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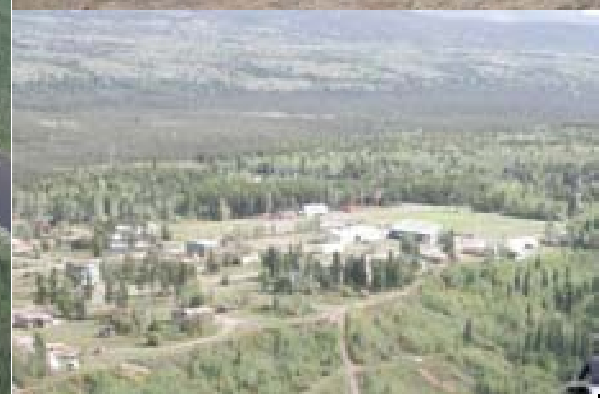

# Mackenzie Valley Highway Extension
# Pehdzeh Ki Ndeh – Dehcho Region

## Project Description Report (PDR)

Northwest Territories Transportation

ITAP

004-P037500-0200-EI-R200-00 | MARCH 2012

Final Report

# EXECUTIVE SUMMARY

An executive summary of the present document has been published separately. Copies of the executive summary can be obtained by contacting the individuals listed in Section 1.1 – Contact Names and Address.

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| REVISION AND PUBLICATION REGISTER | | |
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| Revision N° | Date | Modification And/Or Publication Details |
| 0A | 2011-12-05 | Draft Report |
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# ACRONYMS

| | |
|---|---|
| AANDC | Aboriginal Affairs and Northern Development Canada |
| ARI | Aurora Research Institute |
| AWR | Mackenzie Valley All-Weather Road |
| B.P. | Before Present |
| BC | Boreal Cordillera |
| BC HB | Boreal Cordillera High Boreal |
| BMP | Best Management Practices |
| CCME | Canadian Council of Ministers of the Environment |
| CEA | Cumulative Effects Assessment |
| CEMP | Construction Environmental Management Plan |
| CGCM | Climate Global Circulation Model |
| CHR | Community Health Representative |
| CHW | Community Health Worker |
| CIRL | Canadian Institute of Resources Law |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| DA | Designated Authority |
| DCR | Dehcho Region |
| DFNIMA | Dehcho First Nations Interim Measures Agreement |
| DFO | Fisheries and Oceans Canada |
| DLUPC | Dehcho Land Use Planning Committee |
| DOT | Government of Northwest Territories Department of Transportation |
| EA | Environmental Assessment |
| EIA | Environmental Impact Assessment |
| EIR | Environmental Impact Review |
| ELC | Ecological Land Classification |
| ENR | Government of Northwest Territories Department of Environment and Natural Resources |
| EPP | Environmental Protection Plan |
| ERP | Emergency Response Plan |

| | |
|---|---|
| FNIMA | First Nations Interim Measures Agreement |
| GLWB | Gwich'in Land and Water Board |
| GNWT | Government of Northwest Territories |
| GRRB | Gwich’in Renewable Resources Board |
| GSA | Gwich’in Settlement Area |
| HADD | Harmful Alteration, Disruption or Destruction |
| HSW | Home Support Worker |
| HTES | Highway Technical Engineering Services |
| HWM | High Water Mark |
| INAC | Indian and Northern Affairs Canada |
| KM | Kilometer Marker |
| LS | Low Subarctic |
| LSA | Local Study Area |
| MACA | Government of Northwest Territories Department of Municipal and Community Affairs |
| MGP | MacKenzie Gas Project |
| MPEG | Mackenzie Project Environment Group (for the Gas project) |
| MVEIRB | Mackenzie Valley Environmental Impact Review Board |
| MVH | MacKenzie Valley Highway |
| MVHDR | MacKenzie Valley Highway Dehcho Region |
| MVLUR | Mackenzie Valley Land Use Regulations |
| MVLWB | Mackenzie Valley Land and Water Board |
| MVRMA | Mackenzie Valley Resource Management Act |
| NAAQO | National Ambient Air Quality Objectives |
| NGO | Non-governmental Organization |
| NRCAN | National Resources Canada |
| NWPA | Navigable Waters Protection Act |
| NWT | Northwest Territories |
| NWTWA | Northwest Territories Waters Act |
| PAS | Northwest Territories Protected Areas Strategy |
| PCB | Polychlorinated Phenols |
| PDR | Project Description Report |

| | |
|---|---|
| PKCL | Pehdzeh Ki Contractors Ltd. |
| PKFN | Pehdzeh Ki First Nation |
| PWNHC | Prince of Wales Northern Heritage Centre |
| RSA | Regional Study Area |
| SARA | Species at Risk Act (Federal) |
| SLWB | Sahtu Land and Water Board |
| SSA | Sahtu Settlement Area |
| STP | South Taiga Plains |
| TLU | Traditional Land Use |
| UTM | Universal Transverse Mercator |
| VEC | Valued Environmental Component |
| WHO | World Health Organization |
| WLWB | Wek'eezhii Land and Water Board |

# 1 INTRODUCTION

As part of the Federal Government's long standing vision to develop Canada's north, a program for the construction of an all-weather road in the Western Arctic was implemented. The extension of the Mackenzie Valley Highway (MVH), Pehdzeh Ki Ndeh - Dehcho region, north from Wrigley to the Southern boundary of the Sahtu Settlement Area (102 km), is yet another step towards linking the Southern and Eastern populations of Canada to the Arctic region and is the subject of this Project Description Report (PDR). This PDR will be used by the Government of the Northwest Territories (GNWT), Department of Transport (DOT) to meet the Preliminary Screening requirements of the Mackenzie Valley Land and Water Board (MVLWB) to determine whether the Project should be referred to the Mackenzie Valley Impact Review Board (MVEIRB) for further consideration in the form of an Environmental Assessment (EA).

This PDR has been completed based on a Memorandum of Understanding (MOU) between the Pehdzeh Ki First Nation (PKFN) and GNWT DOT which details what work the Parties would undertake to complete the PDR; how the work would be funded; and how overall project management would be considered.

The section of the MVH in the Pehdzeh Ki Ndeh - Dehcho region is currently serviced by a winter road that extends north of Wrigley at the Northern end of the existing all-weather Mackenzie Highway. An all-weather road will offer substantial benefits locally, regionally and nationally as it eventually joins the Inuvik-Tuktoyaktuk section at the northern part of the Mackenzie Valley. Communities of the Mackenzie Valley have voiced their interest and support for the extension of the MVH, indicating that the road is expected to benefit resource development and the tourism industry that could be generated. The communities also voiced some concerns with regards to social and environmental impacts.

Potential benefits that have been identified include reduced cost of living and doing business, safer and easier access to regional services, expanded business opportunities, improved opportunities for pollution prevention and spill response in the Arctic, increased opportunities to support oil and gas exploration, mine development, and ability for Canada to establish its national sovereignty in the North.

