SPRING MELT, USING EITHER DRIVEN REBAR OR SAND FILLED BARRELS TO SUPPORT SILT FENCE.

TOPOGRAPHIC SURVEY LIMIT

CULVERT

10m TYPICAL

9.50

CULVERT

8.50

9.00

TOPOGRAPHIC SURVEY LIMIT

9.00

RIP RAP AROUND CULVERT END

10.00

9.00

10m TYPICAL

CONTROL MATTING TO BE BIODEGRADABLE MATERIALS ONLY, STRAW OR
OCONUT FIBER WITH JUTE OR COTTON NETTING. TOTAL WEIGHT TO BE A
F 0.27 Kg/sq. m. MATTING TO BE FASTENED FROM SHOULDER OF ROAD
n FROM ROAD TOE OF SLOPE, FOR 10m UP AND DOWN CHAINAGE FROM
CULVERT LOCATION

0 10 20 30 40 50 60 70 80 90 100mm

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**	CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NT	DRAWN BY: FG / CHECKED BY: WO
	DRAWING TITLE: SILT FENCE DETAIL AT CROSSING 5 STATION 8+700	SCALE: 1:500 / DATE: 2010/03/22
		DRAWING NO.: CSK01-09 OF 10

FSC – ANSI–B_L – 11x17

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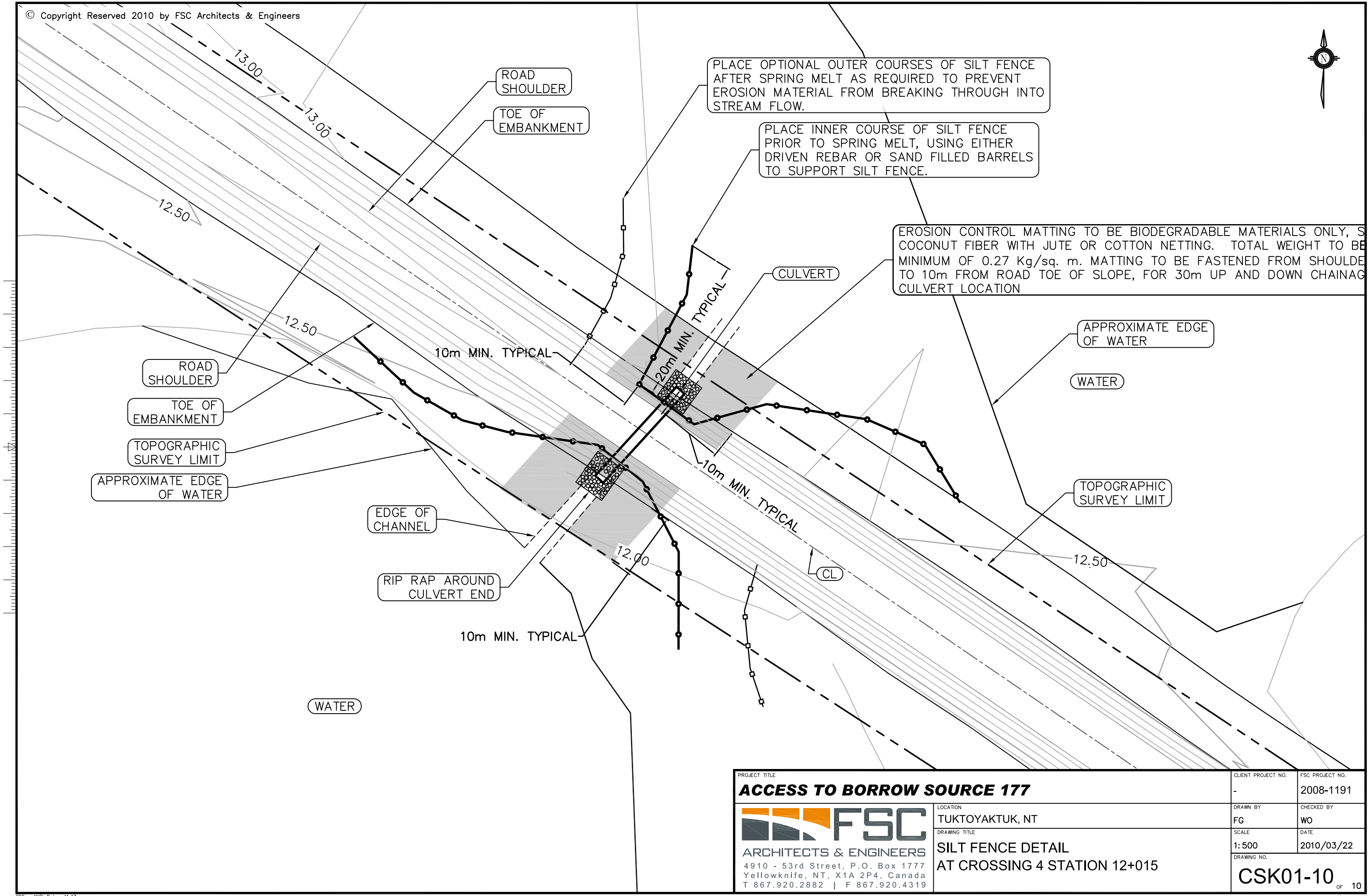

PROJECT TITLE **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO. -	FSC PROJECT NO. 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION TUKTOYAKTUK, NT	DRAWN BY FG	CHECKED BY WO
	DRAWING TITLE SILT FENCE DETAIL AT CROSSING 4 STATION 12+015	SCALE 1:500	DATE 2010/03/22
		DRAWING NO. CSK01-10 OF 10	

Tuktoyaktuk to Pit 177 Access Road

Drainage Report

Revision 3

Project # 2008-1191
March 12, 2010

Prepared for:

E. Grubens Transport
Box 177
Tuktoyaktuk, NT
X0E 1C0

Prepared by:

FSC Architects & Engineers
4910 53rd Street
Yellowknife, NT
X1A 2P4

LISTEN. DESIGN. MANAGE.

FSC File: 2008-1191

March 12, 2010

E. Grubens Transport
Box 177
Tuktoyaktuk, NT
X0E 1C0

Attention: Russell Newmark

Re: Tuktoyaktuk to Pit 177 Access Road Drainage Report – Revision 2

Please find the Revised Final Drainage report for the Tuktoyaktuk to Pit 177 Access Road.

In it we address the drainage requirements at the major crossings on the access road, with particular attention to the requirements of the Government of Canada, Fisheries and Oceans.

We have addressed the comments from Rhonda and Terri at DOT, and the comments from DFO as well.

We trust that this completes the drainage design for this project.

Sincerely,

FSC ARCHITECTS & ENGINEERS

Walter Orr, P. Eng.

Principal

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1 Introduction

1.1 PROJECT BACKGROUND

The construction of the Tuktoyaktuk to Pit 177 granular source access road was authorized in the fall of 2008. Geometric design proceeding immediately by FSC Architects & Engineers (FSC), in concert with the Preliminary Design Review by Kiggiak EBA (EBA). Initial construction started in February 2009 by E Grubens Transport (Grubens).

A preliminary conservative drainage analysis was completed in February 2009 by FSC, and culverts for the initial portion of construction sized, purchased, and for the majority of the constructed alignment, installed by Grubens.

Construction proceeded until the first week of May 2009, when the material haul was shut down by warm weather. In the summer of 2009, embankment shaping and compaction was carried out over the length of the constructed embankment, approximately 11 km of 18 total.

Construction of the embankment for the project is anticipated to be completed before May 1st, 2010, with the final compaction and grading being completed by August 30th, 2010.

In the fall of 2008, EBA carried out the Preliminary Design Review of the proposed route and identified 8 possible stream crossing locations. Those locations were evaluated in the summer of 2009 by IMG Golder (Golder) in report 09-1134-017, and 4 were determined to be either known to be or potentially fish bearing.

The Government of Canada Department of Fisheries and Oceans (DFO) reviewed the Golder report and the design documentation, and met with representative of the Government of the Northwest Territories Department of Transportation (DOT) and FSC in late November 2009.

This report finalizes and documents the design process, decisions and outcomes for this project.

2 Drainage Requirements

2.1 GENERAL

All drainage structures have to be evaluated for their compliance with a number of conditions. These conditions include:

- Rainfall drainage for 1 in 10 year storms without surcharge.
- Rainfall drainage for 1 in 100 year storms while not overtopping the roadway embankment
- Snowmelt for the same return periods
- Fisheries fish passage to meet the Government of Canada Department of Fisheries and Oceans (DFO) requirements, for the specified design fish.

2.2 RAINFALL

The rainfall intensity nomograph for Inuvik will be taken as the design rainfall index for this project, as it is the nearest available rainfall nomograph to this installation.

The following chart shows the rainfall intensity used more these designs.

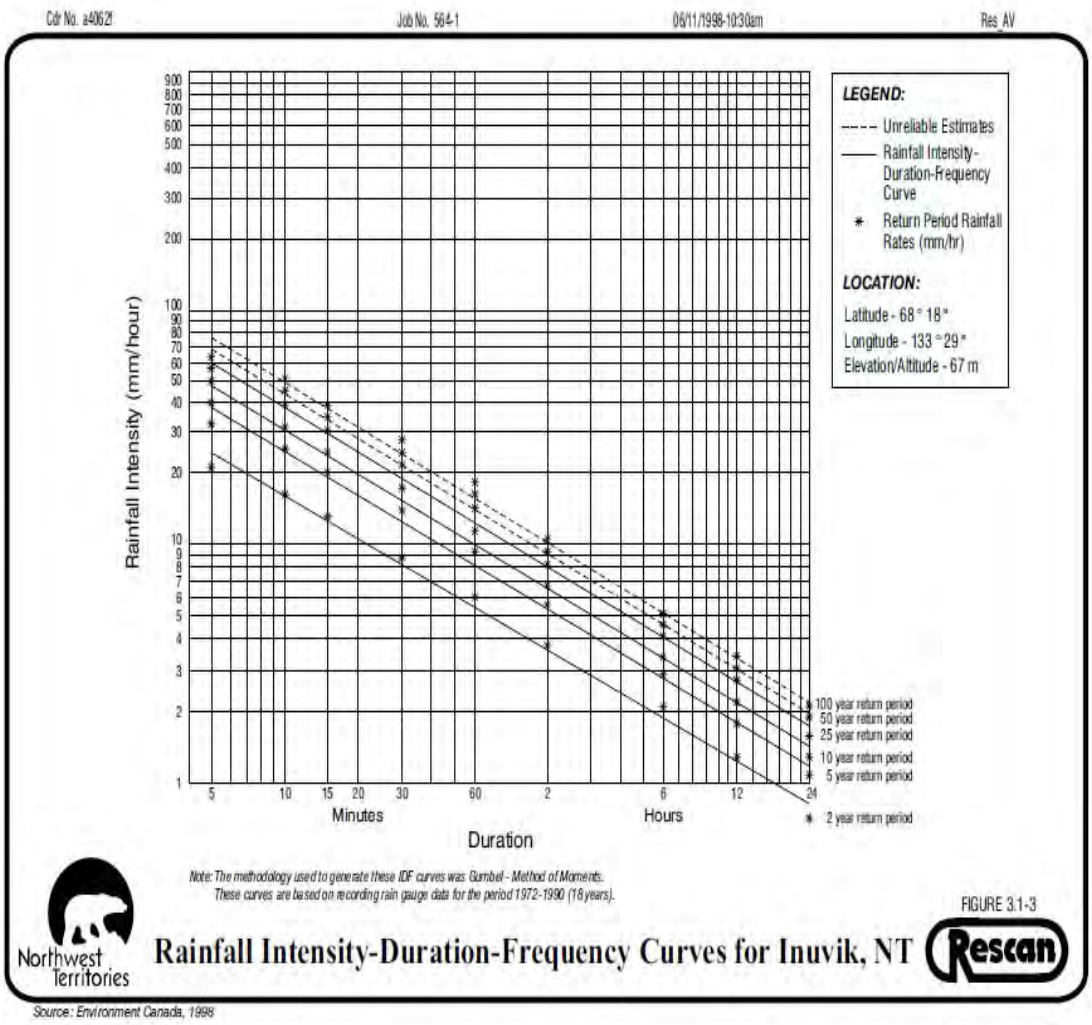


Figure 2.1 Rainfall Intensity for Inuvik, NT

We have utilized the Rational Method of runoff analysis for determining the runoff flow rates for rainfall.

Using the Rational method:

- Q (Flow Rate) = C (Runoff Coefficient) * I (Intensity) *A (Area of Drainage Basin)
- T (Time of Concentration) = 0.0078 (L / S^0.5) ^ .77
  - Where S (Slope) = H (Elevation Change) / L (Length of Drainage Basin)
- Rainfall intensity I varies with time as shown on the nomograph in Figure 2.1.

- The Time of Concentration is the time that it takes the most remote area of the Drainage Basin to run to the outfall structure.

Given these parameters, each drainage structure has a calculated peak flow rate, for different design periods.

2.3 SNOWMELT

The average precipitation for Tuktoyaktuk is given below, by month. Snowfall is converted to equivalent water depths.

June	July	August	September	October	November	December
12.7 mm	20.3 mm	30.5 mm	17.8 mm	17.8 mm	10.2 mm	10.2 mm

January	February	March	April	May	Total
5.1 mm	5.1 mm	5.1 mm	7.6 mm	7.6 mm	149.9 mm

In this study, it is assumed that snow accumulates from September to May, and that snowfall is then passed when melting in June. This accumulation is equal to 86 mm / year.

While this snowfall amount varies by year, the biggest variable in the flow rate of the melt water is not the amount of snow. It is rather the melting rate. This melting rate controls the peak flow regardless of the amount of snow in the snowpack.

Typically, the majority of the melt water passes out of a basin within about two weeks, or 14 days. In some peak times, this same melt may happen in as little as 4 or 5 days.

Conservatively, the 4-day melt scenario with the average snowfall has been used for design for this project.

2.4 FISHERIES AND OCEANS SPECIFIC REQUIREMENTS

2.4.1 Design Flow Rates

The requirements for DFO for fish passage migration delay incorporate a number of desired outcomes. In terms of flow rate of the design hydraulic structures, the following applies.

- Pass the 'design fish' in a 1 in 10 year flow scenario, with no greater than a 3-day delay in passage.

- The design fish must be passed without exceed its maximum sustained swimming speed over the length of the structure in question.

Each of the hydraulic structures at potential or known fish bearing crossings has been designed to accommodate those design requirements.

2.4.2 Design Fish

For this project, the design fish has been designated the Burbot, and the design maximum sustained swimming speed taken to be 0.41 m/s. This design speed was provided to FSC by the GNWT DOT, and sourced through their consultant Golder Associates in July 2009.

This design speed is similar to the design maximum sustained swimming speed of the 9 fin stickleback, a fish known to be found at crossing 5, at station 8700.

2.4.3 Other DFO Requirements and Issues

Impacted Areas

The Action items from the Nov 25th meeting require footprint areas for each potentially fish bearing crossing.

Those footprint areas are shown in sketches attached in Appendix C.

Depth of Culvert Installations in Permafrost Ground Conditions

Culvert installations on fish bearing streams in southern Canada, normally place the elevation of the bottom of the culvert is placed somewhat below the existing streambed.

This 'subcut' is to allow the ordinary transport of streambed material to infill the bottom of the culvert, resulting in a more natural bottom condition than the corrugated metal bottom of the typical culvert.

Northern Canadian practice for culvert installations runs somewhat counter to this practice, at least in the short term. Typically, most culverts installed in northern roads settle quite substantially over the early life of the culvert, due to the extremely low strength of the thawed active thaw zone soils. As a result, drainage only culverts are usually installed with the invert elevated approximately 150 mm above the surrounding ground, and the roadway also elevated above the culvert at that point. Within a few years, each of these culverts will settle at least the 150 mm that they were elevated, and be at or below the previous ground surface.

Clearly, for fish bearing streams, such an elevated invert would be inappropriate, as it would cut off fish passage in year 1. Culverts on fish bearing streams are installed with the invert at the existing ground elevation. The settlement of the installed culvert as time passes, however, is as real for these culverts as the other. We anticipate that all culverts installed on fish bearing streams will settle 150 to 200 mm over the first few years of operation, resulting in the same final result as the original installation of a culvert in southern Canada.

We also face a problem in deliberately cutting into the existing ground if we were to try to install these culverts initially below the existing stream bed. A fundamental design tenet of constructing a roadway in this ice rich permafrost area is to avoid, wherever possible, disturbing the vegetation mat which covers the ground. The vegetation mat acts to help confine the upper soil layers, and minimizes both the future settlements, and silt and sediment transport.

So, cutting into the ground to install a culvert invert below the existing surface elevation, is undesirable.

3 Culvert Hydraulics

3.1 GENERAL

Culverts have a hydraulic capacity for water flow that depends upon several factors. These include diameter, slope, length, type of pipe, and type of pipe end treatment.

The capacity of any particular culvert also depends upon how much surcharge if any is at the inlet and outlet of the culvert. Depending on that surcharge the culvert will either be in what is called 'inlet control' or in what is called 'outlet control'. Design is based upon evaluation of both inlet and outlet control, and accepted the lower value as controlling the capacity of the culvert.

The design methodology for this project is based upon a method developed by the California Department of Highways and subsequently used around the world by most highway design agencies.

It states that the 1 in 10 year flood is to be designed to be passed with the installed culvert flowing without any inlet surcharge.

The 1 in 100 year flood is to be passed utilizing the available head above the culvert.

The geometric design basis for this particular roadway calls for a minimum of 400 mm of cover above the top of any culvert to the shoulder of the road.

In the culvert hydraulic calculations, we set the 1 in 100 year head to be the diameter plus 400 mm.

3.1.1 Inlet Control

Inlet control flow capacity is determined through the use of an 'Inlet Control Nomograph', taken from the 'Handbook of Steel Drainage and Highway Construction Products – Canadian Edition'.

We have determined to use wherever possible one of three possible culvert sizes due to construction logistics. 800 mm, 1600 mm, and 2000 mm diameter were specified for the project. Larger sizes could also be possible depending on the other requirements including fisheries.

Inlet control assumes that inlet losses are larger than the friction losses in the culvert, and thus that the inlet controls the overall flow capacity of the culvert.

The Inlet Control Nomograph gives us the following capacities for the three sizes noted, using the above noted surcharges.

	800 mm	1600 mm	2000 mm
1:10 Year	0.62 cu.m./s	4.20 cu.m./s	8.20 cu.m./s
1:100 Year	0.85 cu.m./s	5.10 cu.m./s	10.90 cu.m./s

For this project we will find that typically inlet control does NOT govern the culvert design.

3.1.2 Outlet Control

Outlet control assumes that the friction losses in the culvert are larger than inlet losses, and thus that the culvert geometry, controls the overall flow capacity of the culvert.

Outlet control considers the length, type of pipe, inlet losses, and slope of the culvert pipe. We have prepared design spreadsheets for outlet control each of the significant crossings. The results are presented in Section 4 and 5.

4 Potentially Fish Bearing Crossings

4.1 GENERAL

In the fall of 2008, EBA identified 8 potentially fish bearing crossings to be evaluated. These crossings were then evaluated in the summer of 2009 by IMG Golder (Golder) in report 09-1134-017.

The crossings were identified by EBA by number from 1 to 8. In the following sections, we have further identified them by station number on the Issued for Construction drawings of the project. One additional crossing location was identified by Golder and numbered as crossing 7B.

Golder identified four Crossings as having fish bearing potential, crossings 4, 5, 6, and 7B. We will examine those crossings in this section.