The PDR identifies, analyses, and collates pertinent and available information for the MVH project to meet the Preliminary Screening requirements of the process administered by the MVLWB. There is a body of information from past studies and reports, mostly from the period 1973 to 2005, which has been used to prepare the PDR for this section of the MVH. This information, supplemented by input received through consultations in 2010 and 2011 as part of this assessment, have been used to characterise the biophysical and human environments, and to predict environmental impacts, gaps in information and subsequent assessment needs for the MVH in the Pehdzeh Ki Ndeh - Dehcho Region.

An overview of the human and socioeconomic components for this section of the MVH has also included meetings and consultation(s) with the public and peoples of the Dehcho Nation. During the consultations participants contributed arboriginal traditional land use and knowledge to the PDR.

## 1.1 CONTACT NAMES AND ADDRESS

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## 1.2 PURPOSE OF THE STUDY

The mandate of this PDR is to gather available pertinent information to conduct a preliminary screening study of the proposed MVH in the Pehdzeh Ki Ndeh - Dehcho Region. According to the Environmental Impact Assessment Guidelines issued by the MVEIRB, the specific purpose of the preliminary screening is to “determine whether a proposed development might have a significant adverse impact on the environment or might cause public concern”. It is not intended to identify and define the details of significant adverse impacts; rather it is designed to give voice to the local, regional and governmental concerns and wishes related to the development of the highway project. This PDR will allow the project to proceed through the approval process for the permitting, construction and long term operation and maintenance phases of the Project, by predicting its potential impacts on the environment both human and biophysical, and wherever possible identifying design consideration to minimize or avoid the predicted impacts.

The objectives of the PDR include the following:

- Describe the project;
- Describe traditional knowledge and land uses;
- Describe the biophysical and human environment;
- Identify public concerns;
- Describe the alignment and design parameters;
- Describe potential biophysical impacts;
- Describe potential social, economic and cultural impacts;
- Provide mitigation measures to those adverse and/or significant impacts;
- Describe cumulative impacts;
- Develop the necessary Environmental Management Plan.

# 2 REGULATORY REVIEW AND APPROVALS

The following section describes the regulatory context for the section of the proposed all-weather Highway extension in the Pehdzeh Ki Ndeh - Dehcho region between Wrigley and the Blackwater River. The regulatory framework is reviewed at the regional and territorial/federal level. Relevant approvals and permits are discussed under a three part temporal sequence to help depict the process:

- Pre-assessment: Permits for field studies conducted in support of the EIA process;
- Assessment: The EIA Process;
- Post-assessment: Authorizations, permits and licences required for construction and operation of the all-weather highway.

## 2.1 CONTEXT

The regulatory and Environmental Impact Assessment (EIA) regime in the Northwest Territories evolved during the 1990s with the settlement of the Gwich'in and Sahtu land claims and the subsequent proclamation of the *Mackenzie Valley Resource Management Act* (MVRMA) in 1998.

The Mackenzie Valley encompasses the majority of the Northwest Territories excluding Wood Buffalo National Park and the Inuvialuit Settlement Region. The proposed all-weather highway passes through three regions of the Mackenzie Valley including the Gwich'in and Sahtu regions which have settled land claims and the Pehdzeh Ki Ndeh - Dehcho region which, at present, does not have a land settlement agreement.

## 2.2 REGULATORY FRAMEWORK

### 2.2.1 Regional

The regulatory framework for resource development in the Mackenzie Valley is dominated by the *Mackenzie Valley Resource Management Act (*MVRMA) which came in to force in 1998. The MVRMA applies exclusively to the Mackenzie Valley region, and establishes processes for land and water use regulation, environmental impact assessment and environmental monitoring and audit. It is the result of commitments made by Canada in satisfaction of promises made to the Gwich'in and Sahtu Dene Metis in their comprehensive land claim agreements. The MVRMA also established public governance institutions responsible for land use planning, land and water management and environmental impact assessment. These are discussed below in relation to the MVRMA.

#### 2.2.1.1 The Mackenzie Valley Land and Water Board (MVLWB)

Part 4 of the MVRMA established the MVLWB in order to fulfill three main functions:

- Issuing land use permits and water licenses in the unsettled claims area until the balance of the land claims are settled in the Mackenzie Valley;
- Processing trans-regional[1] boundary land and water use applications within the Mackenzie Valley;
- Ensuring consistency in the application of the legislation throughout the Mackenzie Valley (CIRL, 1999).

The MVLWB is comprised of three permanent regional panels; the Gwich'in Land and Water Board (GLWB), the Sahtu Land and Water Board (SLWB) and the Wek'eezhii Land and Water Board (WLWB) (established in 2003); four additional members, two nominated by First Nations, one nominated by the Government of the Northwest Territories, and one other; and a chairperson appointed by the federal Minister, nominated by a majority of members.

The Dehcho Region does not have a settled land claim and therefore, for developments within this region, the MVRMA is administered by the MVLWB. This is different to both the Gwich'in Settlement Area (GSA) and the Sahtu Settlement Area (SSA), which, in addition to a regional panel of the MVLWB, each have their own recognized Land Use Planning Boards, as per Part 2 of the MVRMA.

Essentially, the main distinction between the powers of the two types of board is that; whereas land use planning boards may specify conditions that apply to the use of land, water and other resources on a region-wide basis; the land and water boards are responsible for issuing the permits and water licenses for individual developments.

Once the Dehcho land claim is settled, it is likely that the Dehcho Land Use Planning Board will be officially established under the MVRMA and a regional panel will be established. However, for the purposes of this PDR, it is assumed that the MVLWB will continue as the relevant body for this region, fulfilling the role of both boards and liaising with the interim Dehcho Land Use Planning Committee (DLUPC) in respect of the First Nations Interim Measures Agreement.

The present lack of a regional land and water board in the Dehcho Region is not expected to complicate the issuance of land use permits and water licenses as the third mandate of the MVLWB is to ensure consistency in the application of legislation throughout the Mackenzie Valley. In addition, if all sections of the all-weather highway were to be assessed as one project, it would be considered a trans-regional boundary issue and would fall under the jurisdiction of the MVLWB even in the Gwich'in and Sahtu regions.

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1 The phrase 'trans-regional boundary' is used here to refer to regions within the Mackenzie Valley and to avoid confusion with trans-boundary impacts outside the Mackenzie Valley

#### 2.2.1.2 The Mackenzie Valley Environmental Impact Review Board (MVEIRB)

The MVEIRB is the primary authority for EIA in the Mackenzie Valley pursuant to Part 5 of the MVRMA. This includes responsibilities for proposed trans-boundary projects as well as those entirely outside the Mackenzie Valley, which may still adversely impact the region. In these cases:

- If the development is entirely within the Mackenzie Valley but might have significant adverse environmental impacts in other areas, the MVEIRB will notify the authority responsible in that region and request cooperation;
- If the development itself crosses the boundaries of the Mackenzie Valley, the MVEIRB will try to coordinate its environmental assessment with that of the authority responsible in the adjacent region, province or territory;
- If the development is entirely outside the Mackenzie Valley but might have significant adverse impacts within its limits, the MVEIRB may, with the approval of the federal Minister, enter into an agreement with the authority to allow it to participate in the examination of environmental impacts of the development. The MVEIRB will endeavor to cooperate with the authorities of the adjacent regions (MVEIRB, 2004).