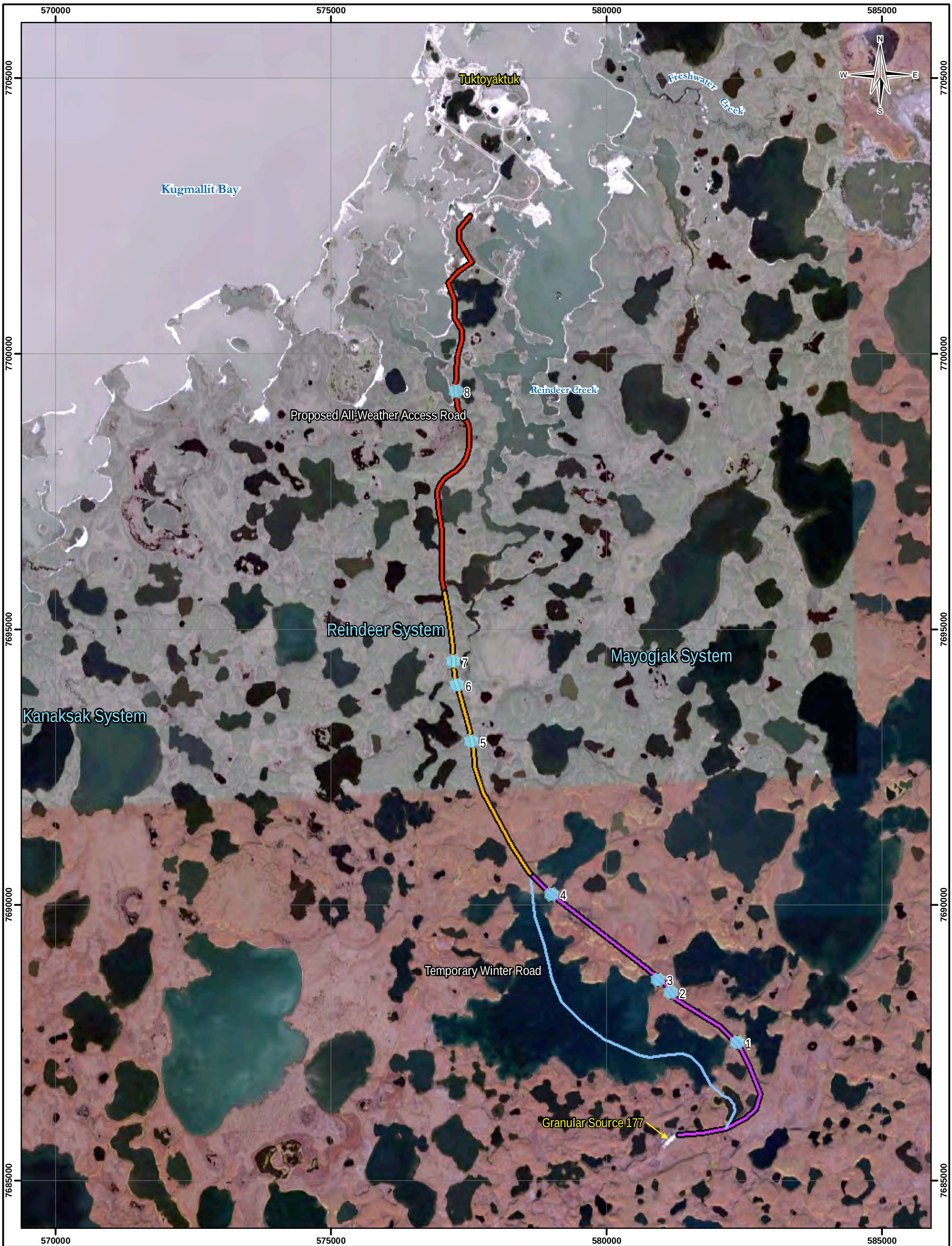
The 2008 EBA drawing is attached inline to the text following.

Appendix A following, is a map of the routing of the roadway, with the associated drainage areas contributing to the flow across the roadway, at the various crossing locations.

Appendix B has the hydraulic worksheets for the various options.

Appendix C has layouts and coverage of each installation in a potentially fish bearing crossing.

Q:\Vancouver\GIS\ENVIRONMENTAL\Y221\Y22101080_TUK\Maps\ConstructionPhaseEnvPlan\Y22101080_FisheriesManagement_Figure3.mxd



LEGEND

- Potential Stream Crossings
- Phase A - All-Weather Access Road
- Phase B - All-Weather Access Road
- Phase C - All-Weather Access Road
- Temporary Winter Road

NOTES

Base data source:
Background imagery provided courtesy of Google Earth and is shown for visual presentation purposes only.

Northwest Territories

Incorporated Hamlet of Tuktoyaktuk — Land of the Pingos

ISSUED FOR USE

PROPOSED TUKTOYAKTUK TO GRANULAR SOURCE 177 ACCESS ROAD

Stream Crossings

PROJECTION: UTM Zone 8	DATUM: NAD83		
Scale: 1:65,000 (1 0.5 0 1 Kilometres)			
FILE NO.: Y22101080_Stream_Xings.mxd			
PROJECT NO.: Y22101080	DWN: MEZ	CKD: TS	REV: 0
OFFICE: EBA-VANC	DATE: January 19, 2009		

KIGGIAK - EBA

Figure X

4.2 CROSSING 4 – STATION 12015 – PROPOSED CULVERT NO. 36 (AND 37)

4.2.1 Golder Report findings:

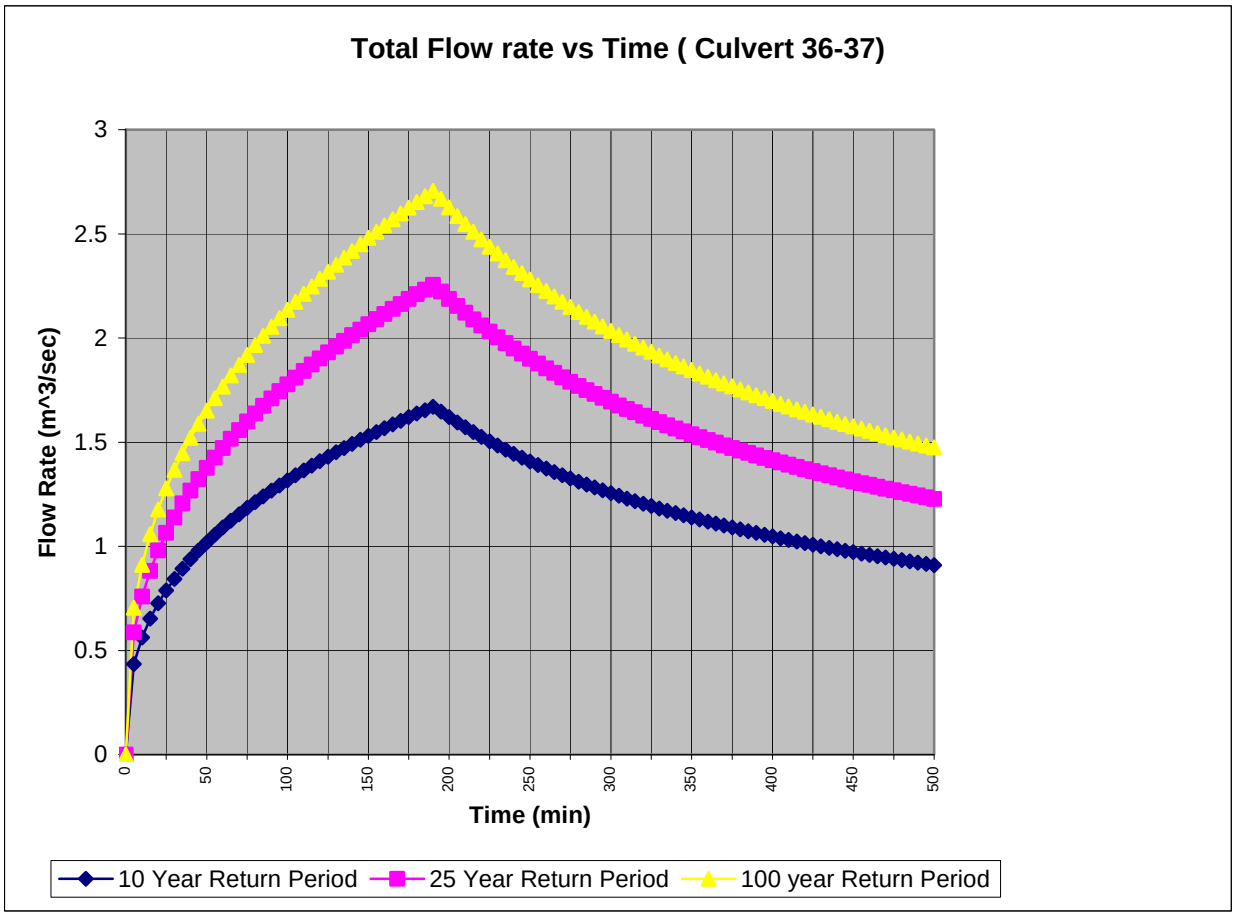
Watercourse that may have potential to support sport fish populations on at least a seasonal basis, and/or provide suitable habitat for forage species.

- Observed Fish Species: Ninespine stickleback
- Total Fish # Observed: 4
- Substrate: Fines/organic material
- Wetted width: 2.75 m
- Maximum Depth: 0.20 m
- Maximum velocity: 0.119 m/s

2) Status: The Access Road has not been built to this location yet. No culvert installed in 2009 season.

4.2.2 Runoff Calculation Results Crossing 4

Site Name		Culvert 36 - 37	
L		7265.46 ft	2215.1 m
H		56.65 ft	17.3 m
Site Contributing Area		2,490,622 m^2	249.06 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		**0.00780**	



The flow value for the DFO Migration Delay condition of 10 year return, 3 day maximum delay is 0.23 cu. m. / sec.

4.2.3 Snow Melt Crossing 4

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	214,194	cu. m.
No. Days	4	days
Snow Melt Q	0.62	m^3/sec

The snow melt of 86 mm melting over 4 days produces a flow rate over that time of 0.62 cu. m. / sec.

4.2.4 Hydraulic Capacity Calculations Crossing 4

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	424.8 L/s	2,068.1 L/s	3,371.8 L/s
1:100 Year	1,320.7 L/s	4,305.1 L/s	4,353.0 L/s

Thus, outlet control governs most cases.

4.2.5 Hydraulic Flow Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 3.29 cu. m/sec.

Crossing 4 at Station 12015 is calculated to require at least a single 1600 mm culvert. This is a change from the originally specified 2 – 1600 mm diameter culverts.

The flow velocity in a single 1600 mm culvert for the DFO fisheries flow case of 0.23 cu. m. / sec is calculated to be 0.11 m/s, well below the burbot (or stickleback) design velocity of 0.41 m/s.

Alternatives Considered

The location chosen for this crossing is on a narrow bridge of land, approximately 65 m wide, between two lakes. Given the topography of the land and the location of the lakes in this area, there is no reasonable alternative than to cross at this location.

Thus, the crossing occurs within 500 m of a lake in either direction.

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of a culvert would be most straightforwardly a single 1600 mm culvert. Using 800 mm culverts would require at least 5 culverts, which is clearly not desirable.

A short span single lane bridge, while also technically feasible, would be at least 20 times as costly as a culvert installation, and provide limited benefits.

Recommendation

We recommend the installation of a single 1600 mm culvert at this location.

4.2.6 Construction Issues

Construction Schedule

The currently scheduled construction time is to install this culvert between March 1 and April 15 2010. This will be before the spring freshet, allowing installation to occur with minimal siltation issues within the streambed. See Section 6 for additional schedule information.

Method of Construction

The culvert will be installed with as little disruption as possible of the existing streambed. Geotechnical fabric will be placed directly on the existing ground, and the culvert placed directly on the ground. Where possible there will be no excavation of the streambed, however under the roadway embankment there may be some limited realignment to suit the straight nature of the culvert.

At either end of the culvert Rip Rap will be placed on the existing ground in an apron to minimize any erosion of the ground due to concentrated flows at high flow volumes.

Due to the time of year of construction, we do not anticipate any flow during construction.

Construction Mitigation Measures:

a. Equipment necessary to the work, including a backhoe, and one 1600mm culvert will be mobilized to the site.

b. No fuel will be stored onsite.

c. Any refuelling that proves necessary will take place well away from the water and will make use of drip trays beneath the fuel dispenser and receptacle.

d. Idle equipment will be moved 200 meters away from any body of water before it is allowed to sit.

e. Any excavated material will be removed away from the water for stockpiling to avoid silt contaminants while the culverts are installed. It will be reused as fill once installation has been completed.

f. Care will be taken to ensure that the excavated material cannot enter the water accidentally or contribute to sedimentation during the work period.

g. Silt fencing will be erected between all work areas and the channel to prevent sediment from entering the stream. They will be left in place until the crossing sites have stabilized.

h. The culvert inlet and outlet will be dressed with placed rock or sandbags to ensure no sloughing of construction materials into the channel.

Explosives to Be Used in Construction

No explosives are to be used in construction of this crossing.

Spill Contingency Plan

The project Spill Contingency Plan is found in the EBA PDR report.

4.3 CROSSING 5 – STATION 8700 – CULVERT NO. 31 AND 32

1) Golder Report findings: Watercourse that may have potential to support sport fish populations on at least a seasonal basis, and/or provide suitable habitat for forage species.

Observed Fish Species: Ninespine stickleback

- Total Fish # Observed: 35
- Substrate: In culvert
- Wetted width: In culvert
- Maximum Depth: 0.22 m
- Maximum velocity: 0.156 m/s

Measurements collected 2-5 metres downstream from crossing:

- Substrate: Fines/organic material
- Wetted width: 13.4 m
- Maximum Depth: 0.15 m
- Maximum velocity: 0.031 m/s

2) Status: Two 800mm spiral culverts were placed, with the invert of the culverts resting at the same elevation as the bottom of the adjacent ponds.

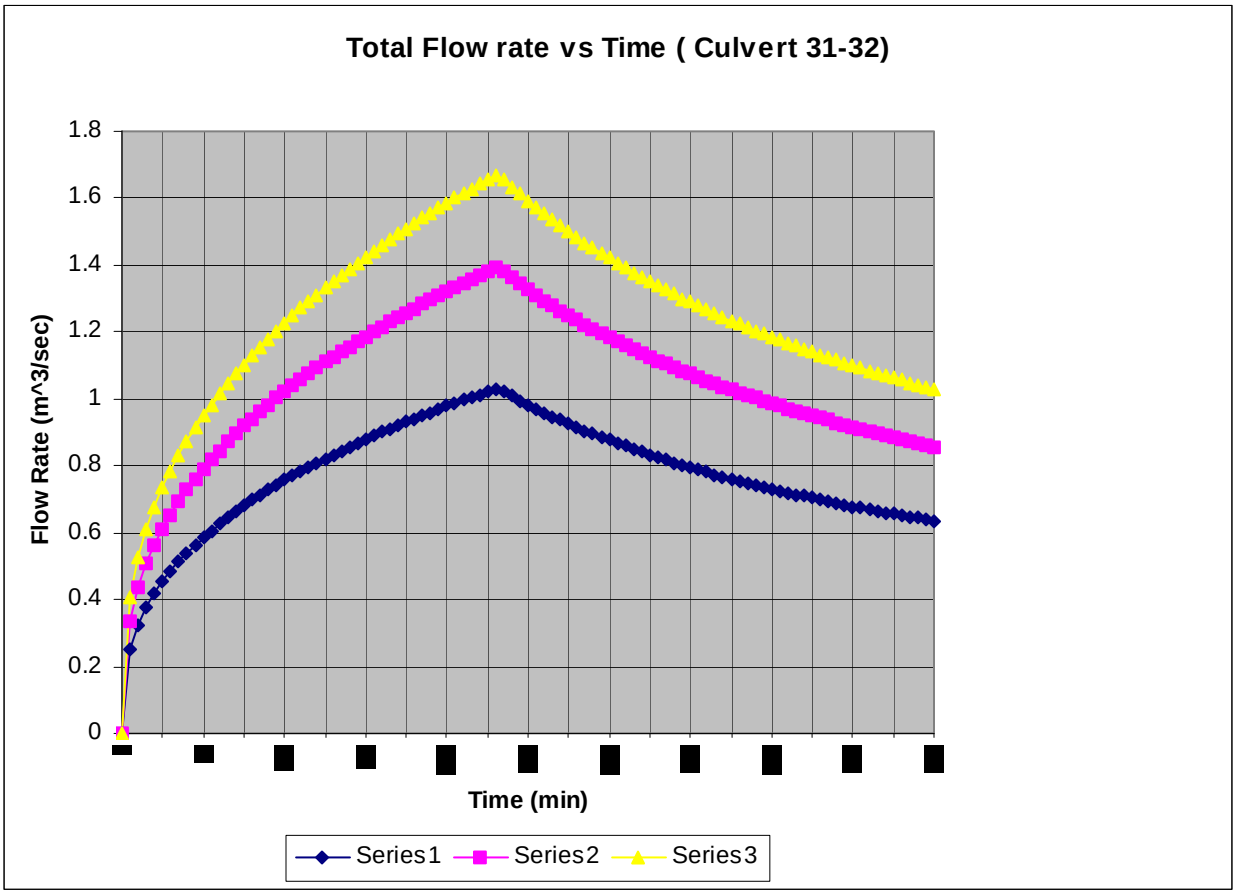
3) Mitigation Measures:

a. Silt fencing will be installed when crews remobilize to this site and will be maintained during any subsequent work, and after demobilization until the site stabilizes.

b. One 800 mm culvert will be replaced with a single 1600 mm culvert installed with the inverts up and downstream at or below the existing grade to eliminate the barrier to fish passage.

4.3.1 Runoff Calculation Results Crossing 5

		Crossing 5 Culvert	
Site Name		31, 32	
L		8600.00 ft	2622.0 m
H		56.65 ft	17.3 m
Site Contributing Area		1,739,000 m^2	173.90 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		**0.00659**	



The flow value for the DFO Migration Delay condition of 10 year return, 3 day maximum delay is 0.16 cu. m. / sec.

4.3.2 Snow Melt Crossing 5

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	214,194	cu. m.
No. Days	4	Days
Snow Melt Q	0.62	m^3/sec

4.3.3 Hydraulic Calculations Crossing 5

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	410.9 L/s	2,076.6 L/s	3,422.1 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s	4,312.7 L/s

Thus, outlet control governs the majority of these cases.

4.3.4 Hydraulic Flow Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 2.10 cu. m/sec.

Crossing 5 at Station 8600 is calculated to require a single 1600 mm culvert or 2 800 mm culverts. Currently there are installed 2 - 800 mm diameter culverts.

The flow velocity in a single 1600 mm culvert for the DFO fisheries flow case is calculated to be 0.08 m/s, well below the burbot (or stickleback) design velocity of 0.41 m/s. The flow velocity in a either one of two 800 mm culvert for the DFO fisheries flow case of 0.16 cu. m. / sec is calculated to be 0.16 m/s, well below the burbot (or stickleback) design velocity of 0.41 m/s.

Crossing 5 currently has 2 – 800 mm culverts installed. While these culverts meet all hydraulic requirements including the DFO fish passage requirements, they were installed in such a way as to present a barrier to fish passage at the outlet.

Alternatives Considered

The location chosen for this crossing is adjacent to the outlet of a small lake, which itself drains a slightly larger basin to the east of the crossing. The downstream extent of the stream travels 400 m before it drains into a chain of lakes

Thus, the crossing occurs within 500 m of a lake in either direction.

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of either a single 1600 mm culvert or 2 - 800 mm culverts would be appropriate. While a single culvert installation is normally preferred, due to lowered impacted area on the streambed, in this case the impacted area of either a single 1600 mm culvert or the installed 2 - 800 mm culverts would be the same.

A short span single lane bridge, while also technically feasible, would be at least 20 times as costly as a culvert installation, would in addition require the grade line of the road to be raised as with crossing 6, increasing the impacted area of the road berm.

Review Meeting

At the March 1, 2010 meeting between DFO, DOT and FSC it was decided that removing the lower of the two existing 800 mm diameter culverts and replacing it with a single 1600 mm culvert would be a preferred outcome. The new 1600 mm culvert will be placed with the upstream and downstream inverts carefully positioned to be at or slightly below the existing grade. The second existing 800 mm culvert will be left in place as an assistance at high flow periods.