Details of the three steps of EIA under the MVRMA are presented later in this section.

### 2.2.2 Territorial and Federal

The evolution of the regulatory framework in the Mackenzie Valley in the 1990s saw recognition that the extensive region encompassed by the Mackenzie River required a regional decision process and authority to reflect regional interests. Consequently, planning, assessment and management responsibilities were transferred to regional bodies. The most significant change occurred in 1998 when the MVRMA was established. Regulations are still largely based on territorial acts and some activities still require federal permitting. Detailed discussion of this can be found below. In addition to the MVRMA, the establishment of the land settlement agreements with the Gwich'in and Sahtu further consolidated regional planning, management and decision-making. Nevertheless, the way that treaties between the Crown and the Aboriginal people are negotiated could be improved in the future land settlement agreements (Asch, 2000).

## 2.3 APPROVALS AND PERMITS

The approvals including licenses, permits and authorizations that are anticipated for the section of the MVH through the Pehdzeh Ki Ndeh - Dehcho Region are described in Table 1 based on this three-part temporal sequence:

- Pre-assessment: Permits for field studies conducted in support of the EIA process;
- Assessment: The EIA Process;
- Post-assessment: Authorizations, permits and licences required for construction and operation.

Many of the regulatory approvals and permits mentioned below are integrated with the DLUPC through the Dehcho First Nations Interim Measures Agreement (DFNIMA).

Table 1: Summary of Approvals and Permits

| LICENCE, PERMIT OR PROCESS | ACT AND/OR REGULATION | RELEVANT BODIES |
|---|---|---|
| Pre-Assessment | | |
| Archaeology Permit | Northwest Territories Archaeological Sites Regulations (Under the *Northwest Territories Act*) | Prince of Wales Northern Heritage Centre (PWNHC) |
| Research Licence | *Northwest Territories Scientists Act* and *Northwest Territories Act* | Aurora Research Institute (ARI) |
| Wildlife Research Licence | *Northwest Territories Wildlife Act* | Government of Northwest Territories Environment and Natural Resources (ENR) |
| Assessment | | |
| Environmental Impact Assessment Process | | |
| Preliminary Screening | *Mackenzie Valley Resource Management Act* (MVRMA) | Mackenzie Valley Land and Water Board (MVLWB) |
| Environmental Assessment (as required) | MVRMA | Mackenzie Valley Environmental Impact Review Board (MVEIRB) |
| Environmental Impact Review (as required) | MVRMA | MVEIRB |
| Post Assessment | | |
| Land | | |
| Land Use Permit | Mackenzie Valley Land Use Regulations (MVLUR) | MVLWB, Aboriginal Affairs and Northern Development Canada (AANDC) (Crown Lands and permit compliance) |
| Quarry Permit | Territorial Quarrying Regulations (*Territorial Lands Act*) | AANDC |
| Explosives Permit | *Explosives Act* | Natural Resources Canada (NRCAN) |
| Water | | |
| Water Licence | Northwest Territories Water Regulations(*Northwest Territories Waters Act*) | MVLWB, AANDC (Crown Lands and licence compliance) |
| Fisheries Authorization and/or Letter of Advice | *Fisheries Act* | Fisheries and Oceans Canada (DFO) |

Note: Based on GeoNorth Limited and Golder Associates, 1999 (p. 78).

### 2.3.1 Pre–Assessment

#### *2.3.1.1 Prince of Wales Northern Heritage Centre (PWNHC)*

Archaeological permits are required to conduct archaeological studies in the Northwest Territories. The PWNHC administers the Northwest Territories Archaeological Sites Regulations under the *Northwest Territories Act*. Permitting and reporting is a requirement from the early stages of a project through to completion. The permit allows the assigned project archaeologist to access privileged information, which will enable him/her to advise the project team on avoidance of important heritage and archaeological sites during project planning and implementation, without divulging the exact location or nature of the valued sites (PWNHC, 2011).

Two types of permits can be applied for; a 'class 1 permit' entitles the permit-holder to survey and document an archaeological site without altering or disturbing it. A 'class 2 permit' also allows the permit-holder to disturb, excavate and remove artefacts from a site. Only qualified archaeologists can obtain this level. An application must be completed for both class 1 and class 2 permits. If the applicant is qualified, the application is sent to the local First Nations, who have stated interests in that particular area. They are given 30 days to respond. If they have concerns, the applicant must address those concerns before a permit will be issued. The final authority regarding archaeological issues is the Territorial Archaeologist of the PWNHC.

#### *2.3.1.2 Government of Northwest Territories Environment and Natural Resources (ENR)*

Under the *NWT Wildlife Act* (Section 24), a valid Wildlife Research Permit is required to study wildlife or wildlife habitat in the Northwest Territories. It is an offence to conduct a survey or census of wildlife or wildlife behaviour or carry out any scientific research relating to wildlife without a permit. The ENR is responsible for issuing Wildlife Research Permits (ENR, 2011). A permit will need to be requested at the pre-assessment stage to gather baseline data on wildlife. This will require a list of species to be studied, the location of the studies and a record of consultation.

A Wildlife Research Permit may also be required for wildlife monitoring during the post-assessment phase. A permit extension can be requested for this purpose.

#### *2.3.1.3 Aurora Research Institute (ARI)*

The AARI is the research division of Aurora College and is responsible for licensing, conducting and coordinating research in accordance with the *NWT Scientists Act*. All research in the Northwest Territories must be licensed and any research that does not fall under the Wildlife or Archaeological legislation requires a Scientific Research licence (ARI, 2011). Summaries of the research conducted each year are distributed to media, community organizations and other researchers. A permit will need to be requested at the pre-assessment stage to gather baseline data on components such as water quality, hydrology and soils. The application will include details of the studies to be undertaken, the location of the studies and a community review. Various scientific research programs are likely to be required throughout the project and at all stages the appropriate research licenses will be applied for and obtained prior to the conduct of any research.

### 2.3.2 Assessment – The Environmental Impact Assessment (EIA) Process

The Mackenzie Valley EIA process under the MVRMA is based on three steps:

- The first step of the EIA process, the preliminary screening, is generally conducted by a land and water board or a government agency. For the all-weather highway project in the Pehdzeh Ki Ndeh – Dehcho region the MVLWB will be responsible for conducting the preliminary screening;
- The second step is to conduct an environmental assessment (EA) at the discretion of the MVEIRB; and finally,
- The third step is the environmental impact review (EIR) in which the MVEIRB may appoint a panel to review the in-depth environmental studies (MVEIRB, 2004).

These steps are described in more detail below. Proposed developments do not necessarily have to go through all three steps before an approval can be granted. In fact, for most development projects, no further assessment is required beyond preliminary screening. This process focuses environmental assessment resources on the developments with the greatest potential impacts.

#### *2.3.2.1 Preliminary Screening*

Preliminary screening is the initial stage in the EIA process and its purpose is to determine, based on a Project Description Report (PDR) prepared by the proponent, whether a project might have a significant adverse impact on the environment or might be a cause for public concern as defined under the MVRMA (s.125 (1)(a)). Preliminary screenings are triggered by an application for an authorization for a development. The regulator that receives the application usually initiates the preliminary screening. Therefore, the MVLWB conducts the majority of preliminary screenings in the Pehdzeh Ki Ndeh – Dehcho region and has a larger role than the MVEIRB in coordinating the preliminary screening process. Developments that do not require land use permits or water licenses are screened by other regulators. In some cases regulators may conduct simultaneous screenings.