No other remediation would be required subsequent to placement of the new 1600 diameter culvert at the proper grades.

Recommendation

We recommend the retention of one of the 2 – 800 mm culverts, with other culvert being replaced with a new 1600 diameter culvert placed at grade so as to not impede the passable of fish in this area.

4.3.5 Construction Issues

Construction Schedule

The currently scheduled construction time is to install this culvert between March 1 and April 15 2010. This will be before the spring freshet, allowing installation to occur with minimal siltation issues within the streambed.

See Section 6 for additional schedule information.

Method of Construction

The culvert will be installed with as little disruption as possible of the existing streambed. Geotechnical fabric will be placed directly on the existing ground, and the culvert placed directly on the ground. Where possible there will be no excavation of the streambed, however under the roadway embankment there may be some limited realignment to suit the straight nature of the culvert.

At either end of the culvert Rip Rap will be placed on the existing ground in an apron to minimize any erosion of the ground due to concentrated flows at high flow volumes.

Due to the time of year of construction, we do not anticipate any flow in the streambed during construction.

Construction Mitigation Measures:

a. Equipment necessary to the work, including a backhoe, and one 1600mm culvert will be mobilized to the site.

b. No fuel will be stored onsite.

c. Any refuelling that proves necessary will take place well away from the water and will make use of drip trays beneath the fuel dispenser and receptacle.

d. Idle equipment will be moved 200 meters away from any body of water before it is allowed to sit.

e. Any excavated material will be removed away from the water for stockpiling to avoid silt contaminants while the culverts are installed. It will be reused as fill once installation has been completed.

f. Care will be taken to ensure that the excavated material cannot enter the water accidentally or contribute to sedimentation during the work period.

g. Silt fencing will be erected between all work areas and the channel to prevent sediment from entering the stream. They will be left in place until the crossing sites have stabilized.

h. The culvert inlet and outlet will be dressed with placed rock or sandbags to ensure no sloughing of construction materials into the channel.

Explosives to Be Used in Construction

No explosives are to be used in construction of this crossing.

Spill Contingency Plan

The project Spill Contingency Plan is found in the EBA PDR report.

4.4 CROSSING 6 – STATION 7390 – PROPOSED CULVERT NO. 26, 27, 28

4.4.1 Golder Report findings

Watercourse that may have potential to support sport fish populations on at least a seasonal basis, and/or provide suitable habitat for forage species.

Observed Fish Species: Ninespine stickleback, Northern pike, Broad whitefish, Cisco

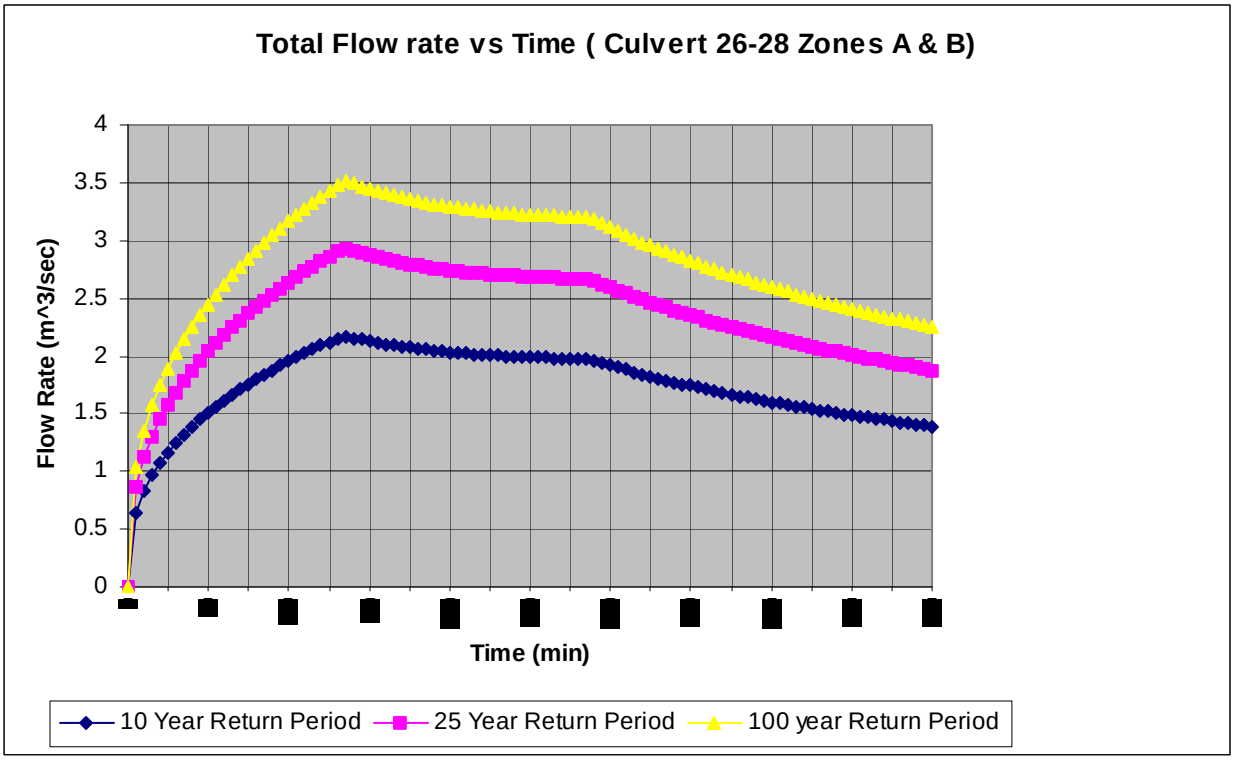
- Total Fish # Observed: 1, 3, 3, 1
- Substrate: Fines/organic material
- Wetted width: 3.6 m.

  (Note: The 2009 Golder Report lists the crossing width as 10.8 m. That width was correct given the original road alignment, which passed entirely over a small pond within the stream itself. Given the proponents consistent intention to minimize the impact of the road and crossing on the watercourse, the roadway was realigned to the west, passing entirely outside of the location of the pond. The wetted width at the crossing location is currently measured as 3.6 m, as shown)
- Maximum Depth: 0.78 m
- Maximum velocity: 0.119 m/s

4.4.2 Runoff Calculation Results Crossing 6

The stream crossing at Crossing 6 – Station 7390 is fed by two separate watersheds, draining into a small lake above the crossing. We have designated these watersheds Zone A and Zone B.

Site Name		Zone A	
L		6727.90 ft	2051.2 m
H		111.56 ft	34.0 m
Site Contributing Area		1536668.10 m^2	153.67 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.01658	
Site Name		Zone B	
L		9165.90 ft	2794.5 m
H		39.36 ft	12.0 m
Site Contributing Area		2271894.00 m^2	227.19 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.00429	



The flow value for the DFO Migration Delay condition of 10 year return, 3 day maximum delay is 0.35 cu. m. / sec.

4.4.3 Snow Melt Crossing 6

Crossing 6 Zone A

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	132,153	cu. m.
No. Days	4	days
Snow Melt Q	0.38	m^3/sec

Crossing 6 Zone B

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	195,383	cu. m.
No. Days	4	days
Snow Melt Q	0.57	m^3/sec

Total snowmelt Q – 0.95 cu. m. / sec

4.4.4 Hydraulic Calculations Crossing 6

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert in this location we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	327.0 L/s	1,715.7 L/s	6,503.2 L/s
1:100 Year	1,124.9 L/s	3,899.9 L/s	8,341.2 L/s

Thus, outlet control governs the majority of the cases.

4.4.5 Hydraulic Flow Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 4.90 cu. m/sec.

Crossing 6 at Station 7390 is calculated to require at least a single 2000 mm culvert. This is a change from the originally specified 1 – 2000 mm culverts and 2 – 1600 mm diameter culverts.

The flow velocity in a single 2000 mm culvert for the DFO fisheries flow case is calculated to be 0.11 m/s, well below the burbot (or stickleback) design velocity of 0.41 m/s.

The preliminary design for this installation called for 1 – 2000 mm culverts and 2 – 1600 mm diameter culverts, to be installed. This final drainage report has through more detailed analysis reduced the peak flow requirements, and thus the number and size of culverts in some locations.

This particular installation is one of those locations. A single 2000 mm culvert has more than sufficient capacity for the entire anticipated flow at this location.

It meets also the DFO fisheries requirements of a single structure, located fully in the streambed, with the minimum impact on fisheries habitat.

Alternatives Considered

The location chosen for this crossing is on an 850 m long stream connecting two small lakes, which drain a fairly large basin to the west of the crossing. The routing for the roadway needs to be within this 850 long section, and there is no apparent difference from a fisheries impact perspective on crossing locations either up or downstream of the chosen location, as the stream is of similar character throughout it's length. Within 500 mm downstream there is no change of width, flow, water depth or tides anticipated. Approximately 210 mm upstream there is a small lake, approximately 400 m x 80 m in size. That upstream lake is part of the drainage collection system which drains through crossing 6.

The preliminary flow calculations in spring 2009 required the installation of 2 - 1600 mm culverts, and one 2000 mm culvert. A revised and more accurate flow calculation carried out in December 2009 reduced the flow rate to a level that could be appropriately handled by a single 2000 mm culvert.

While looking at the initial 3-culvert installation, a short span single lane bridge was also evaluated. It was found that while the short span single lane bridge was also technically feasible, would be at least 5 times as costly as this 3-culvert installation. Given the current reduction in anticipated design flows, the single 2000 mm culvert is anticipated to be 1/10th the cost of the alternate short span single lane bridge.

In addition, the road vertical alignment does not work well with the provision of a short span single lane bridge. At this location, the road vertical profile approaching the crossing is a 5.9% grade. With the installation of a culvert a full roadway width is possible, allowing normal highway speeds to be maintained by traffic.

With the installation of a short span single lane bridge, the roadway grade would need to be reduced to approximately 2% to allow traffic to stop, in the case of the two vehicles approaching the bridge at the same time. To provide the 2% grade would require raising the grade at that location by at least 3.0 m. That would increase the width of fill at the abutments from approximately 40 m (the culvert length) to from 52 to 58 m depending on the side slope of the road. This widening of the embankment would place fill into the adjacent small pond that was mentioned previously.

Such an increase in embankment width and fill into the adjacent pond would significantly increase the impact of the project on fisheries habitat, and is seen as being undesirable.

Review Meeting

At the March 1, 2010 meeting between DFO, DOT and FSC it was decided that installing the new 2000 mm diameter culvert would be acceptable for the requirements of the crossing. Discussion as to the appropriate location for that culvert determined that it would be possible to place the culvert at a 'less skewed' orientation to the roadway by running from the upstream streambed location, directly to the tundra pond on the east side of the road. This less skewed orientation would result in a shorter culvert, presenting less of a barrier to passage to the resident fish population.

Recommendation

We recommend the installation of a single 2000 mm culvert at this location, running from the existing stream bed upstream to the existing tundra pond downstream.

4.4.6 Construction Issues

Construction Schedule

The currently scheduled construction time is to install this culvert between March 1 and April 15 2010. This will be before the spring freshet while the stream is frozen to the bottom, allowing installation to occur with minimal siltation issues within the streambed.

See Section 6 for additional schedule information.

Method of Construction

The culvert will be installed with as little disruption as possible of the existing streambed. Geotechnical fabric will be placed directly on the existing ground, and the culvert placed directly on the ground. As the revised culvert location under the roadway embankment is at a slightly different location from the existing streambed, the new location will be excavated and the culvert placed in predominately dry condtions, allowing a better installation with less likelihood of settlement to take place.

There will be a realignment of the existing flow channel to suit the straight nature of the culvert.

At either end of the culvert Rip Rap will be placed on the existing ground in an apron to minimize any erosion of the ground due to concentrated flows at high flow volumes.

Due to the time of year of construction, we do not anticipate any flow in the streambed during construction.

Construction Mitigation Measures:

a. Equipment necessary to the work, including a backhoe, and one 1600mm culvert will be mobilized to the site.

b. No fuel will be stored onsite.

c. Any refueling that proves necessary will take place well away from the water and will make use of drip trays beneath the fuel dispenser and receptacle.

d. Idle equipment will be moved 200 meters away from any body of water before it is allowed to sit.

e. Any excavated material will be removed away from the water for stockpiling to avoid silt contaminants while the culverts are installed. It will be reused as fill once installation has been completed.

f. Care will be taken to ensure that the excavated material cannot enter the water accidentally or contribute to sedimentation during the work period.

g. Silt fencing will be erected between all work areas and the channel to prevent sediment from entering the stream. They will be left in place until the crossing sites have stabilized.

h. The culvert inlet and outlet will be dressed with placed rock or sandbags to ensure no sloughing of construction materials into the channel.

Explosives to Be Used in Construction

No explosives are to be used in construction of this crossing.

Spill Contingency Plan

The project Spill Contingency Plan is found in the EBA PDR report.

4.5 CROSSING 7B– STATION 5833 – CULVERT NO. 17

1) Golder Report findings: Small watercourse that does not provide fish habitat at the crossing location but may contribute to downstream habitat.

- Substrate: Fines/organic material
- Wetted width: 1.9 m
- Maximum Depth: 0.19 m
- Maximum velocity: 0.083 m/s

2) Status: One 800mm spiral culvert was placed on the existing ground, with the invert of the culvert resting at the same elevation as the bottom of the adjacent pond.

3) Mitigation: Care will be taken to ensure that the structures cannot become perched during low water events.

The location of culvert 17, crossing 7B is some 3.5 m higher than the nearby culvert 16, a non fish bearing drainage culvert which drains the nearest small lake from west to east. Culvert 17 drains a small (100 x 100 m) marshy of ice rich polygonal terrain south of that lake. There is no anticipation of any significant flow through this culvert due to the small drainage area.

The area has been noted by Golder as not being fish bearing habitat, but as possibly contributing to fish bearing habitat, with water flow present at the time of inspection.

Alternatives Considered

Given the minimal flows noted by Golder (and expected due to small drainage catchment area), the most appropriate and straightforward crossing type would be the installation of a a single 800 mm culvert.

No larger or more complex alternatives would seem to be appropriate for this installation.

Recommendation

We recommend the retention of the single 800 mm culvert at this location.

5 Non Fish Bearing Drainage Culverts

5.1 GENERAL

The majority of the culverts installed on this project are equalization or surface runoff culverts not associated with streams, either ephemeral or permanent.

In addition, the minimum culvert size on this project has been set to be 800 mm diameter for reasons of long-term performance with expected settlements, rather than sized hydraulically to a smaller diameter.

As such, the majority of the culverts are NOT specifically sized hydraulically, but rather located at known locations which would otherwise trap water behind the embankment. We will not address those culverts in more detail in this document.

In the section previous, we addressed the potentially fish bearing crossings. These include the other 4 crossings identified by EBA in the fall of 2008.

This section will address the other surface runoff culverts, on non-fish bearing ephemeral drainage courses which were identified by EBA as crossings in the fall of 2008.

Appendix A following, is a map of the routing of the roadway, with the associated drainage areas contributing to the flow across the roadway, at the various crossing locations.

Appendix B has the hydraulic worksheets for the various options.

5.2 CROSSING 1 – STATION 17460

There is no culvert to be installed at the site designated crossing 1. The site is some 18 m higher than either of the lakes on each side, and the road runs on a ridge at that location. Crossing 1 hydraulically does not exist.

5.3 CROSSING 2 – STATION 14860 – CULVERT NO. 40

Culvert 40 has not been constructed at the date of preparation of this report. A single 800 diameter culvert is proposed to be installed.

This location is some 3 m higher than either water body on either side. It is installed strictly as a balancing culvert, to ensure that water on one side does not rise above the other during spring melt.

There is no anticipation of any runoff flow through this culvert in normal years.

5.4 CROSSING 3 – STATION 14504 – CULVERT NO. 39

Culvert 39 has not been constructed at the date of preparation of this report. A single 800 diameter culvert is proposed to be installed.

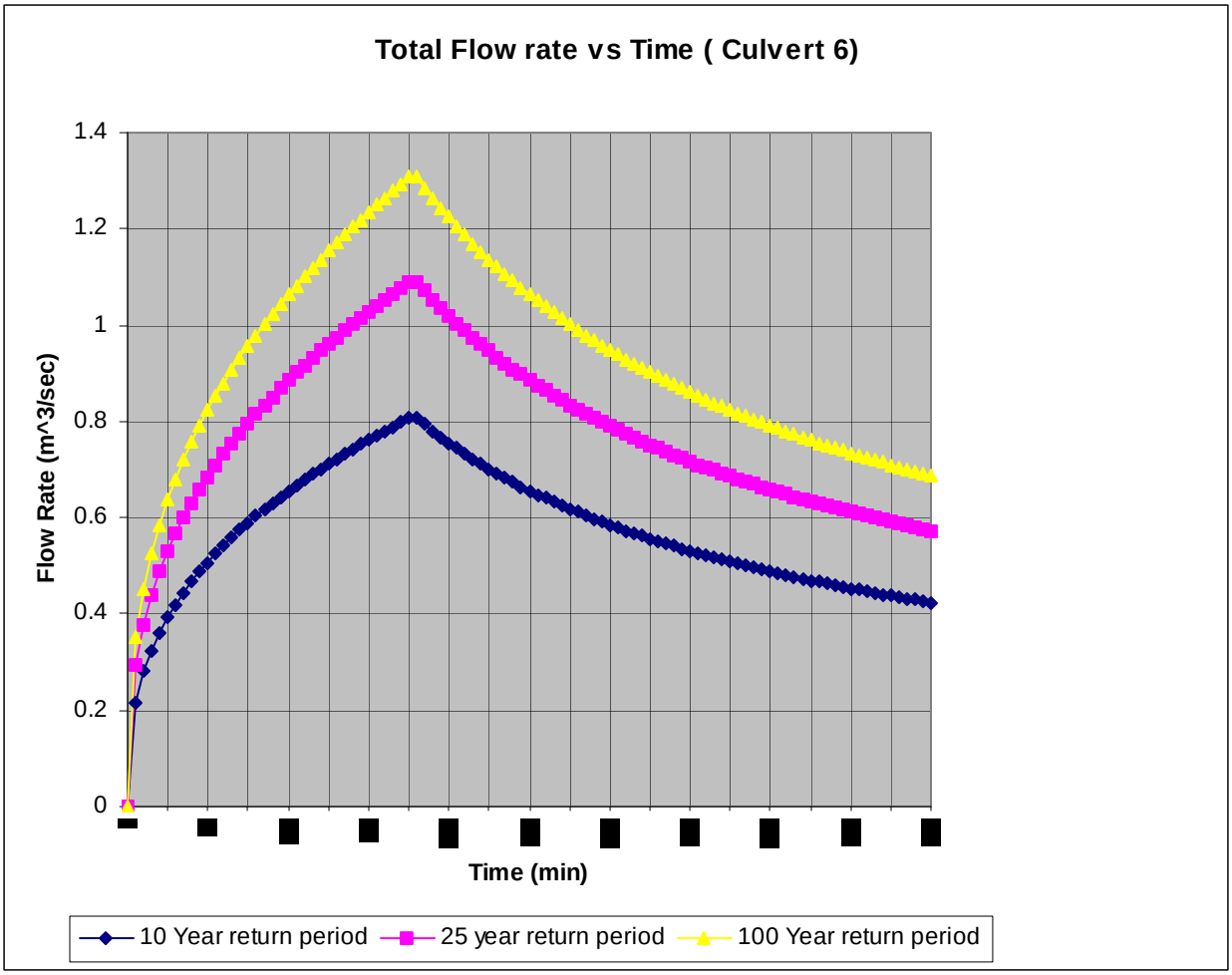
This location is some 9 m higher than either water body on either side. It is installed strictly as a runoff culvert, to ensure that water flowing down the adjacent hill on one side is able to pass to the low side and not pond adjacent to the roadway.

5.5 STATION 2285– CULVERT NO. 6

Culvert 6 has been constructed at the date of preparation of this report. A single 1600 diameter culvert has been installed.