It is anticipated that, due to the trans-regional boundary nature of the proposed Highway, the entire highway project will be reviewed as one development by the MVLWB rather than by individual regions. As a part of the preliminary screening process, this PDR will be made available to landowners, stakeholders, regulators and other organizations for their review and comments. The screening process may involve public meetings and hearings and the proponent may be asked to submit supplementary information to meet the screener's requirements.

Listed below are the agencies and groups likely to be included in the screening process:

- Indian and Northern Affairs Canada;
- Department of Fisheries and Oceans;
- Canadian Heritage;
- Environment Canada;
- Pehdzeh Ki First Nation;
- Dehcho Land Use Planning Committee;
- Land Owners;
- Local Governments / Communities;
- Local Renewable Resource Councils or Hunters and Trappers Associations;
- MVEIRB;
- MVLWB;
- National Energy Board;
- Natural Resources Canada;
- Non Governmental Organizations;
- Prince of Wales Northern Heritage Centre;
- GNWT Department of Municipal and Community Affairs;
- GNWT Department of Resources, Wildlife and Economic Development;
- GNWT Department of Health and Social Services (MVEIRB, 2004).

Having conducted the preliminary screening the MVLWB will refer a development to the MVEIRB for environmental assessment if it fails the 'might' test, i.e. if it is determined that it 'might' have a significant adverse affect on the environment or that it 'might' be a cause of public concern. The term 'might' instead of 'likely' means that under the MVRMA, the MVEIRB has a more sensitive trigger for further assessment than other EIA processes. If the preliminary screening determines that an environmental assessment is required, the MVRMA mandates that an environmental assessment be carried out by the MVEIRB. However, if the preliminary screening does not refer the development for an environmental assessment, the MVRMA allows for developments still to be referred to the MVEIRB by:

- A regulatory authority, the National Energy Board, or a department or agency of the federal or territorial government; or,
- A local government.

It is noted that as the Dehcho Region does not have a settled claim, it would not seem to have a basis for a referral. However, the Dehcho First Nations Interim Measures Agreement would appear to provide a legal basis for MVRMA to allow a referral to go to the MVEIRB from the DLUPC.

It should be noted that to ensure that an EIA occurs before a development's impacts happen, the MVRMA requires that no irrevocable actions are taken before EIA requirements are met. This means that no authorizations (permits, licenses and other authorizations) should be issued before the preliminary screening is conducted.

#### 2.3.2.2 *Environmental Assessment (EA)*

The second level of review is the environmental assessment. The MVEIRB establishes the scope of the report and, once the developer submits an EA report and public input is obtained and reported, the MVEIRB determines if the report addresses the following adequately:

- The impacts of the development (including cumulative impacts and impacts from malfunctions);
- The significance of those impacts;
- Public comments;
- Mitigation measures;
- Anything else that the MVEIRB deems relevant (MVEIRB, 2004).

The MVEIRB's 'Report of Assessment' will make one of the following determinations:

- The proposed development is not likely to cause significant adverse environmental impacts or to be the cause of significant public concern, and should proceed through the regulatory process;
- The proposed development is likely to cause significant adverse environmental impacts or public concern that can be mitigated and should proceed through the regulatory process with certain conditions;
- The proposed development is likely to cause significant adverse environmental impacts or public concern and should undergo an Environmental Impact Review (EIR);
- The proposed development is likely to cause adverse environmental impacts or public concern so significant that it is not justifiable and should be rejected without an EIR (MVEIRB, 2004).

#### 2.3.2.3 *Environmental Impact Review (EIR)*

EIR is the third level of evaluation for the Mackenzie Valley EIA process. An EIR builds on the environmental assessment and involves the examination of a development proposal by a Review Panel of three or more persons nominated by the MVEIRB. This can include non-MVEIRB members chosen for their expertise. The proponent prepares an environmental impact statement based on the terms of reference prepared by the MVEIRB in consultation with the responsible Ministers and First Nations and, subsequent to public scrutiny and other analyses, hearings, or meetings, the panel makes recommendations to the federal and responsible Ministers for a decision. After considering the panel's recommendations, the Minister may adopt them or refer them back to the panel for reconsideration. Should reconsideration be required, following a subsequent consultation with the panel, the Minister may adopt the recommendations with modifications or reject them.

### 2.3.3 Post-Assessment

#### *2.3.3.1 Land Authorizations*

As mentioned above, for the Dehcho Region, the MVLWB is responsible for land use permitting. This is conducted in accordance with the Mackenzie Valley Land Use Regulations (MVLUR) as defined by the MVRMA. However, some authorizations, as described below, are still the responsibility of federal regulators. Land use permits may be required to conduct activities such as the following:

- Clearing and construction within the Highway right-of-way;
- Excavation;
- Accessing borrow sources;
- Gaining temporary access to temporary borrow sources;
- Use of explosives;
- Borrow source investigations (depending upon equipment used);
- Establishing campsites, fuel and supply storage sites.

##### *2.3.3.1.1 Mackenzie Valley Land Use Regulations (MVLUR)*

The MVLUR are enacted under the MVRMA and are modeled closely on the Territorial Land Use Regulations. The MVLUR establishes three types of land use permits: “Type A”, “Type B”, or “Type C”. For the most part, “Type A” permits pertain to activities that are more involved and more extensive than those activities covered under “Type B.” “Type C” permits apply exclusively to Tlicho lands. A “Type A” permit is issued according to (amongst others):

- The method and equipment used to clear land;
- Proposed land clearing area (if exceeding 1.5 m in width and 4 hectares (ha) in area);
- The quantities of fuel stored on the alignment (container exceeding fuel capacity of 4,000 litres (L) or a fuel storage facility with a capacity of 80,000 L or more).

Additional thresholds may apply, but the ones stated above indicate that a “Type A” land use permit will be required for construction of the new highway. Pre-construction field investigations (in particular borrow source assessments) will use drilling equipment. However, until the timing and specifications of the equipment are determined, it is not known whether an investigations stage permit would be “Type A” or “Type B”.

Timelines established in Section 22 and 23 of the MVLUR indicate that the responsible land and water board must make a land use permitting decision within 42 days of receipt of an application for a “Type A” permit and 10 days for “Type B” permit.

*2.3.3.1.2 Aboriginal Affairs and Northern Development Canada (AANDC)*

AANDC has a wide range of responsibilities under two mandates. Of these two mandates, the Northern Development mandate includes managing and issuing permits for granular resources, negotiating access to Crown lands and inspecting and monitoring land use permit and water license compliance.

**Granular Resources**

In the Mackenzie Valley, quarrying activities on federal Crown land require a Quarry Permit. Applications for Quarrying Permits are assessed by AANDC to determine:

- The need for a new pit or quarry, and the availability of an existing one;
- Whether potential reserves of the granular material are adequately identified and assessed;
- Whether the application and proposed development plan maximize appropriate use of granular resources, especially in areas where materials are scarce.

The anticipated borrow material sources and the volume of borrow material required for the Dehcho section of the MVH Extension are discussed the Project Description section below. This is intended to aid AANDC in their review of the project in the context of total known and estimated granular resources available. Note that the proponent has yet to assess the planned borrow sources for material quality, quantity, ice content, and other critical characteristics. This information will be submitted to AANDC when quarry permit applications are made. Following its review, and assuming the ‘right’ to the land has been negotiated and a land use permit obtained, AANDC will be the body that issues Quarry Permits for the Highway under the Territorial Quarrying Regulations.

**Crown Land**

AANDC manages surface activities on Crown lands in the Northwest Territories through the administration, regulation, inspection and enforcement of legislation. The MVH Dehcho section will cross Crown Lands. For this project, the proponent will work with AANDC to negotiate the right to conduct the necessary investigations and to construct the highway across Crown lands.

**Compliance**

AANDC is also responsible for managing compliance with land or water authorizations under the MVLUR and Northwest Territories Waters Regulations, respectively. The proponent will notify AANDC in advance of activities on the project. In addition, AANDC's Operations Branch will conduct inspections of right-of-way clearing, water crossings, borrow sources, and temporary winter access roads to ensure the methods and approach are being applied in accordance with the project's specific terms and conditions.

Finally, AANDC has developed a series of guidelines that will be used for the planning and construction of the highway and associated infrastructure on Crown lands. Guidelines published for northern land use include Pits and Quarries, Permafrost, Access Roads and Trails, Camp and Support Facilities (AANDC, 2011).

*2.3.3.1.3 Natural Resources Canada (NRCAN)*

Explosives may be required to access material at select borrow sources along the Highway alignment. The storage and use of explosives at a work site is administered by NRCAN under the *Explosives Act*. Appropriate approvals will be acquired to enable use of explosives when required.

*2.3.3.1.4 Dehcho Land Use Planning Committee (DLUPC)*

The DLUPC was established in 2001 as set out in the DFNIMA. The Committee includes a Board of five members[2] who have a responsibility to guide the development of a land use plan and ensure that proper consultation and communication is occurring with all relevant parties. The actual development of the plan will be done by staff at the Land Use Planning Office. The DLUPC is expected to be involved in consultation throughout the EIA Process for developments within the Dehcho region. The DLUPC is expected to be consulted with respect to land and water use implications of the development consistent with the DFNIMA.

The DFNIMA states that the DLUPC may be consulted for the Dehcho Region on the following:

- Land Use Planning;
- Land Withdrawal;
- Land and Water Regulation;
- Sales and Leases of Surface Lands;
- Commissioner's Lands;
- Town of Hay River;

[2] One representative each from the Government of Canada and the Government of the Northwest Territories, two representatives from the Dehcho First Nations, and the chair of the Committee chosen by the other four Committee members.

- Mineral Development (Excluding Oil and Gas);
- Oil and Gas Activity;
- Oil and Gas Benefit Plans;
- Geophysical Operations;
- Interim Resource Development Agreement;
- Mineral Impact and Benefit Agreements;
- Forest Management;
- Environmental Impact and Review Board;
- NWT Protected Areas Strategy;
- Nahanni National Park Reserve;
- Tourism;
- Great Slave Lake Fishery;
- Trans-boundary and Overlap Issues.

#### 2.3.3.2 Water Authorizations

The MVLWB has jurisdiction in respect of all uses of water and deposits of waste into water for which a license would be required under the *Northwest Territories Waters Act* (NWTWA). The Highway extension project will require licenses for activities such as the following:

- Water course crossings;
- Water usage;
- Camps;
- Deposit of waste;
- Handling and storage of petroleum and other hazardous materials.

##### 2.3.3.2.1 Northwest Territories Waters Regulations (NWTWR)

Part 3 of the MVRMA contains the provisions outlining the land and water boards' jurisdiction and responsibilities for water management. This does not replace the NWTWA but makes the changes necessary to adapt it to be consistent with the requirements of the various land claims in the Mackenzie Valley. Therefore, the NWTWA still applies in the Mackenzie Valley but in a modified manner.

The NWTWR define the use of two types of permit: "Type A" and "Type B." Based on the principle and ancillary activities involved in constructing the Highway, the project will likely be deemed a 'Miscellaneous Undertaking'. The main factor influencing the project's requirement for a "Type A" or "Type B" water license is the volume of 'direct water use' per day. The estimated maximum daily water volumes over the lifespan of the water license will range from 500 $m^3$ to 1 000 $m^3$ per day at peak usage and encompassing the full range of seasonal activities, which are presented in the Project Description section below. A “Type A” license will be sought to allow for the necessary daily direct water use, deposition of waste, construction of watercourse crossings, and other regulated activities.

The NWTWR will be considered by the MVLWB during the preliminary screening process.

##### *2.3.3.2.2 Fisheries and Oceans Canada (DFO)*

The Northwest Territories falls within the Central and Arctic Region, which is the largest of the DFO’s six regions. As regulator of the *Fisheries Act,* the DFO reviews projects for the potential for Harmful Alteration, Disruption or Destruction (HADD) of fish habitat under Section 35, which contains the following subsections:

- 35 (1) No person shall carry out any work or undertaking that results in a HADD;
- 35 (2) No person contravenes subsection (1) by causing a HADD by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act (DFO, 2010a).

To fulfill its responsibilities under the *Fisheries Act* Section 35, DFO established a Guiding Principle of no net loss of productive capacity of fish habitats to ensure that developments do not result in a diminishment in quality or quantity of fish habitats that support fish production. This no net loss principle, however, provides discretion to the Minister by allowing for the replacement of habitat losses (authorized under Section 35(2)) through the provision of approved habitat compensation (DFO, 2010a).

DFO does not issue permits for a project. However, DFO is responsible for issuing a Letter of Advice for projects elements that are not expected to result in a HADD, or an Authorization for elements that constitute a potential HADD under Section 35(2). A Letter of Advice typically sets out guidelines and/or mitigation measures that, when followed, would prevent a HADD. An Authorization recognizes that a HADD is likely to occur, and therefore includes an agreement between the project proponent and DFO for compensation that will achieve no net loss. These documents are intended to assist the proponent when applying provisions under the Fisheries Act to their particular project circumstances, thereby supporting compliance with the Act by following the outlined conditions.

In addition, DFO has developed a series of Operational Statements that provide guidance to project proponents regarding specific types of projects (DFO, 2007). Where Operational Statements apply and are followed, proponents do not need an approval from DFO. For example, in the Northwest Territories, DFO has published the following Operational Statements of potential applicability to the Mackenzie Valley Highway: clear-span bridges; ice bridges and snow fills; temporary stream crossings; culvert maintenance; and maintenance of riparian vegetation in existing rights-of-way (DFO, 2007 – DFO, 2007e).