5.5.1 Runoff Calculation Results Culvert 6

Site Name		Culvert 6	
L		6549.18 ft	1996.7 m
H		49.20 ft	15.0 m
Site Contributing Area		1,161,103 m^2	116.11 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.00751	



5.5.2 Snow Melt Culvert 6

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	99,855	cu. m.
No. Days	4	days
Snow Melt Q	0.29	m^3/sec

5.5.3 Hydraulic Calculations Culvert 6

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	410.9 L/s	2,076.6 L/s	3,422.1 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s	4,312.7 L/s

Thus, outlet control governs the majority of these cases.

5.5.4 Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 1.60 cu. m/sec.

Culvert 16 at Station 5480 is calculated to require at least a single 1600 mm culvert.

Alternatives Considered

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of a culvert would be most straightforwardly a single 1600 mm culvert. Using 800 mm culverts would require at least 3 culverts, which is not desirable.

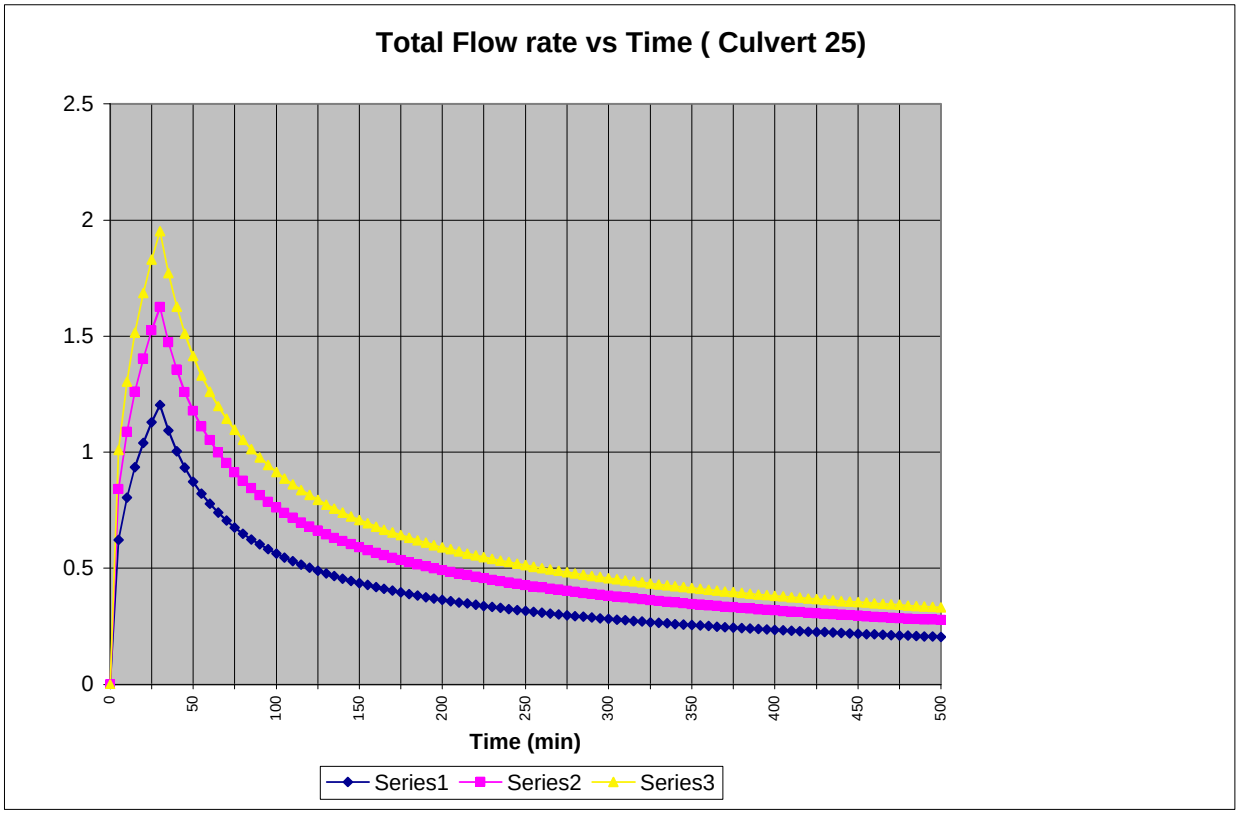
We recommend the installation of a single 1600 mm culvert at this location.

5.6 CROSSING 7 – STATION 7330 – CULVERT NO. 25

Crossing 7 has been constructed at the date of preparation of this report. A single 1600 diameter culvert has been installed.

5.6.1 Runoff Calculation Results

Site Name		Culvert 25	
L		1649.84 ft	503.0 m
H		81.34 ft	24.8 m
Site Contributing Area		560,063 m^2	56.01 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.04930	



5.6.2 Snow Melt Crossing 7

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	48,165	cu. m.
No. Days	4	days
Snow Melt Q	0.14	m^3/sec

5.6.3 Hydraulic Calculations

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	424.8 L/s	2,068.1 L/s	3,371.8 L/s
1:100 Year	1,320.7 L/s	4,305.1 L/s	4,353.0 L/s

Thus, outlet control governs most cases.

5.6.4 Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 2.09 cu. m/sec.

Crossing 7 at Station 7330 is calculated to require at least a single 1600 mm culvert.

Alternatives Considered

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of a culvert would be most simply a single 1600 mm culvert. Using 800 mm culverts would require at least 4 culverts, which is not desirable.

Recommendation

We recommend the installation of a single 1600 mm culvert at this location.

Crossing 8 – Station 1030 – Culvert No. 2

Culvert 1 has not been constructed at the date of preparation of this report. A single 800 diameter culvert is proposed to be installed.

This location is some 3 m higher than either water body on either side. It is installed strictly as a balancing culvert, to ensure that water on one side does not rise above the other during spring melt.

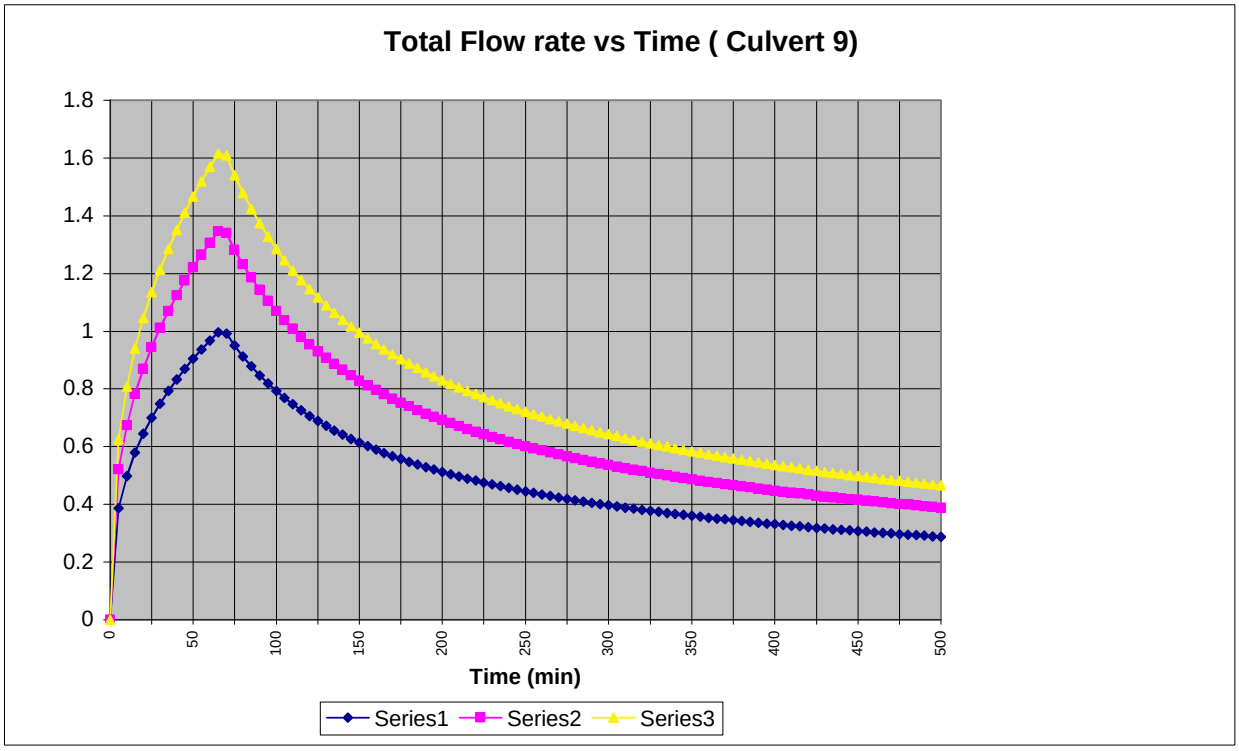
There is no anticipation of any runoff flow through this culvert.

5.7 STATION 3474 – CULVERT NO. 9

Culvert 9 has been constructed at the date of preparation of this report. A single 1600 diameter culvert was installed.

5.7.1 Runoff Calculation Results

Site Name		Culvert 9	
L		2668.35 ft	813.5 m
H		41.00 ft	12.5 m
Site Contributing Area		787,389 m^2	78.74 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.01537	



5.7.2 Snow Melt Culvert 9

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	67,715	cu. m.
No. Days	4	days
Snow Melt Q	0.20	m^3/sec

5.7.3 Hydraulic Calculations

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	410.9 L/s	2,076.6 L/s	3,422.1 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s	4,312.7 L/s

Thus, outlet control governs the majority of these cases.

5.7.4 Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 1.82 cu. m/sec.

Culvert 9 at Station 1030 is calculated to require at least a single 1600 mm culvert.

Alternatives Considered

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of a culvert would be most straightforwardly a single 1600 mm culvert. Using 800 mm culverts would require at least 4 culverts, which is not desirable.

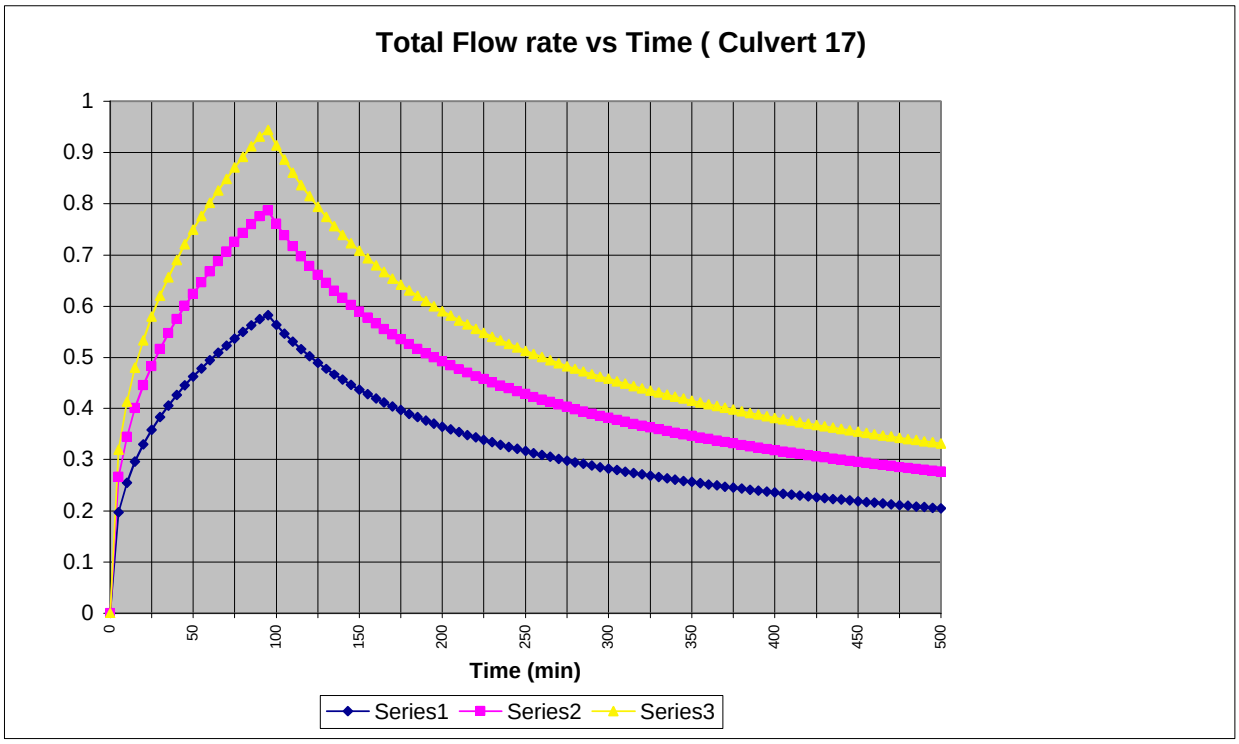
Recommendation

We recommend the installation of a single 1600 mm culvert at this location.

5.8 STATION 5832 – CULVERT NO. 16

5.8.1 Runoff Calculation Results

Site Name		Culvert 17	
L		3455.15 ft	1053.4 m
H		37.72 ft	11.5 m
Site Contributing Area		560,063 m^2	56.01 HA
Runoff	**Co-efficient (C)**	0.5	
Ground Slope		0.01092	



5.8.2 Snow Melt Culvert 16

Snow Melt	0.086	m of rain equivalent
Snow Melt Volume	48,165	cu. m.
No. Days	4	days
Snow Melt Q	0.14	m^3/sec

5.8.3 Hydraulic Calculations

We have derived the following capacities for this installation. The capacities differ under the 1:10 year and 1:100 year cases due to additional head being allowed in the 1:100 year case.

Under Inlet control, for a single culvert we calculate these capacities:

Inlet Control	800 mm	1600 mm	2000 mm
1:10 Year	620.0 L/s	4,200.0 L/s	8,200.0 L/s
1:100 Year	850.0 L/s	5,100.0 L/s	10,900.0 L/s

Under outlet control, for a single culvert we calculate these capacities. See Appendix B..

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	479.4 L/s	2,355.8 L/s	3,850.8 L/s
1:100 Year	1,312.8 L/s	4,407.3 L/s	4,716.2 L/s

Thus, outlet control governs the majority of these cases.

5.8.4 Hydraulic Flow Discussion and Recommendations

The design cases for this installation include the following:

100 year flow + snow melt = 1.08 cu. m/sec.

Culvert 9 at Station 1030 is calculated to require at least a single 1600 mm culvert.

Alternatives Considered

Given the flow rates calculated previously, and the construction decision to limit culvert sizes to 800 mm, 1600 mm and as required larger, the installation of a culvert would be most straightforwardly a single 1600 mm culvert. Using 800 mm culverts would require at least 3 culverts, which is not desirable.

Recommendation

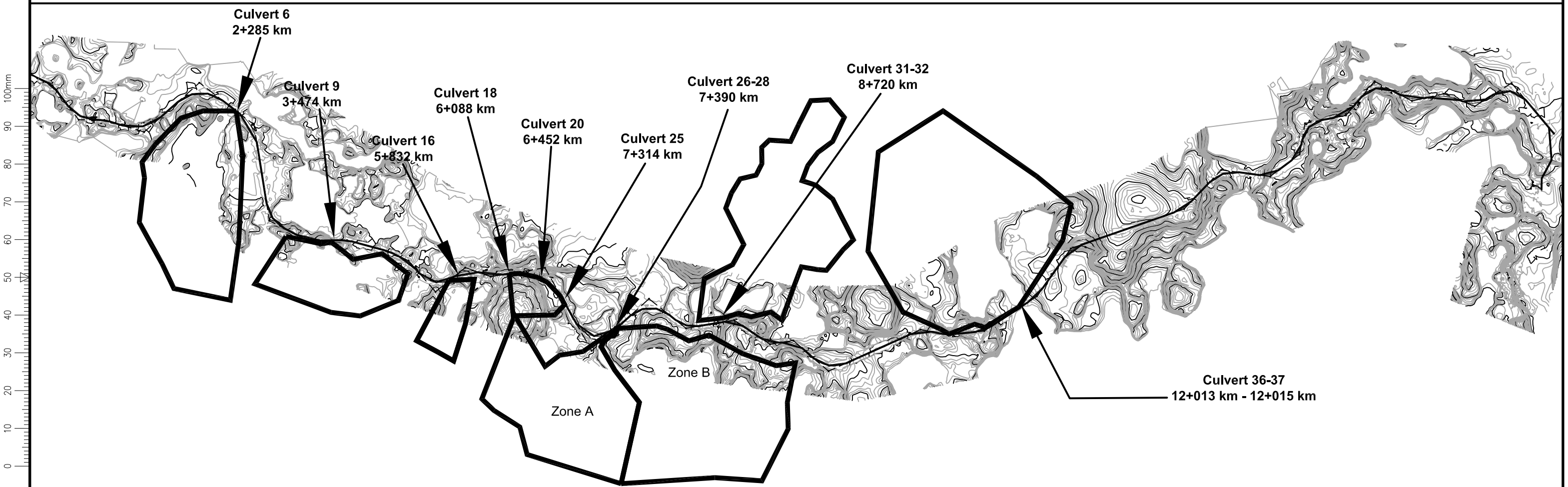
We recommend the installation of a single 1600 mm culvert at this location.

6 Construction Schedule 2010

The following construction schedule is anticipated to be followed in 2010.

Jan 15th	Commence construction of winter roads necessary to complete the work
	Complete winter road adjacent to Section C section (Km 0+000 to km 1+000)
	Will need to complete winter road adjacent to Section A (Km 12+000 to Km 18+575)
Feb 1st	Begin work in quarry
Feb 15th	Begin transport, hauling, spreading of gravel onto Section C areas to be completed
Feb 15-28	Complete remaining road construction of Section C
March 1-31	Installation of remaining drainage only culverts in Section C
March 1-31	Completion of road construction on Section A
	Install drainage only culverts in Section A as construction proceeds
April 1-15	New realignment and culvert installation at 7+520 (Stream crossing #6)
April 7-15	New Culvert installation at 12+015 (Stream crossing #4)
April 7-15	Remediate current culvert installation at 8+723 (Stream crossing #5)
April 15 to June 30	Monitor Roadway embankment and stream crossings to ensure silt fencing and other measures are intact and functioning properly
	Ensure crossing 5 tailwater empoundment is functioning properly
June 30 to August 15	Shape and Compact embankment surface and sideslopes.
	Grade roadway surface to final elevations and compact drivable surface
	Finalize culvert side slope protection

7 Appendix A – Culvert Locations and Area Boundary



PROJECT TITLE

TUKTOYAKTUK GRAVEL SOURCE ACCESS ROAD

FSC
ARCHITECTS & ENGINEERS
4910 - 53rd Street, P.O. Box 1777
Yellowknife, NT, X1A 2P4, Canada
T 867.920.2882 | F 867.920.4319

LOCATION: TUKTOYAKTUK, NT

DRAWING TITLE

CULVERT LOCATION & AREA BOUNDARY

CLIENT PROJECT NO.	FSC PROJECT NO.
-	2008-1191
DRAWN BY: FG / OA	CHECKED BY:
SCALE: N.T.S	DATE: FEBRUARY 15, 2010
DRAWING NO.	OF ___

FSC – ANSI-B_L – 11x17

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8 Appendix B – Calculation Worksheets

Culvert Capacity - Tuktoyaktuk Access to km 177 Pit

km 7390 Culvert Installation

California Balanced Design - 1 in 10 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Minimum Transit Time (t)
	0.80 m	0.00 m	0.30%	40.0 m	0.12 m	0.20 m	0.70	0.12 m	0.65 m/s	327.0 L/s	8.3	2,710.0 L/s	1.40 m	9.0	0.60 m/s	0.60 m/s	-211.59 sec
	0.90 m	0.00 m	0.30%	40.0 m	0.12 m	0.23 m	0.70	0.12 m	0.69 m/s	436.5 L/s	6.2	2,710.0 L/s	1.30 m	7.0	0.61 m/s	0.61 m/s	-201.46 sec
	1.00 m	0.00 m	0.30%	40.0 m	0.12 m	0.25 m	0.70	0.12 m	0.72 m/s	563.8 L/s	4.8	2,710.0 L/s	1.20 m	5.0	0.69 m/s	0.69 m/s	-142.81 sec
	1.10 m	0.00 m	0.30%	40.0 m	0.12 m	0.28 m	0.70	0.12 m	0.75 m/s	709.3 L/s	3.8	2,710.0 L/s	1.10 m	4.0	0.71 m/s	0.71 m/s	-132.05 sec
	1.20 m	0.00 m	0.30%	40.0 m	0.12 m	0.30 m	0.70	0.12 m	0.77 m/s	873.2 L/s	3.1	2,710.0 L/s	1.00 m	4.0	0.60 m/s	0.60 m/s	-211.59 sec
	1.30 m	0.00 m	0.30%	40.0 m	0.12 m	0.33 m	0.70	0.12 m	0.80 m/s	1,055.6 L/s	2.6	2,710.0 L/s	0.90 m	3.0	0.68 m/s	0.68 m/s	-147.84 sec
	1.40 m	0.00 m	0.30%	40.0 m	0.12 m	0.35 m	0.70	0.12 m	0.82 m/s	1,256.8 L/s	2.2	2,710.0 L/s	0.80 m	3.0	0.59 m/s	0.59 m/s	-226.22 sec
	1.50 m	0.00 m	0.30%	40.0 m	0.12 m	0.38 m	0.70	0.12 m	0.84 m/s	1,476.8 L/s	1.8	2,710.0 L/s	0.70 m	2.0	0.77 m/s	0.77 m/s	-112.12 sec
	1.60 m	0.00 m	0.30%	40.0 m	0.12 m	0.40 m	0.70	0.12 m	0.85 m/s	1,715.7 L/s	1.6	2,710.0 L/s	0.60 m	2.0	0.67 m/s	0.67 m/s	-151.56 sec
	1.70 m	0.00 m	0.30%	40.0 m	0.12 m	0.43 m	0.70	0.12 m	0.87 m/s	1,973.6 L/s	1.4	2,710.0 L/s	0.50 m	2.0	0.60 m/s	0.60 m/s	-213.94 sec
	1.80 m	0.00 m	0.30%	40.0 m	0.12 m	0.45 m	0.70	0.12 m	0.88 m/s	2,250.4 L/s	1.2	2,710.0 L/s	0.40 m	2.0	0.53 m/s	0.53 m/s	-326.58 sec
	1.90 m	0.00 m	0.30%	40.0 m	0.12 m	0.48 m	0.70	0.12 m	0.90 m/s	2,546.2 L/s	1.1	2,710.0 L/s	0.30 m	1.0	0.96 m/s	0.96 m/s	-73.29 sec
revised Headwater - lowered inv	**2.00 m**	0.50 m	0.30%	40.0 m	0.12 m	0.50 m	0.70	0.62 m	2.07 m/s	6,503.2 L/s	0.4	2,710.0 L/s	0.20 m	1.0	0.86 m/s	0.86 m/s	-88.37 sec

California Balanced Design - 1 in 100 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.30%	40.0 m	0.12 m	0.20 m	0.70	1.42 m	2.24 m/s	1,124.9 L/s	3.1	3,520.0 L/s	1.40 m	4.0	1.75 m/s	1.75 m/s	-29.84 sec
	0.90 m	1.20 m	0.30%	40.0 m	0.12 m	0.23 m	0.70	1.32 m	2.28 m/s	1,447.6 L/s	2.4	3,520.0 L/s	1.30 m	3.0	1.84 m/s	1.84 m/s	-27.89 sec
	1.00 m	1.10 m	0.30%	40.0 m	0.12 m	0.25 m	0.70	1.22 m	2.29 m/s	1,797.7 L/s	2.0	3,520.0 L/s	1.20 m	2.0	2.24 m/s	2.24 m/s	-21.85 sec
	1.10 m	1.00 m	0.30%	40.0 m	0.12 m	0.28 m	0.70	1.12 m	2.28 m/s	2,166.9 L/s	1.6	3,520.0 L/s	1.10 m	2.0	1.85 m/s	1.85 m/s	-27.74 sec
	1.20 m	0.90 m	0.30%	40.0 m	0.12 m	0.30 m	0.70	1.02 m	2.25 m/s	2,545.7 L/s	1.4	3,520.0 L/s	1.00 m	2.0	1.56 m/s	1.56 m/s	-34.90 sec
	1.30 m	0.80 m	0.30%	40.0 m	0.12 m	0.33 m	0.70	0.92 m	2.20 m/s	2,922.9 L/s	1.2	3,520.0 L/s	0.90 m	2.0	1.33 m/s	1.33 m/s	-43.67 sec
	1.40 m	0.70 m	0.30%	40.0 m	0.12 m	0.35 m	0.70	0.82 m	2.13 m/s	3,285.4 L/s	1.1	3,520.0 L/s	0.80 m	1.0	2.29 m/s	2.29 m/s	-21.31 sec
	1.50 m	0.60 m	0.30%	40.0 m	0.12 m	0.38 m	0.70	0.72 m	2.05 m/s	3,617.5 L/s	1.0	3,520.0 L/s	0.70 m	1.0	1.99 m/s	1.99 m/s	-25.29 sec
	1.60 m	0.50 m	0.30%	40.0 m	0.12 m	0.40 m	0.70	0.62 m	1.94 m/s	3,899.9 L/s	0.9	3,520.0 L/s	0.60 m	1.0	1.75 m/s	1.75 m/s	-29.84 sec
	1.70 m	0.40 m	0.30%	40.0 m	0.12 m	0.43 m	0.70	0.52 m	1.81 m/s	4,108.3 L/s	0.9	3,520.0 L/s	0.50 m	1.0	1.55 m/s	1.55 m/s	-35.06 sec
	1.80 m	0.30 m	0.30%	40.0 m	0.12 m	0.45 m	0.70	0.42 m	1.65 m/s	4,210.0 L/s	0.8	3,520.0 L/s	0.40 m	1.0	1.38 m/s	1.38 m/s	-41.10 sec
	1.90 m	0.20 m	0.30%	40.0 m	0.12 m	0.48 m	0.70	0.32 m	1.47 m/s	4,157.9 L/s	0.8	3,520.0 L/s	0.30 m	1.0	1.24 m/s	1.24 m/s	-48.11 sec
revised Headwater - lowered inv	**2.00 m**	0.90 m	0.30%	40.0 m	0.12 m	0.50 m	0.70	1.02 m	2.66 m/s	8,341.2 L/s	0.4	3,520.0 L/s	0.20 m	1.0	1.12 m/s	1.12 m/s	-56.30 sec

Fisheries - 3 Day Delay 1:10 Years	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.30%	40.0 m	0.12 m	0.20 m	0.70	1.42 m	2.24 m/s	1,124.9 L/s	0.3	350.0 L/s	1.40 m	1.0	0.70 m/s	0.70 m/s	-139.71 sec
	0.90 m	1.20 m	0.30%	40.0 m	0.12 m	0.23 m	0.70	1.32 m	2.28 m/s	1,447.6 L/s	0.2	350.0 L/s	1.30 m	1.0	0.55 m/s	0.55 m/s	-285.38 sec
	1.00 m	1.10 m	0.30%	40.0 m	0.12 m	0.25 m	0.70	1.22 m	2.29 m/s	1,797.7 L/s	0.2	350.0 L/s	1.20 m	1.0	0.45 m/s	0.45 m/s	-1122.53 sec
	1.10 m	1.00 m	0.30%	40.0 m	0.12 m	0.28 m	0.70	1.12 m	2.28 m/s	2,166.9 L/s	0.2	350.0 L/s	1.10 m	1.0	0.37 m/s	0.37 m/s	959.06 sec
	1.20 m	0.90 m	0.30%	40.0 m	0.12 m	0.30 m	0.70	1.02 m	2.25 m/s	2,545.7 L/s	0.1	350.0 L/s	1.00 m	1.0	0.31 m/s	0.31 m/s	397.88 sec
	1.30 m	0.80 m	0.30%	40.0 m	0.12 m	0.33 m	0.70	0.92 m	2.20 m/s	2,922.9 L/s	0.1	350.0 L/s	0.90 m	1.0	0.26 m/s	0.26 m/s	273.39 sec
	1.40 m	0.70 m	0.30%	40.0 m	0.12 m	0.35 m	0.70	0.82 m	2.13 m/s	3,285.4 L/s	0.1	350.0 L/s	0.80 m	1.0	0.23 m/s	0.23 m/s	219.02 sec
	1.50 m	0.60 m	0.30%	40.0 m	0.12 m	0.38 m	0.70	0.72 m	2.05 m/s	3,617.5 L/s	0.1	350.0 L/s	0.70 m	1.0	0.20 m/s	0.20 m/s	188.73 sec
	1.60 m	0.50 m	0.30%	40.0 m	0.12 m	0.40 m	0.70	0.62 m	1.94 m/s	3,899.9 L/s	0.1	350.0 L/s	0.60 m	1.0	0.17 m/s	0.17 m/s	169.55 sec
	1.70 m	0.40 m	0.30%	40.0 m	0.12 m	0.43 m	0.70	0.52 m	1.81 m/s	4,108.3 L/s	0.1	350.0 L/s	0.50 m	1.0	0.15 m/s	0.15 m/s	156.37 sec
	1.80 m	0.30 m	0.30%	40.0 m	0.12 m	0.45 m	0.70	0.42 m	1.65 m/s	4,210.0 L/s	0.1	350.0 L/s	0.40 m	1.0	0.14 m/s	0.14 m/s	146.81 sec
	1.90 m	0.20 m	0.30%	40.0 m	0.12 m	0.48 m	0.70	0.32 m	1.47 m/s	4,157.9 L/s	0.1	350.0 L/s	0.30 m	1.0	0.12 m/s	0.12 m/s	139.59 sec
revised Headwater - lowered inv	**2.00 m**	0.50 m	0.30%	40.0 m	0.12 m	0.50 m	0.70	0.62 m	2.07 m/s	6,503.2 L/s	0.1	350.0 L/s	0.20 m	1.0	0.11 m/s	0.11 m/s	133.96 sec

Projecting from Fill - ke =	0.9	
Bevelled End - ke =	0.7	
0.024	Mannings N for Normal CSP	
0.013	Mannings N for Ultraflow Pipe	
0.30 m	Minimum Head above Pipe to shoulder	
2.20 m	Current Depth of Fill at Shoulder	
350.0 L/s	10 Year Fisheries	
2,710.0 L/s	10 Year Flood	
3,520.0 L/s	100 Year Flood	
40.00 m	Length of Culvert	
0.12 m	Elevation Drop over Length of Culvert	
0.41 m/s	Burbot Cruising Swimming Speed	
0.41 m/s	Burbot Maximum Sustained Swimming Speed	
0.41 m/s	Burbot Maximum Dart Speed	

Head H = (1+ke+(2*g*n^2*L)/R^1.333)*(V^2/2*g)
Velocity V = ((H*2*g)/(1+ke+(2*g*n^2*L)/R^1.333))^0.5

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	327.0 L/s	1,715.7 L/s	6,503.2 L/s
1:100 Year	1,124.9 L/s	3,899.9 L/s	8,341.2 L/s

Culvert Capacity - Tuktoyaktuk Access to km 177 Pit

km 8700 Culvert Installation - Crossing 5

California Balanced Design - 1 in 10 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Installed	Actual Velocity (m/s)	Fish Swimming Issues	Minimum Transit Time (t)
	0.80 m	0.00 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	0.17 m	0.82 m/s	410.9 L/s	2.5	1,030.0 L/s	1.40 m	2.0	1.02 m/s	1.02 m/s	-52.07 sec
	0.90 m	0.00 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	0.17 m	0.86 m/s	545.2 L/s	1.9	1,030.0 L/s	1.30 m	2.0	0.81 m/s	0.81 m/s	-80.09 sec
	1.00 m	0.00 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	0.17 m	0.89 m/s	700.3 L/s	1.5	1,030.0 L/s	1.20 m	2.0	0.66 m/s	0.66 m/s	-130.23 sec
	1.10 m	0.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	0.17 m	0.92 m/s	876.5 L/s	1.2	1,030.0 L/s	1.10 m	2.0	0.54 m/s	0.54 m/s	-242.58 sec
	1.20 m	0.00 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	0.17 m	0.95 m/s	1,073.8 L/s	1.0	1,030.0 L/s	1.00 m	1.0	0.91 m/s	0.91 m/s	-63.91 sec
	1.30 m	0.00 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.17 m	0.97 m/s	1,292.4 L/s	0.8	1,030.0 L/s	0.90 m	1.0	0.78 m/s	0.78 m/s	-87.43 sec
	1.40 m	0.00 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.17 m	1.00 m/s	1,532.4 L/s	0.7	1,030.0 L/s	0.80 m	1.0	0.67 m/s	0.67 m/s	-123.50 sec
	1.50 m	0.00 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.17 m	1.02 m/s	1,793.8 L/s	0.6	1,030.0 L/s	0.70 m	1.0	0.58 m/s	0.58 m/s	-185.12 sec
	1.60 m	0.00 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.17 m	1.03 m/s	2,076.6 L/s	0.5	1,030.0 L/s	0.60 m	1.0	0.51 m/s	0.51 m/s	-312.87 sec
	1.70 m	0.00 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.17 m	1.05 m/s	2,380.9 L/s	0.4	1,030.0 L/s	0.50 m	1.0	0.45 m/s	0.45 m/s	-730.85 sec
	1.80 m	0.00 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.17 m	1.06 m/s	2,706.5 L/s	0.4	1,030.0 L/s	0.40 m	1.0	0.40 m/s	0.40 m/s	6112.03 sec
	1.90 m	0.00 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.17 m	1.08 m/s	3,053.6 L/s	0.3	1,030.0 L/s	0.30 m	1.0	0.36 m/s	0.36 m/s	684.91 sec
	2.00 m	0.00 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.17 m	1.09 m/s	3,422.1 L/s	0.3	1,030.0 L/s	0.20 m	1.0	0.33 m/s	0.33 m/s	389.57 sec

California Balanced Design - 1 in 100 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Installed	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	1.47 m	2.40 m/s	1,208.4 L/s	1.4	1,670.0 L/s	1.40 m	2.0	1.66 m/s	1.66 m/s	-25.58 sec
	0.90 m	1.20 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	1.37 m	2.43 m/s	1,547.7 L/s	1.1	1,670.0 L/s	1.30 m	1.0	2.63 m/s	2.63 m/s	-14.45 sec
	1.00 m	1.10 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	1.27 m	2.44 m/s	1,914.1 L/s	0.9	1,670.0 L/s	1.20 m	1.0	2.13 m/s	2.13 m/s	-18.64 sec
	1.10 m	1.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	1.17 m	2.42 m/s	2,299.3 L/s	0.7	1,670.0 L/s	1.10 m	1.0	1.76 m/s	1.76 m/s	-23.75 sec
	1.20 m	0.90 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	1.07 m	2.38 m/s	2,694.0 L/s	0.6	1,670.0 L/s	1.00 m	1.0	1.48 m/s	1.48 m/s	-30.00 sec
	1.30 m	0.80 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.97 m	2.33 m/s	3,087.3 L/s	0.5	1,670.0 L/s	0.90 m	1.0	1.26 m/s	1.26 m/s	-37.73 sec
	1.40 m	0.70 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.87 m	2.25 m/s	3,466.7 L/s	0.5	1,670.0 L/s	0.80 m	1.0	1.08 m/s	1.08 m/s	-47.42 sec
	1.50 m	0.60 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.77 m	2.16 m/s	3,817.7 L/s	0.4	1,670.0 L/s	0.70 m	1.0	0.95 m/s	0.95 m/s	-59.81 sec
	1.60 m	0.50 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.67 m	2.05 m/s	4,122.6 L/s	0.4	1,670.0 L/s	0.60 m	1.0	0.83 m/s	0.83 m/s	-76.08 sec
	1.70 m	0.40 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.57 m	1.92 m/s	4,359.6 L/s	0.4	1,670.0 L/s	0.50 m	1.0	0.74 m/s	0.74 m/s	-98.24 sec
	1.80 m	0.30 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.47 m	1.77 m/s	4,500.3 L/s	0.4	1,670.0 L/s	0.40 m	1.0	0.66 m/s	0.66 m/s	-129.94 sec
	1.90 m	0.20 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.37 m	1.59 m/s	4,504.9 L/s	0.4	1,670.0 L/s	0.30 m	1.0	0.59 m/s	0.59 m/s	-178.77 sec
	2.00 m	0.10 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.27 m	1.37 m/s	4,312.7 L/s	0.4	1,670.0 L/s	0.20 m	1.0	0.53 m/s	0.53 m/s	-263.21 sec

Fisheries - 3 Day Delay 1:10 Years	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Installed	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	1.47 m	2.40 m/s	1,208.4 L/s	0.1	160.0 L/s	1.40 m	2.0	0.16 m/s	0.16 m/s	127.57 sec
	0.90 m	1.20 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	1.37 m	2.43 m/s	1,547.7 L/s	0.1	160.0 L/s	1.30 m	1.0	0.25 m/s	0.25 m/s	201.90 sec
	1.00 m	1.10 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	1.27 m	2.44 m/s	1,914.1 L/s	0.1	160.0 L/s	1.20 m	1.0	0.20 m/s	0.20 m/s	155.13 sec
	1.10 m	1.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	1.17 m	2.42 m/s	2,299.3 L/s	0.1	160.0 L/s	1.10 m	1.0	0.17 m/s	0.17 m/s	132.43 sec
	1.20 m	0.90 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	1.07 m	2.38 m/s	2,694.0 L/s	0.1	160.0 L/s	1.00 m	1.0	0.14 m/s	0.14 m/s	119.17 sec
	1.30 m	0.80 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.97 m	2.33 m/s	3,087.3 L/s	0.1	160.0 L/s	0.90 m	1.0	0.12 m/s	0.12 m/s	110.55 sec
	1.40 m	0.70 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.87 m	2.25 m/s	3,466.7 L/s	0.0	160.0 L/s	0.80 m	1.0	0.10 m/s	0.10 m/s	104.55 sec
	1.50 m	0.60 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.77 m	2.16 m/s	3,817.7 L/s	0.0	160.0 L/s	0.70 m	1.0	0.09 m/s	0.09 m/s	100.17 sec
	1.60 m	0.50 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.67 m	2.05 m/s	4,122.6 L/s	0.0	160.0 L/s	0.60 m	1.0	0.08 m/s	0.08 m/s	96.85 sec
	1.70 m	0.40 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.57 m	1.92 m/s	4,359.6 L/s	0.0	160.0 L/s	0.50 m	1.0	0.07 m/s	0.07 m/s	94.25 sec
	1.80 m	0.30 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.47 m	1.77 m/s	4,500.3 L/s	0.0	160.0 L/s	0.40 m	1.0	0.06 m/s	0.06 m/s	92.19 sec
	1.90 m	0.20 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.37 m	1.59 m/s	4,504.9 L/s	0.0	160.0 L/s	0.30 m	1.0	0.06 m/s	0.06 m/s	90.51 sec
	2.00 m	0.10 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.27 m	1.37 m/s	4,312.7 L/s	0.0	160.0 L/s	0.20 m	1.0	0.05 m/s	0.05 m/s	89.12 sec

Projecting from Fill - ke =	0.9	0.024	Mannings N for Normal CSP
Bevelled End - ke =	0.7	0.013	Mannings N for Ultraflow Pipe

0.30 m	Minimum Head above Pipe to shoulder
2.20 m	Current Depth of Fill at Shoulder
160.0 L/s	10 Year Fisheries Flow Condition
1,030.0 L/s	10 Year Flood
1,670.0 L/s	100 Year Flood
32.00 m	Length of Culvert
0.17 m	Elevation Drop over Length of Culvert

0.41 m/s	Burbot Cruising Swimming Speed
0.41 m/s	Burbot Maximum Sustained Swimming Speed
0.41 m/s	Burbot Maximum Dart Speed