The various stream crossings that are part of this project have been well studied. Some are already completed but those which have not will be sited and designed to avoid or mitigate adverse impacts on fish and fish habitat (i.e. HADD), wherever possible. As such, it is expected that some project elements such as watershed equalization culverts can be completed through the issuance of Letters of Advice by DFO, or by application of relevant Operational Statements. If there are circumstances where a HADD is unavoidable, DFO will be consulted to discuss and determine suitable compensation strategies so that the necessary application for Authorization pursuant to Section 35(2) of the *Fisheries Act* can be submitted.

The Fisheries Act regulations will be considered by the MVLWB during the preliminary screening process.

###### *2.3.3.2.3 Transport Canada*

Transport Canada is responsible for issuing permits under the *Navigable Waters Protection Act* (NWPA). Under the Act and Regulations, the project will require a permit for the construction of stream crossings (bridges or culverts). The Act requires approvals to be obtained for any structure that may interfere with navigation if it is constructed in, over, under, through or across any navigable water bodies. An application will be submitted to Transport Canada after bridge and/or culvert design reaches the necessary level of completeness for the assessment of the proposed structures at each potentially navigable stream crossing. Larger streams crossed by the Highway will constitute navigable waters. The Minor Waters User Guide (Transport Canada, 2010) describes criteria used to establish when a small stream does not require an application under the NWPA.

# 3 PROJECT DESCRIPTION

This section of the PDR describes the project's components associated with the planning, design and construction stages as well as those aspects likely to have an impact on the natural and human environments. The proposed alignment of the MVH in the Pehdzeh Ki Ndeh - Dehcho Region north of Wrigley closely resembles that of the existing winter road. The following sections describe the geographical location of the optimized alignment and the rationale behind the use of this alignment. Design parameters, terrain conditions, geotechnical route investigation, mitigation techniques, construction methods on permafrost, likely borrow sources of construction materials and life cycle assessment will be described as well.

## 3.1 PROJECT BACKGROUND

### 3.1.1 Northern Vision – All-Weather Road in the Western Arctic

As part of the Federal Government's long standing vision to develop the Canadian North, a program for the construction of an all-weather road in the Western Arctic was implemented as part of the early 1960s "Northern Vision", which was seen as the final link to connect Canada from coast to coast to coast.

In the 1960's and 70's, there were a number of studies undertaken by the Federal Government in support of constructing an all-weather highway through the Mackenzie Valley. These studies involved developing detailed road alignments, gathering environmental data and undertaking engineering design.

By 1972, the Federal Government started construction of the Mackenzie Valley Highway from Fort Simpson to Inuvik. Extensive construction, surveying, environmental and design work was carried out until 1976.

In 1977, with the increasing uncertainty regarding oil and gas development potential and other political, economic and legal issues of the time, construction was halted. The Federal Government abandoned the route 18 km south of Wrigley.

Work on this highway was revived by the Government of the Northwest Territories (GNWT) in the early 2000's. Through a funding partnership with the Federal Government, a program was implemented to construct permanent bridges at all stream crossings. These bridges, which will extend the winter road's window of operation and reduce environmental concerns at stream crossings, will ultimately serve the future all-weather highway (NWTC, 2005).

### 3.1.2 Mackenzie Valley Highway Extension (MVH)

#### *3.1.2.1 The Existing Highway and Winter Road System*

The existing all-weather NWT Highway 1 extends 690 km northwards from the Alberta-NWT border and ends at Wrigley. All the river crossings use ice-bridges in winter and ferries in summer. The all-weather Highway 1 leads to a winter road system north of Wrigley. The winter road extends north from Wrigley along the Mackenzie River Valley to Tulita, Norman Wells and Fort Good Hope, for a total distance of 482 km. The winter road system is reconstructed annually (GeoNorth Limited and Golder Associates, 1999).

Currently, the communities of Tulita, Deline, Norman Wells and Fort Good Hope can only be reached by road during the winter, and the only all-weather road to Tsiigehtchic and Inuvik is the Dempster Highway via Yukon.

#### *3.1.2.2 The Mackenzie Valley Highway Extension (MVH)*

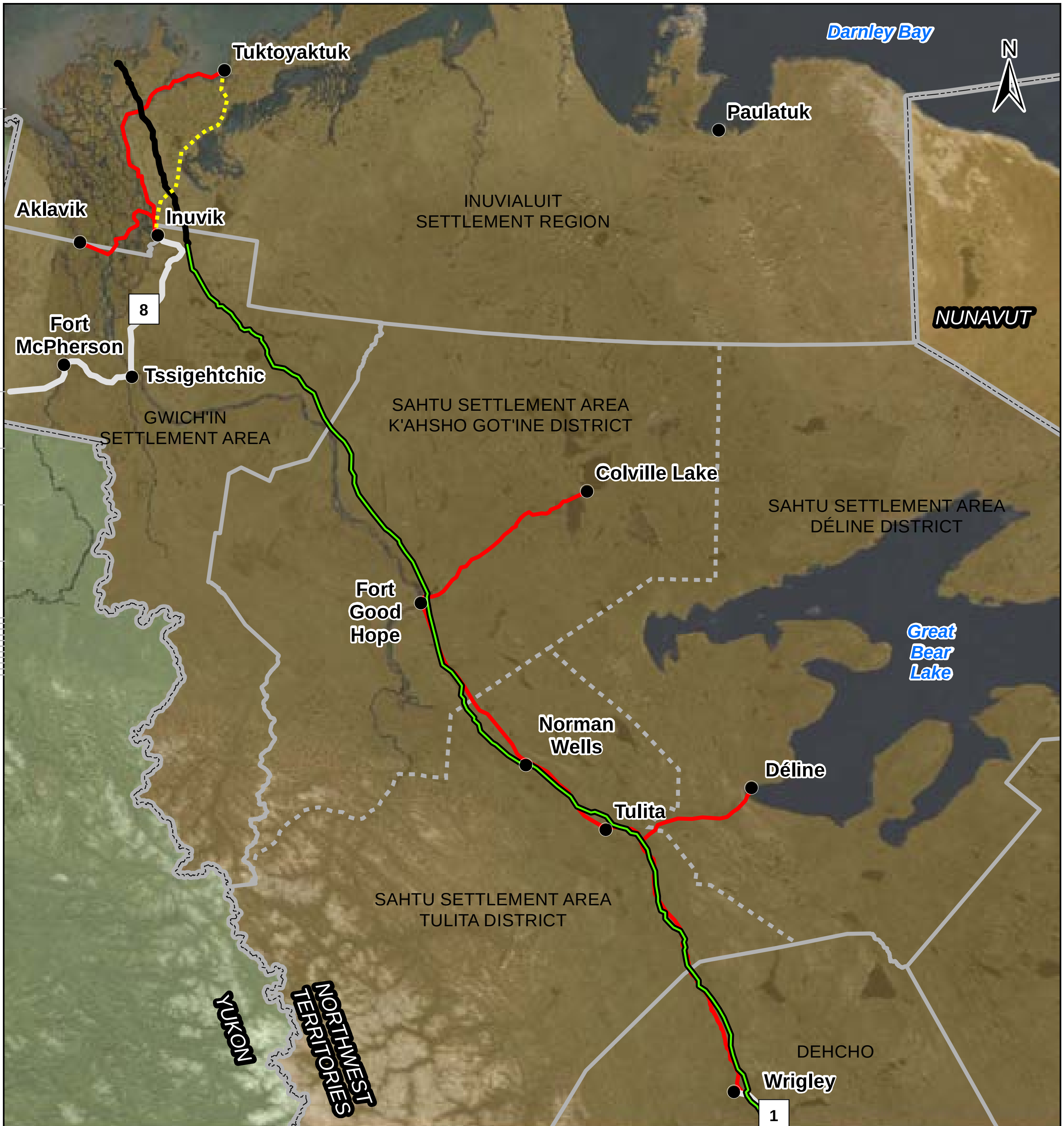
The total length of the MVH Extension is 965 km of which 820 km correspond to the section from Wrigley to the junction with the Dempster Highway near Inuvik, and the last 145 km from the Inuvik to Tuktoyaktuk (DOT, 2009).