Entrance Losses	Head H = (1+ke+(2*g*n^2*L)/R^1.333)*(V^2/2*g)
He=ke*V^2/19.62	Velocity V = ((H*2*g)/(1+ke+(2*g*n^2*L)/R^1.333))^0.5

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	410.9 L/s	2,076.6 L/s	3,422.1 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s	4,312.7 L/s

Culvert Capacity - Tuktoyaktuk Access to km 177 Pit

km 12050 Culvert Installation - Crossing 4

California Balanced Design - 1 in 10 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Minimum Transit Time (t)	Diameter (m)
	0.80 m	0.00 m	0.65%	23.0 m	0.15 m	0.20 m	0.90	0.15 m	0.85 m/s	424.8 L/s	3.9	1,670.0 L/s	1.40 m	4.0	0.83 m/s	0.83 m/s	-54.69 sec	**0.80 m**
	0.90 m	0.00 m	0.65%	23.0 m	0.15 m	0.23 m	0.90	0.15 m	0.88 m/s	560.0 L/s	3.0	1,670.0 L/s	1.30 m	3.0	0.88 m/s	0.88 m/s	-49.46 sec	**0.90 m**
	1.00 m	0.00 m	0.65%	23.0 m	0.15 m	0.25 m	0.90	0.15 m	0.91 m/s	715.1 L/s	2.3	1,670.0 L/s	1.20 m	3.0	0.71 m/s	0.71 m/s	-76.98 sec	**1.00 m**
	1.10 m	0.00 m	0.65%	23.0 m	0.15 m	0.28 m	0.90	0.15 m	0.94 m/s	890.4 L/s	1.9	1,670.0 L/s	1.10 m	2.0	0.88 m/s	0.88 m/s	-49.08 sec	**1.10 m**
	1.20 m	0.00 m	0.65%	23.0 m	0.15 m	0.30 m	0.90	0.15 m	0.96 m/s	1,085.7 L/s	1.5	1,670.0 L/s	1.00 m	2.0	0.74 m/s	0.74 m/s	-70.06 sec	**1.20 m**
	1.30 m	0.00 m	0.65%	23.0 m	0.15 m	0.33 m	0.90	0.15 m	0.98 m/s	1,301.1 L/s	1.3	1,670.0 L/s	0.90 m	2.0	0.63 m/s	0.63 m/s	-104.98 sec	**1.30 m**
	1.40 m	0.00 m	0.65%	23.0 m	0.15 m	0.35 m	0.90	0.15 m	1.00 m/s	1,536.7 L/s	1.1	1,670.0 L/s	0.80 m	1.0	1.08 m/s	1.08 m/s	-34.08 sec	**1.40 m**
	1.50 m	0.00 m	0.65%	23.0 m	0.15 m	0.38 m	0.90	0.15 m	1.01 m/s	1,792.3 L/s	0.9	1,670.0 L/s	0.70 m	1.0	0.95 m/s	0.95 m/s	-42.99 sec	**1.50 m**
	1.60 m	0.00 m	0.65%	23.0 m	0.15 m	0.40 m	0.90	0.15 m	1.03 m/s	2,068.1 L/s	0.8	1,670.0 L/s	0.60 m	1.0	0.83 m/s	0.83 m/s	-54.69 sec	**1.60 m**
	1.70 m	0.00 m	0.65%	23.0 m	0.15 m	0.43 m	0.90	0.15 m	1.04 m/s	2,364.0 L/s	0.7	1,670.0 L/s	0.50 m	1.0	0.74 m/s	0.74 m/s	-70.61 sec	**1.70 m**
	1.80 m	0.00 m	0.65%	23.0 m	0.15 m	0.45 m	0.90	0.15 m	1.05 m/s	2,679.9 L/s	0.6	1,670.0 L/s	0.40 m	1.0	0.66 m/s	0.66 m/s	-93.39 sec	**1.80 m**
	1.90 m	0.00 m	0.65%	23.0 m	0.15 m	0.48 m	0.90	0.15 m	1.06 m/s	3,015.8 L/s	0.6	1,670.0 L/s	0.30 m	1.0	0.59 m/s	0.59 m/s	-128.49 sec	**1.90 m**
	2.00 m	0.00 m	0.65%	23.0 m	0.15 m	0.50 m	0.90	0.15 m	1.07 m/s	3,371.8 L/s	0.5	1,670.0 L/s	0.20 m	1.0	0.53 m/s	0.53 m/s	-189.18 sec	**2.00 m**

California Balanced Design - 1 in 100 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)	Diameter (m)
	0.80 m	1.30 m	0.65%	23.0 m	0.15 m	0.20 m	0.90	1.45 m	2.63 m/s	1,320.7 L/s	2.1	2,710.0 L/s	1.40 m	2.0	2.70 m/s	2.70 m/s	-10.06 sec	**0.80 m**
	0.90 m	1.20 m	0.65%	23.0 m	0.15 m	0.23 m	0.90	1.35 m	2.64 m/s	1,679.9 L/s	1.6	2,710.0 L/s	1.30 m	2.0	2.13 m/s	2.13 m/s	-13.37 sec	**0.90 m**
	1.00 m	1.10 m	0.65%	23.0 m	0.15 m	0.25 m	0.90	1.25 m	2.63 m/s	2,064.4 L/s	1.3	2,710.0 L/s	1.20 m	2.0	1.73 m/s	1.73 m/s	-17.49 sec	**1.00 m**
	1.10 m	1.00 m	0.65%	23.0 m	0.15 m	0.28 m	0.90	1.15 m	2.59 m/s	2,465.3 L/s	1.1	2,710.0 L/s	1.10 m	1.0	2.85 m/s	2.85 m/s	-9.42 sec	**1.10 m**
	1.20 m	0.90 m	0.65%	23.0 m	0.15 m	0.30 m	0.90	1.05 m	2.54 m/s	2,872.4 L/s	0.9	2,710.0 L/s	1.00 m	1.0	2.40 m/s	2.40 m/s	-11.58 sec	**1.20 m**
	1.30 m	0.80 m	0.65%	23.0 m	0.15 m	0.33 m	0.90	0.95 m	2.47 m/s	3,274.4 L/s	0.8	2,710.0 L/s	0.90 m	1.0	2.04 m/s	2.04 m/s	-14.10 sec	**1.30 m**
	1.40 m	0.70 m	0.65%	23.0 m	0.15 m	0.35 m	0.90	0.85 m	2.38 m/s	3,658.0 L/s	0.7	2,710.0 L/s	0.80 m	1.0	1.76 m/s	1.76 m/s	-17.03 sec	**1.40 m**
	1.50 m	0.60 m	0.65%	23.0 m	0.15 m	0.38 m	0.90	0.75 m	2.27 m/s	4,007.8 L/s	0.7	2,710.0 L/s	0.70 m	1.0	1.53 m/s	1.53 m/s	-20.47 sec	**1.50 m**
	1.60 m	0.50 m	0.65%	23.0 m	0.15 m	0.40 m	0.90	0.65 m	2.14 m/s	4,305.1 L/s	0.6	2,710.0 L/s	0.60 m	1.0	1.35 m/s	1.35 m/s	-24.52 sec	**1.60 m**
	1.70 m	0.40 m	0.65%	23.0 m	0.15 m	0.43 m	0.90	0.55 m	1.99 m/s	4,526.6 L/s	0.6	2,710.0 L/s	0.50 m	1.0	1.19 m/s	1.19 m/s	-29.34 sec	**1.70 m**
	1.80 m	0.30 m	0.65%	23.0 m	0.15 m	0.45 m	0.90	0.45 m	1.82 m/s	4,641.7 L/s	0.6	2,710.0 L/s	0.40 m	1.0	1.06 m/s	1.06 m/s	-35.12 sec	**1.80 m**
	1.90 m	0.20 m	0.65%	23.0 m	0.15 m	0.48 m	0.90	0.35 m	1.62 m/s	4,606.8 L/s	0.6	2,710.0 L/s	0.30 m	1.0	0.96 m/s	0.96 m/s	-42.14 sec	**1.90 m**
	2.00 m	0.10 m	0.65%	23.0 m	0.15 m	0.50 m	0.90	0.25 m	1.39 m/s	4,353.0 L/s	0.6	2,710.0 L/s	0.20 m	1.0	0.86 m/s	0.86 m/s	-50.82 sec	**2.00 m**

Fisheries - 3 Day Delay 1:10 Years	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)	Diameter (m)
	0.80 m	1.30 m	0.65%	23.0 m	0.15 m	0.20 m	0.90	1.45 m	2.63 m/s	1,320.7 L/s	0.2	230.0 L/s	1.40 m	1.0	0.46 m/s	0.46 m/s	-483.49 sec	**0.80 m**
	0.90 m	1.20 m	0.65%	23.0 m	0.15 m	0.23 m	0.90	1.35 m	2.64 m/s	1,679.9 L/s	0.1	230.0 L/s	1.30 m	1.0	0.36 m/s	0.36 m/s	474.59 sec	**0.90 m**
	1.00 m	1.10 m	0.65%	23.0 m	0.15 m	0.25 m	0.90	1.25 m	2.63 m/s	2,064.4 L/s	0.1	230.0 L/s	1.20 m	1.0	0.29 m/s	0.29 m/s	196.32 sec	**1.00 m**
	1.10 m	1.00 m	0.65%	23.0 m	0.15 m	0.28 m	0.90	1.15 m	2.59 m/s	2,465.3 L/s	0.1	230.0 L/s	1.10 m	1.0	0.24 m/s	0.24 m/s	136.92 sec	**1.10 m**
	1.20 m	0.90 m	0.65%	23.0 m	0.15 m	0.30 m	0.90	1.05 m	2.54 m/s	2,872.4 L/s	0.1	230.0 L/s	1.00 m	1.0	0.20 m/s	0.20 m/s	111.31 sec	**1.20 m**
	1.30 m	0.80 m	0.65%	23.0 m	0.15 m	0.33 m	0.90	0.95 m	2.47 m/s	3,274.4 L/s	0.1	230.0 L/s	0.90 m	1.0	0.17 m/s	0.17 m/s	97.16 sec	**1.30 m**
	1.40 m	0.70 m	0.65%	23.0 m	0.15 m	0.35 m	0.90	0.85 m	2.38 m/s	3,658.0 L/s	0.1	230.0 L/s	0.80 m	1.0	0.15 m/s	0.15 m/s	88.26 sec	**1.40 m**
	1.50 m	0.60 m	0.65%	23.0 m	0.15 m	0.38 m	0.90	0.75 m	2.27 m/s	4,007.8 L/s	0.1	230.0 L/s	0.70 m	1.0	0.13 m/s	0.13 m/s	82.19 sec	**1.50 m**
	1.60 m	0.50 m	0.65%	23.0 m	0.15 m	0.40 m	0.90	0.65 m	2.14 m/s	4,305.1 L/s	0.1	230.0 L/s	0.60 m	1.0	0.11 m/s	0.11 m/s	77.81 sec	**1.60 m**
	1.70 m	0.40 m	0.65%	23.0 m	0.15 m	0.43 m	0.90	0.55 m	1.99 m/s	4,526.6 L/s	0.1	230.0 L/s	0.50 m	1.0	0.10 m/s	0.10 m/s	74.51 sec	**1.70 m**
	1.80 m	0.30 m	0.65%	23.0 m	0.15 m	0.45 m	0.90	0.45 m	1.82 m/s	4,641.7 L/s	0.0	230.0 L/s	0.40 m	1.0	0.09 m/s	0.09 m/s	71.96 sec	**1.80 m**
	1.90 m	0.20 m	0.65%	23.0 m	0.15 m	0.48 m	0.90	0.35 m	1.62 m/s	4,606.8 L/s	0.0	230.0 L/s	0.30 m	1.0	0.08 m/s	0.08 m/s	69.93 sec	**1.90 m**
	2.00 m	0.10 m	0.65%	23.0 m	0.15 m	0.50 m	0.90	0.25 m	1.39 m/s	4,353.0 L/s	0.1	230.0 L/s	0.20 m	1.0	0.07 m/s	0.07 m/s	68.29 sec	**2.00 m**

Projecting from Fill - ke = 0.9
Bevelled End - ke = 0.7

0.024 Mannings N for Normal CSP
0.013 Mannings N for Ultraflow Pipe

0.30 m Minimum Head above Pipe to shoulder
2.20 m Current Depth of Fill at Shoulder
230.0 L/s 10 Year Fisheries Flow Condition
1,670.0 L/s 10 Year Flood
2,710.0 L/s 100 Year Flood
23.00 m Length of Culvert
0.15 m Elevation Drop over Length of Culvert

4.00 fps 0.41 m/s Burbot Cruising Swimming Speed
10.00 fps 0.41 m/s Burbot Maximum Sustained Swimming Speed
21.00 fps 0.41 m/s Burbot Maximum Dart Speed

Entrance Losses
He=ke*V^2/19.62

Head H = (1+ke+(2*g*n^2*L)/R^1.333)*(V^2/2*g)
Velocity V = ((H*2*g)/(1+ke+(2*g*n^2*L)/R^1.333))^0.5

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	424.8 L/s	2,068.1 L/s	3,371.8 L/s
1:100 Year	1,320.7 L/s	4,305.1 L/s	4,353.0 L/s

Culvert Capacity - Tuktoyaktuk Access to km 177 Pit

km 2285 Culvert Installation - Crossing 7B

California Balanced Design - 1 in 10 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Minimum Transit Time (t)
	0.80 m	0.00 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	0.17 m	0.82 m/s	410.9 L/s	2.0	810.0 L/s	1.40 m	2.0	0.81 m/s	0.81 m/s	-80.86 sec
	0.90 m	0.00 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	0.17 m	0.86 m/s	545.2 L/s	1.5	810.0 L/s	1.30 m	2.0	0.64 m/s	0.64 m/s	-141.21 sec
	1.00 m	0.00 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	0.17 m	0.89 m/s	700.3 L/s	1.2	810.0 L/s	1.20 m	2.0	0.52 m/s	0.52 m/s	-302.85 sec
	1.10 m	0.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	0.17 m	0.92 m/s	876.5 L/s	0.9	810.0 L/s	1.10 m	1.0	0.85 m/s	0.85 m/s	-72.34 sec
	1.20 m	0.00 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	0.17 m	0.95 m/s	1,073.8 L/s	0.8	810.0 L/s	1.00 m	1.0	0.72 m/s	0.72 m/s	-104.51 sec
	1.30 m	0.00 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.17 m	0.97 m/s	1,292.4 L/s	0.6	810.0 L/s	0.90 m	1.0	0.61 m/s	0.61 m/s	-159.80 sec
	1.40 m	0.00 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.17 m	1.00 m/s	1,532.4 L/s	0.5	810.0 L/s	0.80 m	1.0	0.53 m/s	0.53 m/s	-275.42 sec
	1.50 m	0.00 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.17 m	1.02 m/s	1,793.8 L/s	0.5	810.0 L/s	0.70 m	1.0	0.46 m/s	0.46 m/s	-661.62 sec
	1.60 m	0.00 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.17 m	1.03 m/s	2,076.6 L/s	0.4	810.0 L/s	0.60 m	1.0	0.40 m/s	0.40 m/s	4482.39 sec
	1.70 m	0.00 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.17 m	1.05 m/s	2,380.9 L/s	0.3	810.0 L/s	0.50 m	1.0	0.36 m/s	0.36 m/s	602.18 sec
	1.80 m	0.00 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.17 m	1.06 m/s	2,706.5 L/s	0.3	810.0 L/s	0.40 m	1.0	0.32 m/s	0.32 m/s	349.00 sec
	1.90 m	0.00 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.17 m	1.08 m/s	3,053.6 L/s	0.3	810.0 L/s	0.30 m	1.0	0.29 m/s	0.29 m/s	257.41 sec
	2.00 m	0.00 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.17 m	1.09 m/s	3,422.1 L/s	0.2	810.0 L/s	0.20 m	1.0	0.26 m/s	0.26 m/s	210.29 sec

California Balanced Design - 1 in 100 Year Flood	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	1.47 m	2.40 m/s	1,208.4 L/s	1.1	1,310.0 L/s	1.40 m	1.0	2.61 m/s	2.61 m/s	-14.57 sec
	0.90 m	1.20 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	1.37 m	2.43 m/s	1,547.7 L/s	0.8	1,310.0 L/s	1.30 m	1.0	2.06 m/s	2.06 m/s	-19.40 sec
	1.00 m	1.10 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	1.27 m	2.44 m/s	1,914.1 L/s	0.7	1,310.0 L/s	1.20 m	1.0	1.67 m/s	1.67 m/s	-25.44 sec
	1.10 m	1.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	1.17 m	2.42 m/s	2,299.3 L/s	0.6	1,310.0 L/s	1.10 m	1.0	1.38 m/s	1.38 m/s	-33.04 sec
	1.20 m	0.90 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	1.07 m	2.38 m/s	2,694.0 L/s	0.5	1,310.0 L/s	1.00 m	1.0	1.16 m/s	1.16 m/s	-42.76 sec
	1.30 m	0.80 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.97 m	2.33 m/s	3,087.3 L/s	0.4	1,310.0 L/s	0.90 m	1.0	0.99 m/s	0.99 m/s	-55.46 sec
	1.40 m	0.70 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.87 m	2.25 m/s	3,466.7 L/s	0.4	1,310.0 L/s	0.80 m	1.0	0.85 m/s	0.85 m/s	-72.56 sec
	1.50 m	0.60 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.77 m	2.16 m/s	3,817.7 L/s	0.3	1,310.0 L/s	0.70 m	1.0	0.74 m/s	0.74 m/s	-96.59 sec
	1.60 m	0.50 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.67 m	2.05 m/s	4,122.6 L/s	0.3	1,310.0 L/s	0.60 m	1.0	0.65 m/s	0.65 m/s	-132.48 sec
	1.70 m	0.40 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.57 m	1.92 m/s	4,359.6 L/s	0.3	1,310.0 L/s	0.50 m	1.0	0.58 m/s	0.58 m/s	-191.45 sec
	1.80 m	0.30 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.47 m	1.77 m/s	4,500.3 L/s	0.3	1,310.0 L/s	0.40 m	1.0	0.51 m/s	0.51 m/s	-305.35 sec
	1.90 m	0.20 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.37 m	1.59 m/s	4,504.9 L/s	0.3	1,310.0 L/s	0.30 m	1.0	0.46 m/s	0.46 m/s	-614.98 sec
	2.00 m	0.10 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.27 m	1.37 m/s	4,312.7 L/s	0.3	1,310.0 L/s	0.20 m	1.0	0.42 m/s	0.42 m/s	-4580.62 sec