The GNWT is committed to the design, development, construction, and maintenance of a highway extending NWT Highway 1 (the Mackenzie Valley Highway) from Wrigley to the Dempster Highway, and extending NWT Highway 8 (the Dempster Highway) from Inuvik to Tuktoyaktuk. This project is usually referred to as the Mackenzie Valley All-Weather Road (AWR) to Tuktoyaktuk, or simply the Mackenzie Valley Highway (MVH). Henceforth in this document, the highway that runs along the Mackenzie River valley is referred to as the Mackenzie Valley Highway (MVH). The section of the Mackenzie Highway in the Pehdzeh Ki Ndeh – Dehcho Region is referred to as the MVH Dehcho Region (MVHDR), (DOT, 2011). See Figure 1 – Overview Map.

In 1999, the GNWT-DOT conducted four studies to verify if, from a range of perspectives, it made sense to link the communities along the Mackenzie Valley with an all-weather road. These studies included an Environmental Scoping Study, an Engineering Update Study, a Cost Benefit and Economic Impact Analysis, and a Financing Study.

In 2000, an environmental information update for selected stream crossings along the Mackenzie valley winter road was carried out for the GNWT by GeoNorth and Golder Associates (2000). This study was undertaken during the summer of 1999 to provide information at 16 stream crossings and 13 drainage crossings along the winter road. Since then, bridges and culverts were constructed along the winter road over selected watercourses.

The GNWT has already constructed 34 of the required 40 bridges along the Mackenzie Valley Winter Road which will form part of the all-weather MVH route (DOT, 2011).




- Community
- Winter Road
- Mackenzie Highway Concept
- Gravel Highway
- Proposed Inuvik to Tuktoyaktuk Highway (2009)
- Gas Pipeline
- District Boundary
- Settlement Boundary
- Territorial Boundary
- 1 Highway Number


*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Mackenzie Gas Project, 2007*
*- Northwest Territories, Centre for Geomatics*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Figure 1**
**Overview**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C101-00 |
| Drawn : | G. Lemay | Scale : | 1:4 000 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 100 km

Projection UTM zone 10N, WGS84

DESSAU

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## 3.2 THE MACKENZIE VALLEY HIGHWAY EXTENSION IN THE PEHDZEH KI NDEH - DEHCHO REGION

### 3.2.1 Location

The optimized alignment for the MVH Pehdzeh Ki Ndeh - Dehcho Region is presented in further detail in Section 3.6 and illustrated in Appendix 1. The 100 km long alignment is located close to and east of the Mackenzie River, starting south of Hodgson Creek Bridge (near Wrigley) and ending at the southern limit of the Sahtu Settlement Area, 11 km north of the Blackwater River.

The approximate latitude and longitude coordinates of the southern and northern limits of the MVH in the Pehdzeh Ki Ndeh - Dehcho Region extremities are:

- South of Hodgson Creek Bridge: 123° 28' 44" W and 63° 13' 58" N;
- North of Blackwater River at the boundary between the Pehdzeh Ki Ndeh - Dehcho Region and the Sahtu Settlement Area, Tulita District: 124° 16' 27" W and 64° 01' 08" N.

### 3.2.2 General Surroundings

The proposed route for the MVH in the Pehdzeh Ki Ndeh – Dehcho Region is based essentially on the alignment of the existing winter road. With the exception of certain strategic improvements, most of the optimized alignment follows the existing winter road. As illustrated in the following photos, the area surrounding the existing winter road is already disturbed to some extent. In all certainty, impacts on the environment, wildlife and vegetation are already being experienced in areas surrounding the existing winter road.

Photo 1: Existing winter road alignment near Bob's Canyon Creek (summer view-July 2011)

Photo 2: Existing winter road alignment at the Hodgson Creek Bridge (winter view-January 2012)

The alignment is entirely located within the physiographical region known as the Mackenzie Plain at the boundary of the Franklin Mountains, which is characterized by flat to gently undulating relief. Typical features include thick morainal deposits and glacio-fluvial features from retreating glaciers of the last glaciations. Sensitive physical components present in the area include permafrost, muskeg, massive ground ice, retrogressive thaw flow landslides, thermokarst, and thermal erosion.

This region is also characterized by a diverse and productive vegetation cover that is mainly composed of coniferous species with some deciduous species of the South Taiga Plains Ecological Zone. The ecosystem supports a large variety of animal species such as various large mammals (moose, woodland caribou, grizzly bear, etc.), more than 110 breeding bird species and potentially some amphibian species.

Aquatic habitats are diversified including the Mackenzie River and an array of smaller rivers, creeks and streams. Various lakes, ponds and wetlands are also present within close proximity of the proposed alignment. These waterways and bodies are the habitat of more than 30 species of fishes.

Though Wrigley is not included the MVH in the Pehdzeh Ki Ndeh - Dehcho Region alignment, it has been included in the assessment of the human environment because of its importance and the way this section will affect Wrigley. Apart from Wrigley, this section of the proposed alignment does not include permanent human settlements. Nonetheless, there are various areas of traditional use such as burial and sacred grounds, moose hunting areas including isolated cabins, fishing activities and a significant number of known archaeological sites. There is also a concentration of these human features reported and recorded at and north of the Blackwater River to the border between the Dehcho Region and the Sahtu Settlement Area. It is important to note that the entire planned alignment is included in the proposed Pehdzeh Ki Ndeh Area conservation zone, which is intended to protect the local PKFN’s subsistence harvesting needs.

### 3.2.3 Watercourse Crossings

As presented in the following table, there are eight significant watercourse crossings along the alignment, five of which already have bridges namely Hodgson Creek bridge (KM 691.4), Ochre River bridge (KM 722.4), Whitesand Creek bridge (KM 731.0), Dam Creek bridge (KM 764.4) and Blackwater River bridge (KM 784.1). The two others crossings, Strawberry Creek bridge (KM 746.5) and Bob's Canyon Creek bridge (KM 753.5), require the construction of bridges by the GNWT. Finally, there is a bridge at Vermillion Creek South (KM 750.1) that must be rehabilitated by the GNWT.

## 3.3 RATIONALE

The Wrigley to Blackwater River segment of the prolongation project of the MVH is the section that connects with the existing segment of the all-weather Highway that presently ends north of Wrigley. This segment will connect with various others that will bring the MVH to the community of Tuktoyaktuk on the shore of the Beauford Sea. This project will have national, regional and local benefits, which are presented hereafter.