Fisheries - 3 Day Delay 1:10 Years	Diameter (m)	HW Surcharge	Slope	Length (m)	Pipe Drop	Hyd. Radius	Entrance Loss Coeff	H	Velocity (m/s)	Single Culvert Capacity (L/s)	Number of Culverts Required	Calculated Q (L/s)	Fill over Pipe at Shoulder	Actual of Culverts Required	Actual Velocity (m/s)	Fish Swimming Issues	Transit Time (t)
	0.80 m	1.30 m	0.53%	32.0 m	0.17 m	0.20 m	0.90	1.47 m	2.40 m/s	1,208.4 L/s	0.1	110.0 L/s	1.40 m	1.0	0.22 m/s	0.22 m/s	167.40 sec
	0.90 m	1.20 m	0.53%	32.0 m	0.17 m	0.23 m	0.90	1.37 m	2.43 m/s	1,547.7 L/s	0.1	110.0 L/s	1.30 m	1.0	0.17 m/s	0.17 m/s	134.97 sec
	1.00 m	1.10 m	0.53%	32.0 m	0.17 m	0.25 m	0.90	1.27 m	2.44 m/s	1,914.1 L/s	0.1	110.0 L/s	1.20 m	1.0	0.14 m/s	0.14 m/s	118.54 sec
	1.10 m	1.00 m	0.53%	32.0 m	0.17 m	0.28 m	0.90	1.17 m	2.42 m/s	2,299.3 L/s	0.0	110.0 L/s	1.10 m	1.0	0.12 m/s	0.12 m/s	108.75 sec
	1.20 m	0.90 m	0.53%	32.0 m	0.17 m	0.30 m	0.90	1.07 m	2.38 m/s	2,694.0 L/s	0.0	110.0 L/s	1.00 m	1.0	0.10 m/s	0.10 m/s	102.32 sec
	1.30 m	0.80 m	0.53%	32.0 m	0.17 m	0.33 m	0.90	0.97 m	2.33 m/s	3,087.3 L/s	0.0	110.0 L/s	0.90 m	1.0	0.08 m/s	0.08 m/s	97.82 sec
	1.40 m	0.70 m	0.53%	32.0 m	0.17 m	0.35 m	0.90	0.87 m	2.25 m/s	3,466.7 L/s	0.0	110.0 L/s	0.80 m	1.0	0.07 m/s	0.07 m/s	94.52 sec
	1.50 m	0.60 m	0.53%	32.0 m	0.17 m	0.38 m	0.90	0.77 m	2.16 m/s	3,817.7 L/s	0.0	110.0 L/s	0.70 m	1.0	0.06 m/s	0.06 m/s	92.02 sec
	1.60 m	0.50 m	0.53%	32.0 m	0.17 m	0.40 m	0.90	0.67 m	2.05 m/s	4,122.6 L/s	0.0	110.0 L/s	0.60 m	1.0	0.05 m/s	0.05 m/s	90.07 sec
	1.70 m	0.40 m	0.53%	32.0 m	0.17 m	0.43 m	0.90	0.57 m	1.92 m/s	4,359.6 L/s	0.0	110.0 L/s	0.50 m	1.0	0.05 m/s	0.05 m/s	88.51 sec
	1.80 m	0.30 m	0.53%	32.0 m	0.17 m	0.45 m	0.90	0.47 m	1.77 m/s	4,500.3 L/s	0.0	110.0 L/s	0.40 m	1.0	0.04 m/s	0.04 m/s	87.25 sec
	1.90 m	0.20 m	0.53%	32.0 m	0.17 m	0.48 m	0.90	0.37 m	1.59 m/s	4,504.9 L/s	0.0	110.0 L/s	0.30 m	1.0	0.04 m/s	0.04 m/s	86.21 sec
	2.00 m	0.10 m	0.53%	32.0 m	0.17 m	0.50 m	0.90	0.27 m	1.37 m/s	4,312.7 L/s	0.0	110.0 L/s	0.20 m	1.0	0.04 m/s	0.04 m/s	85.34 sec

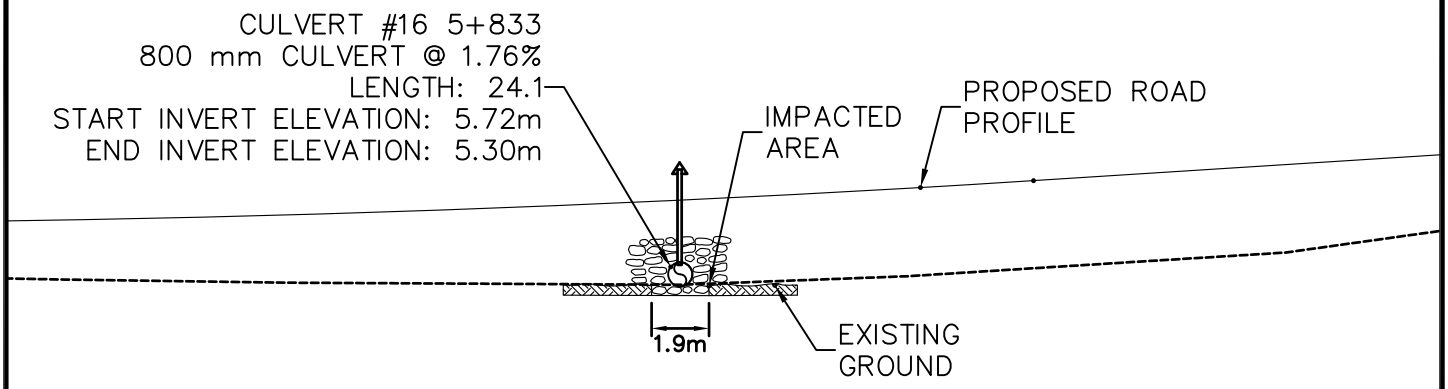
Projecting from Fill - ke =	0.9		
Bevelled End - ke =	0.7		
	0.024	Mannings N for Normal CSP	
	0.013	Mannings N for Ultraflow Pipe	
	0.30 m	Minimum Head above Pipe to shoulder	
	2.20 m	Current Depth of Fill at Shoulder	
	110.0 L/s	10 Year Fisheries Flow Condition	
	810.0 L/s	10 Year Flood	
	1,310.0 L/s	100 Year Flood	
	32.00 m	Length of Culvert	
	0.17 m	Elevation Drop over Length of Culvert	
4.00 fps	0.41 m/s	Burbot Cruising Swimming Speed	
10.00 fps	0.41 m/s	Burbot Maximum Sustained Swimming Speed	
21.00 fps	0.41 m/s	Burbot Maximum Dart Speed	

Entrance Losses
He=ke*V^2/19.62

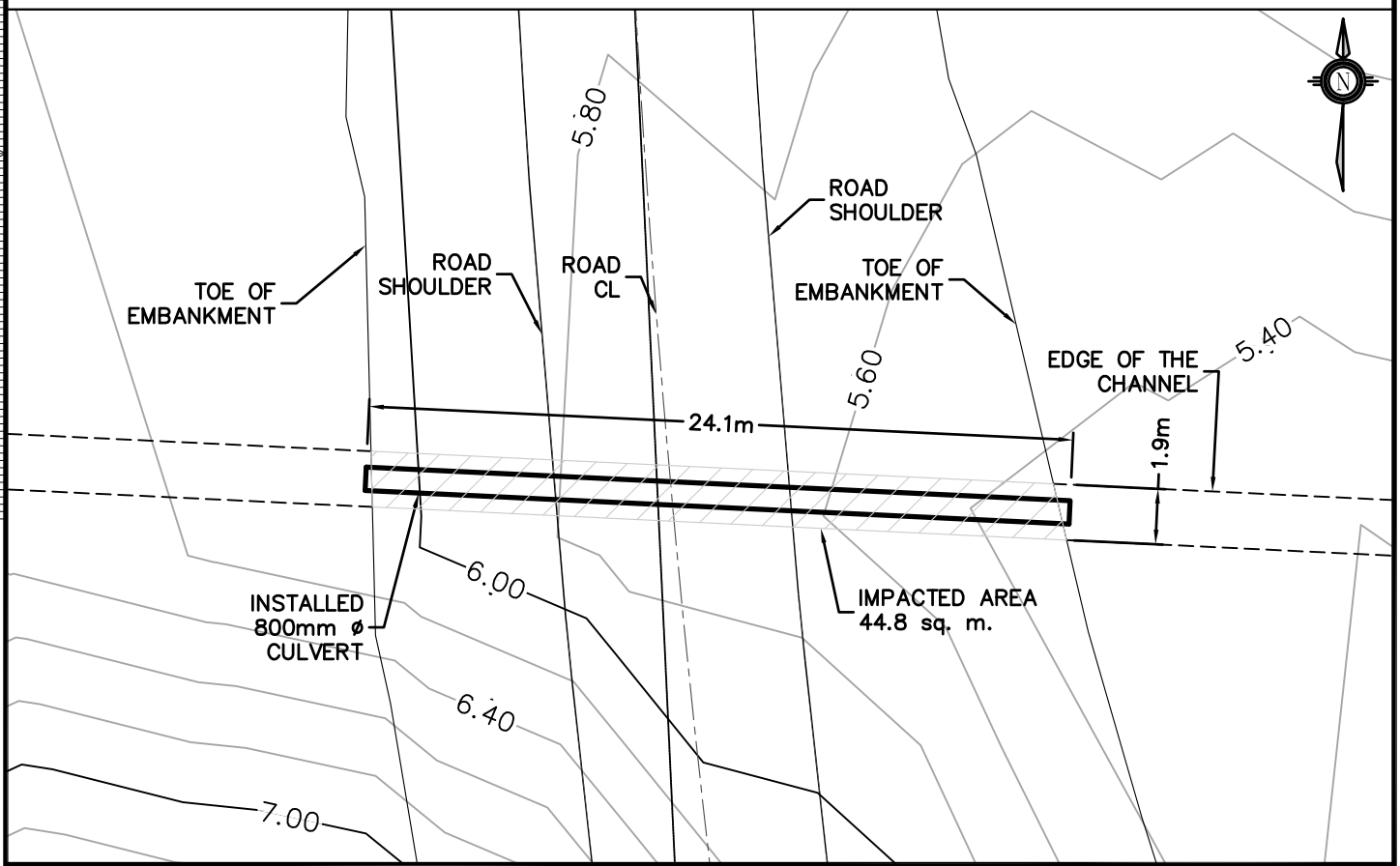
Head H = (1+ke+(2*g*n^2*L)/R^1.333)*(V^2/2*g)
Velocity V = ((H*2*g)/(1+ke+(2*g*n^2*L)/R^1.333))^0.5

Outlet Control	800 mm	1600 mm	2000 mm
1:10 Year	410.9 L/s	2,076.6 L/s	3,422.1 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s	4,312.7 L/s

9 Appendix C – Culvert Views and Coverage



NOTE: THIS LOCATION DOES NOT HAVE A CLEARLY DEFINED OWHL OR NORMAL FLOW CHANNEL. IMPACTED AREA IS BASED UPON GOLDER FIELD REPORT OBSERVATIONS OF FLOW WIDTH 30 JUNE 2009.



PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 7B STATION 5+833	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-01	OF 06

FSC – ANSI–A – 8.5x11

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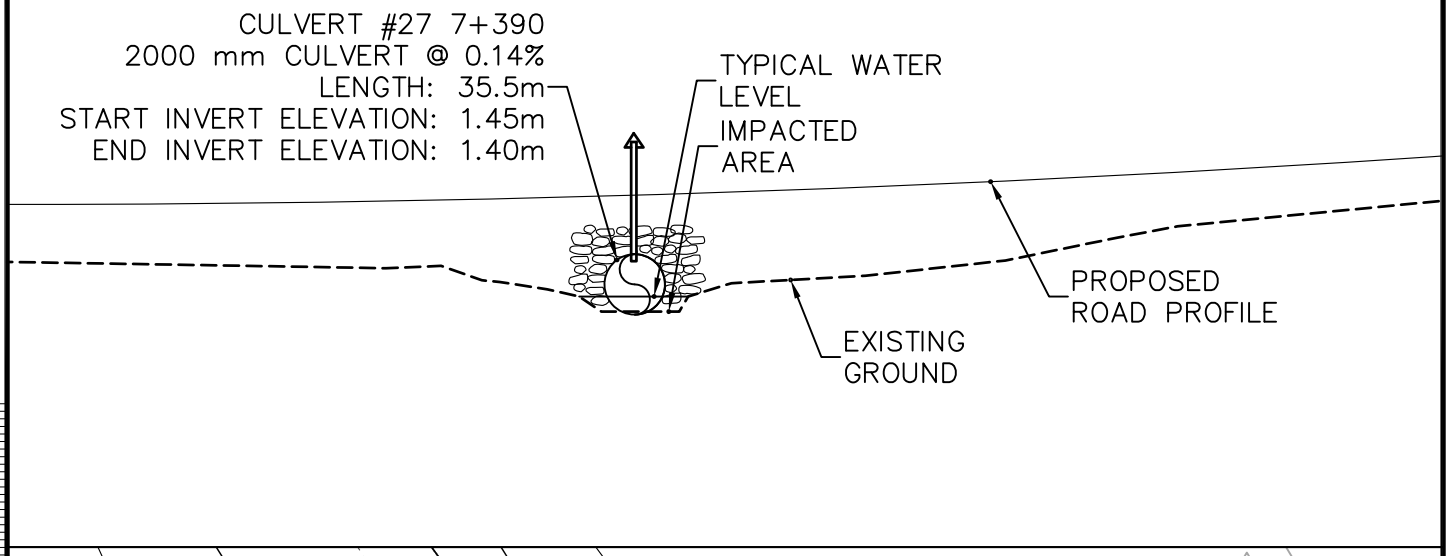

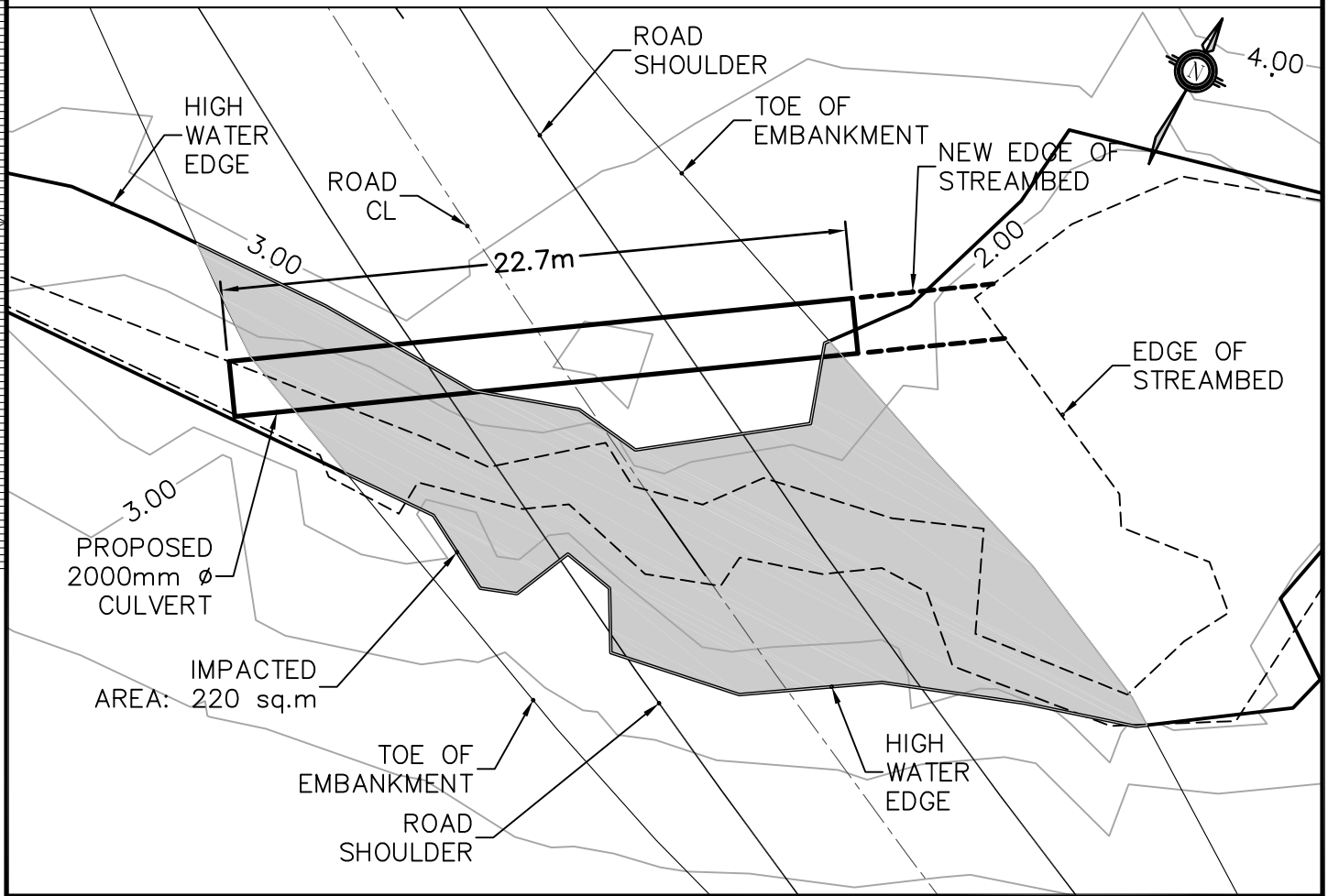

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 6 STA 7+390	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-02	OF 06

FSC – ANSI–A – 8.5x11

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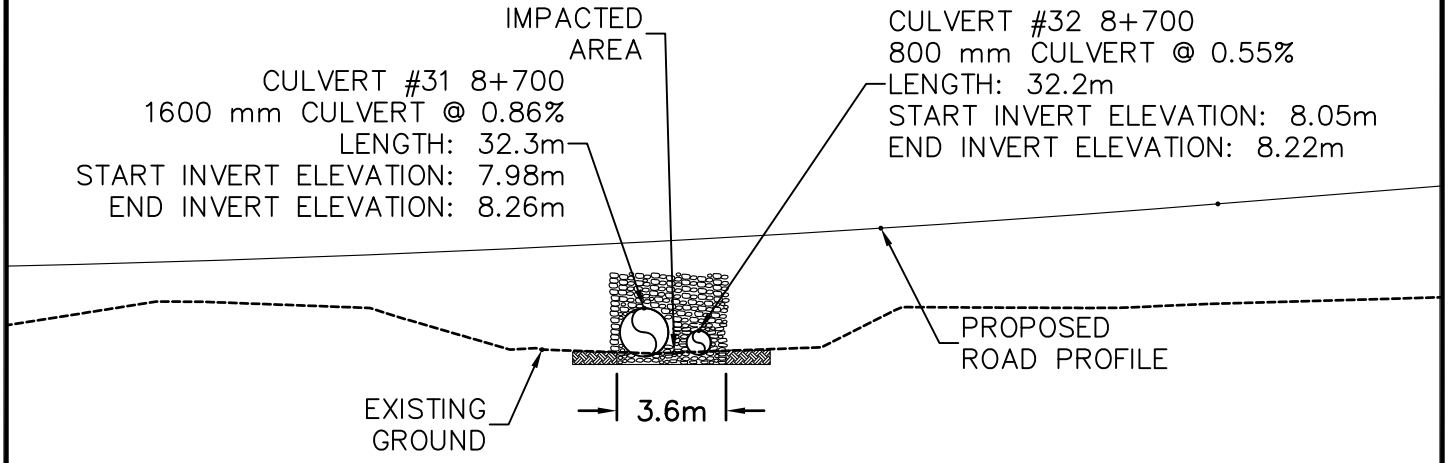

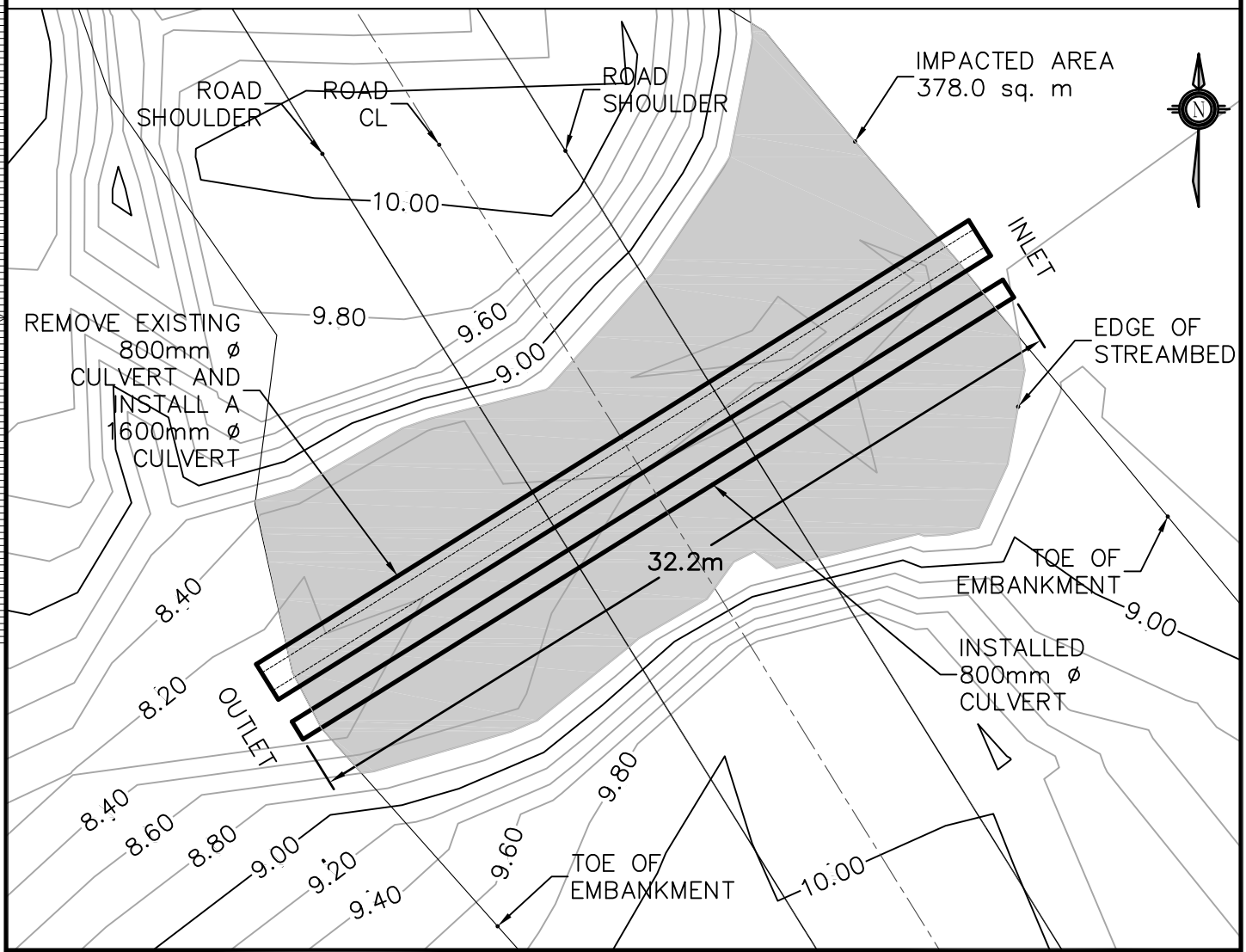

0 10 20 30 40 50 60 70 80 90 100mm

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
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		DRAWING NO.: CSK01-03	OF 06

FSC – ANSI–A – 8.5x11

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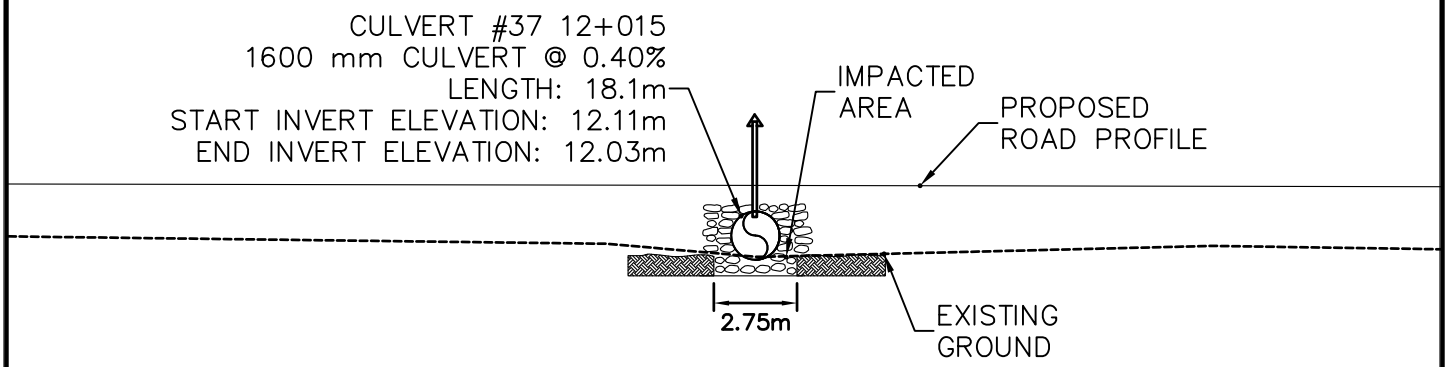
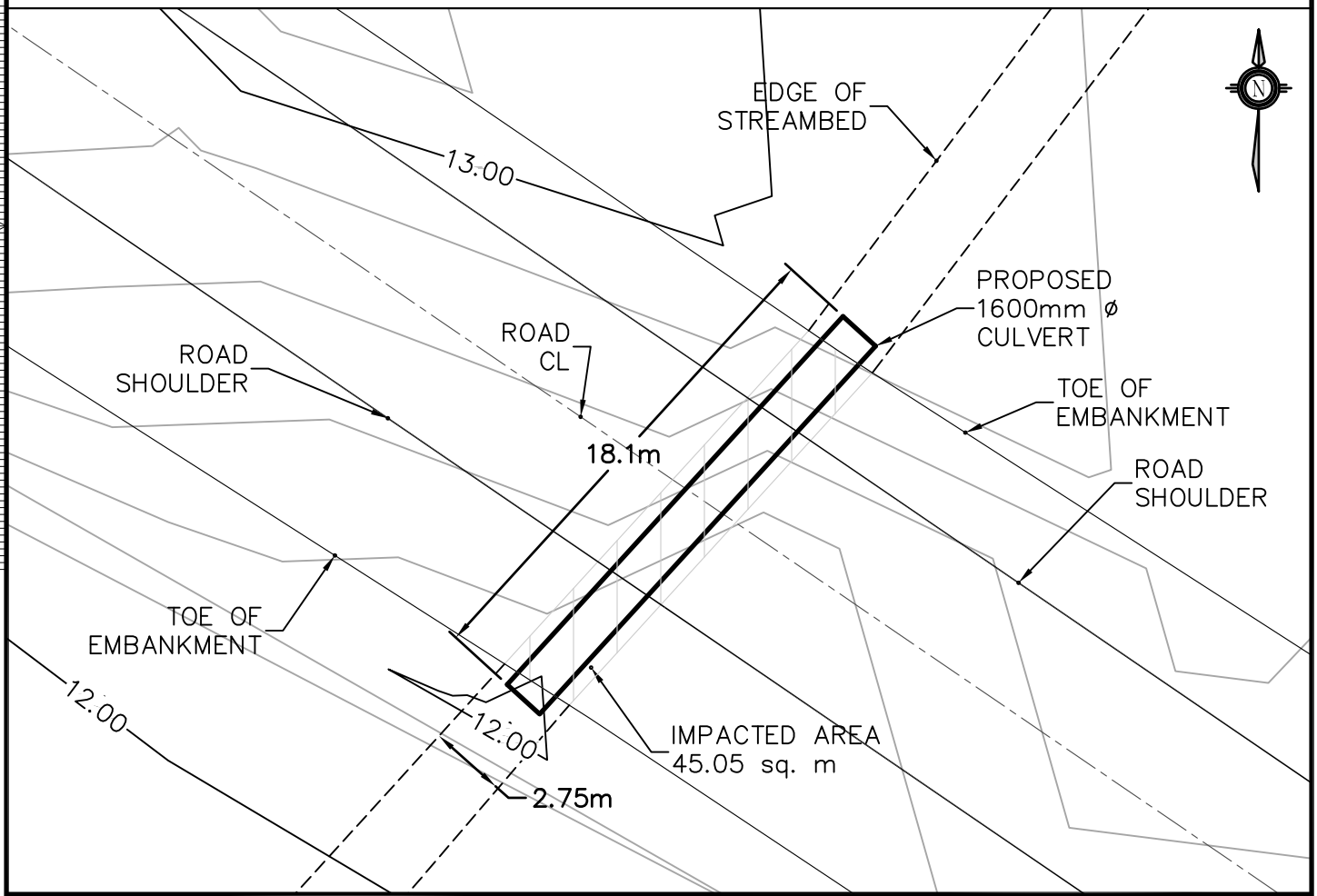


NOTE: THIS LOCATION DOES NOT HAVE A CLEARLY DEFINED OWHL OR NORMAL FLOW CHANNEL. IMPACTED AREA IS BASED UPON GOLDER FIELD REPORT OBSERVATIONS OF FLOW WIDTH 30 JUNE 2009.



PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NWT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CROSSING 4 STATION 12+015	SCALE: 1:250	DATE: 2010/03/12
		DRAWING NO.: CSK01-04	OF 06

FSC – ANSI–A – 8.5x11

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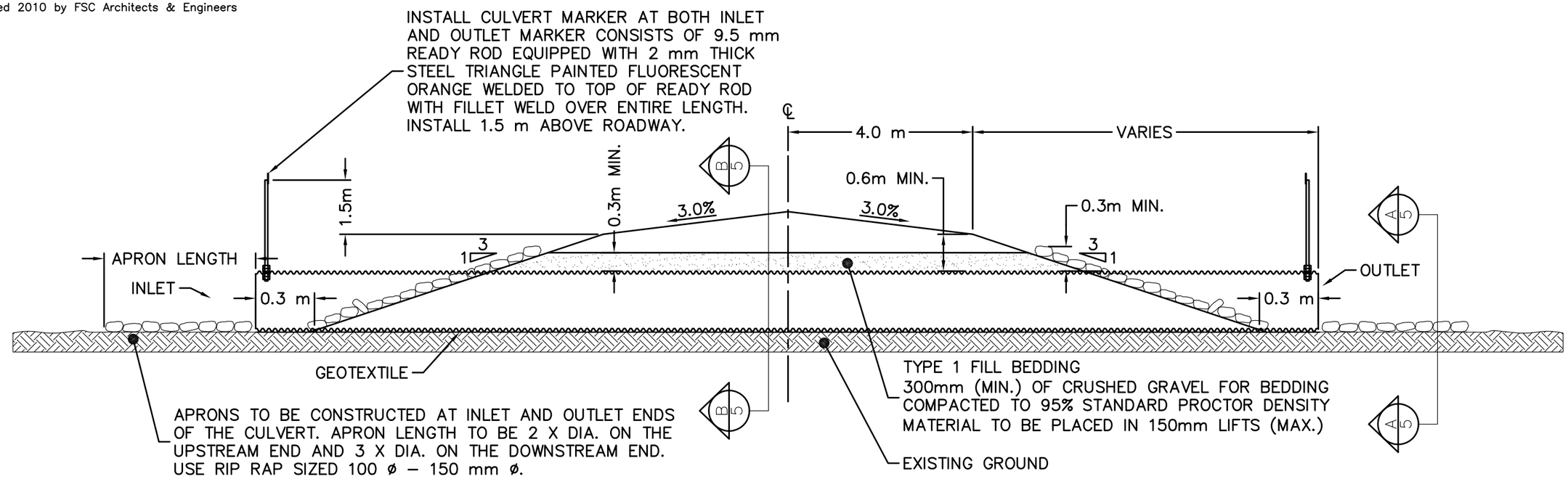
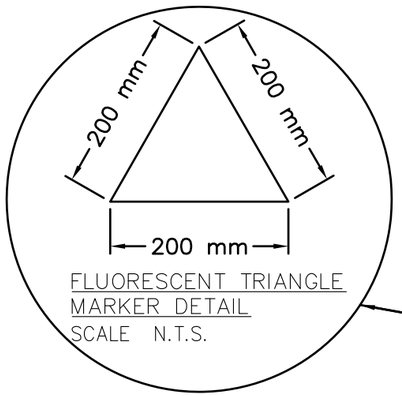
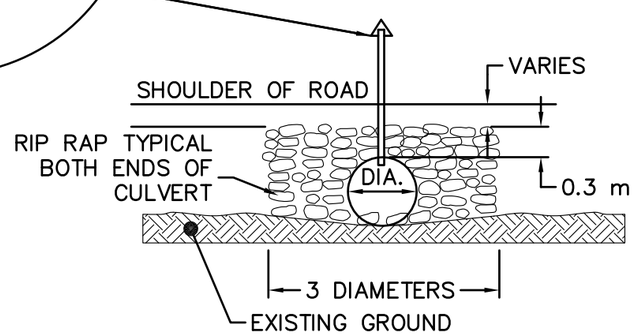


NOTES:
1– 100 mm MIN. GRADE BETWEEN UPSTREAM INLET TO DOWNSTREAM OUTLET.
2– GRADES TO BE SET AS SHOWN.
3– LENGTH AS SHOWN ON DRAWINGS.

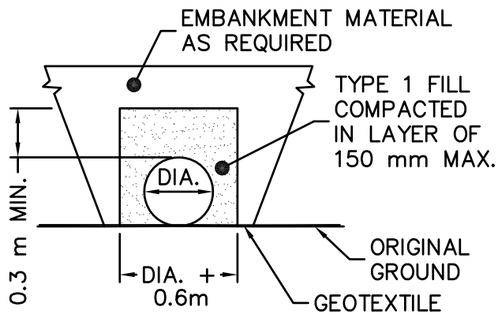
TYPICAL ROADWAY CULVERT DETAIL 1/5
SCALE N.T.S.



FLUORESCENT TRIANGLE MARKER DETAIL
SCALE N.T.S.



CULVERT ELEVATION VIEW A/5
SCALE N.T.S.



TYPICAL CULVERT BEDDING B/5
SCALE N.T.S.

PROJECT TITLE: **ACCESS TO BORROW SOURCE 177**		CLIENT PROJECT NO.: -	FSC PROJECT NO.: 2008-1191
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 | F 867.920.4319	LOCATION: TUKTOYAKTUK, NT	DRAWN BY: FG	CHECKED BY: WO
	DRAWING TITLE: CULVERT DETAILS	SCALE: N.T.S.	DATE: 2010/03/12
		DRAWING NO.: CSK01-05 OF 06	

FSC – ANSI–B_L – 11x17

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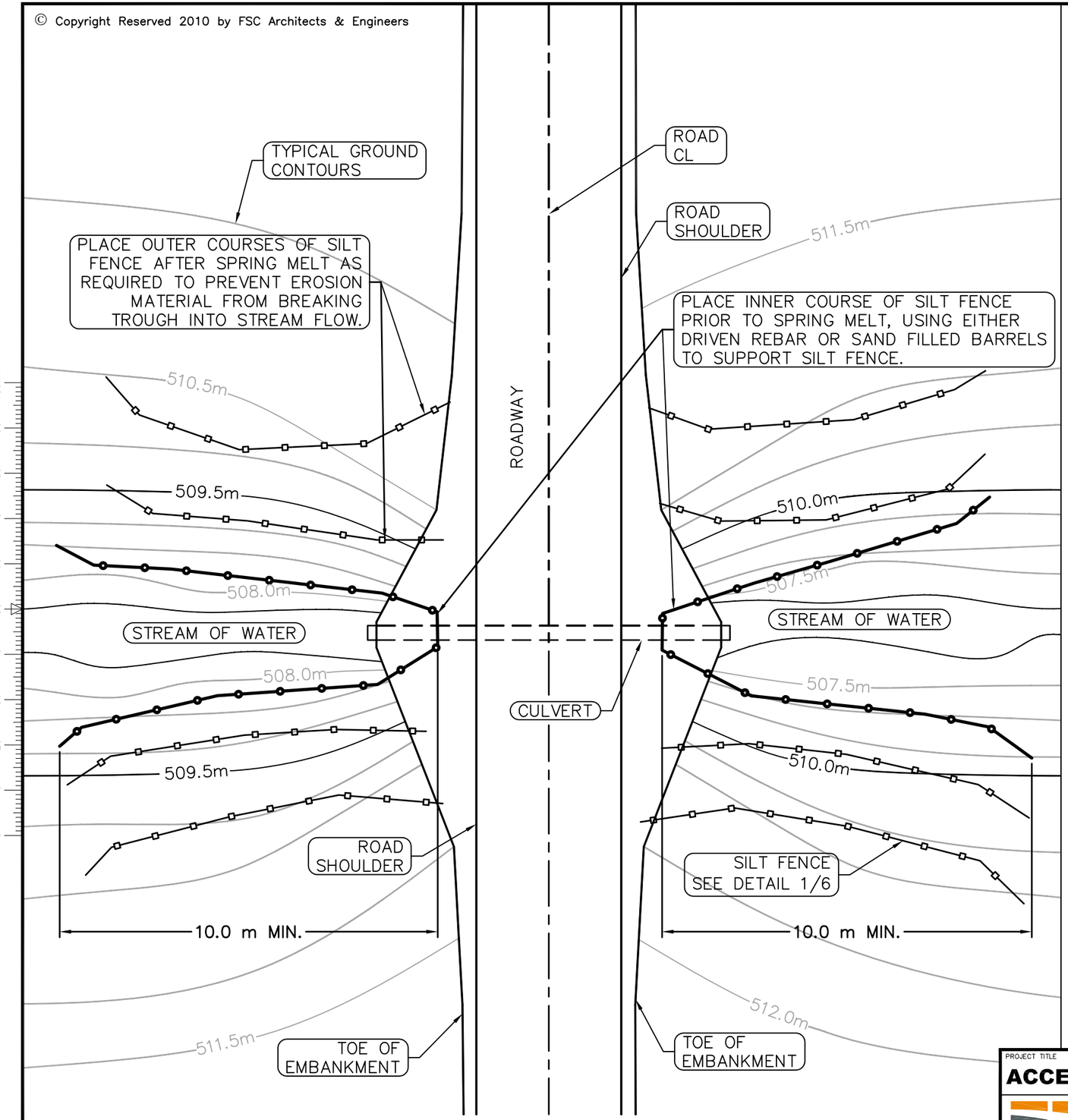
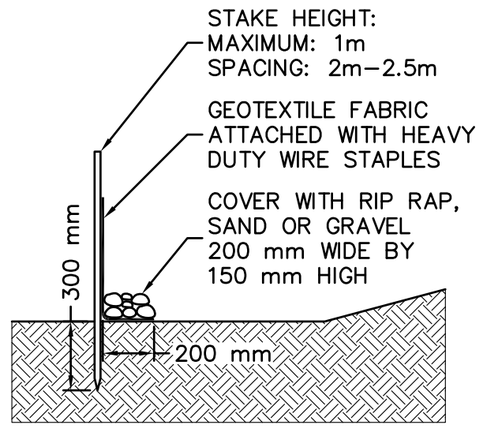


TYPICAL SILT FENCE INSTALLATION 1/6
SCALE N.T.S.



TYPICAL SILT FENCE INSTALLTION 1/6
SCALE N.T.S.

SILT FENCE NOTES:
- INSTALL BEFORE LAND IS DISTURBED
- INSTALL ON DOWN SLOPE SIDE OF SITE PARALLEL TO CONTOUR OF THE LAND
- STAKE POSTS ON DOWNHILL SIDE
- EXTENDED ENDS UP SLOPE ENOUGH TO ALLOW WATER TO POND BEHIND FENCE
- TURN ENDS OF FENCE UPHILL
- COVER 200 mm OF FABRIC AT THE BOTTOM WITH RIP RAP, SAND, OR GRAVEL LEAVE NO GAPS.
- OVERLAP SECTIONS OF SILT FENCE, OR TWIST ENDS OF SILT FENCE TOGETHER.
- INSPECT AND REPAIR ONCE A WEEK AND AFTER EVERY RAIN. REMOVE SEDIMENT IF DEPOSITS REACH HALF THE FENCE HEIGHT
- MAINTAIN UNTIL A VEGETATION IS ESTABLISHED

PROJECT TITLE
ACCESS TO BORROW SOURCE 177

CLIENT PROJECT NO.: -
FSC PROJECT NO.: 2008-1191

FSC ARCHITECTS & ENGINEERS
4910 - 53rd Street, P.O. Box 1777
Yellowknife, NT, X1A 2P4, Canada
T 867.920.2882 | F 867.920.4319

LOCATION: TUKTOYAKTUK, NT
DRAWN BY: FG
CHECKED BY: WO
DRAWING TITLE: SILT FENCE DETAILS AT POTENTIALY FISH BEARING CROSSING
SCALE: N.T.S.
DATE: 2010/03/12
DRAWING NO.: CSK01-06 OF 06