### 3.3.1 Connecting the Arctic Coast to Canada

At the national level, connecting the Arctic Coast to the rest of Canada is crucial to the country's socioeconomic future. The completion of the MVH to the Arctic Coast is a cornerstone of the GNWT's plan for present and future economic development in the NWT. However, the benefits of completing the MVH extend much further than the northern regions it would be connecting. The highway is the final step in connecting Canada's three coasts and is critical for the future protection and prosperity of Canadians (DOT, 2009).

The need and rationale for a new all-weather road corridor in the western arctic, that was identified and has been extensively discussed since the beginning of the project in the late 1950's, include:

- Provision of a year round transportation link connecting the Mackenzie Delta and the Mackenzie Valley with the rest of the Northwest Territories and southern Canada;
- Supporting resource exploration, development, and production to stimulate the regional economy;
- Decreasing the cost of living for residents by increasing access to governmental and private goods and services;
- Increasing access to health care, educational resources and employment opportunities;
- Enabling opportunities for communities and families to interact and share social and cultural connections and participate in recreational and sporting activities;
- Creating business opportunities in fields such as tourism and hospitality as well as various others;

Table 2: Mackenzie Valley Winter Road Bridges Dehcho Region

| MACKENZIE VALLEY WINTER ROAD BRIDGES DEHCHO REGION[3] | | LENGTH (m) | DECK WIDTH / OPENING (m) | SUPERSTRUCTURE / STRUCTURE | FOUNDATION | YEAR CONSTRUCTED | COMMENTS |
|---|---|---|---|---|---|---|---|
| KM 784.1 | Blackwater River | 297,00 | 6,0 | Four spans, WG-Steel Girders/ Concrete Deck / plus 10m jump spans at each end | Steel pipe piles /Steel pipe piers / Concrete Abutments | 2010 | |
| KM 764.4 | Dam Creek | 18,30 | 4,0 | Painted Steel Girders / Timber Deck | Binwall Abutments -Three Steel H-Piles | 1996 | Pile foundation suitable for winter use, only. |
| *KM 753.5* | *Bob's Canyon Creek* | *50,48* | *6.0x2.985* | *Arch Culvert* | *Open bottom* | | *Construction Winter 2012* |
| KM 750.1 | Vermillion Creek South | 115,90 | 4,0 | WG-Steel Girders / Concrete Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 | Date of rehabilitation or -construction unknown |
| *KM 746.5* | *Strawberry Creek* | *44.480*<br>*22.880* | *14.0x7.076*<br>*6.0x2.985* | *2 - Arch Culverts* | *Open bottom* | | *Construction Winter / Spring 2012* |
| KM 731.0 | Whitesand | 88,50 | 4,0 | WG-Steel Girders / Concrete Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 | |
| KM 722.4 | Ochre River | 102,30 | 4,0 | WG-Steel Girders / Timber Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 | |
| KM 691.4 | Hodgson Creek | 24,40 | 4,3 | WG-Steel Girders / Timber Deck | Binwall abutments / Timber Bearing Pads | 1988 | Replacement with new bridge on optimized alignment is recommended. |

Source: DOT, 2011

[3] The kilometre markings identified in this table are those provided by the DOT on their MVH website (2011)

- Delivering government's commitment to economic development in the Northwest Territories;
- Improving the efficiency (through cost reduction and better access to supplies and help) of the existing facilities that provide emergency response in case of contaminant spillage and that act in pollution prevention;
- Providing an effective demonstration of Canada's sovereignty on its share of the northern hemisphere, sea and lands;
- More recently, the provision of fibre optic cable from southern Canada to the Arctic Ocean to enhance communications and support future development.

The completion of the Project Description Reports (PDR) for the various sections of the proposed MVH extension north of Wrigley is an essential step leading to the construction of this highway. The completion of the PDRs will assist in the engagement of the federal government to invest in this road and allow an environmental assessment of the highway to begin. The GNWT is working to complete these PDRs in partnership with Land Claims and Aboriginal groups in the Mackenzie Valley.

### 3.3.2 Completing the Mackenzie Valley Highway in the Dehcho Region

This proposed section of the highway is currently serviced by a winter road. As presented in the previous section, an all-weather road will offer substantial benefits locally and regionally as well as nationally. Communities of the Mackenzie Valley have previously voiced their interest in and support for the extension of the resource and tourism industry that could be generated but not without raising some concerns over social and environmental impacts.

The cost of living and doing business will be lowered as safer and easier access to regional services will be increased. Other benefits of completing the all-weather road program will be felt in business opportunities, tourism, pollution prevention and spill response in oil and gas exploration and development.

The MVH project will provide potential benefits to the Dehcho Region communities by:

- Increasing mobility;
- Connecting Wrigley to the six communities of Tulita, Norman Wells, Fort Good Hope, Tsiigehtchic, Inuvik and Tuktoyaktuk
- Lowering the general living costs;
- Improving the quality of life and standard of living;
- Promoting economic diversification;
- Promoting self-reliance by expanding development in renewable and non-renewable resources;
- Promoting employment, training, education and business.

At a local scale, the construction of the specific section in the Pehdzeh Ki Ndeh - Dehcho Region, between Wrigley and the north boundary of the Dehcho Region will:

- Increase the social and economical development of Wrigley as it may become a required stop between the Mackenzie River ferry and the communities to the north;
- Facilitate access, for the local population, to their traditional hunting and fishing areas;
- Facilitate the maintenance of the various hunting cabins present along the existing winter road;
- Allow the development of lodges that could accommodate tourists wishing to discover the pristine local environment for trekking, hunting, fishing and cultural activities;
- Improve security for people exploiting the local territory through easier and faster access to medical facilities in case of accident;
- Accelerate response time in the case of an accidental spill or a leak from the existing pipeline.

The extension of the MVH in the Pehdzeh Ki Ndeh – Dehcho region is yet another step towards linking the southern and eastern populations of Canada to the Arctic Region.

## 3.4 DESIGN PARAMETERS FOR THE ALL-WEATHER HIGHWAY

The design parameters considered in the preliminary design of the MVH are based on the Geometric Design Guidelines published by the Transportation Association of Canada (TAC). Based on the guide’s design classification system, the MVH is considered as a RAU 90. This classification represents an arterial, undivided road in a rural setting with a design speed of 90 km/h. Based on these parameters; the posted speed limit for the MVH will be 80 km/h.

The considered design parameters will allow for year-round use by haul trucks and passenger vehicles according to the size and weight limitations outlined in the Northwest Territories Highway regulations. The following design parameters will be summarily defined in this PDR based on the previously mentioned design classification, RAU 90:

### Design Embankment

Ground information and geotechnical data has been analysed to define the terrain type, which is related to a specific thickness of embankment limitation. This will guide the designer in the design of the preliminary geometry.

### Geometric Design

Geometric design parameters will be developed based on appropriate guidelines for public highways in the Northwest Territories. No optimization for the profile will be analyzed in this PDR; this matter will be addressed during a later stage of the design process.

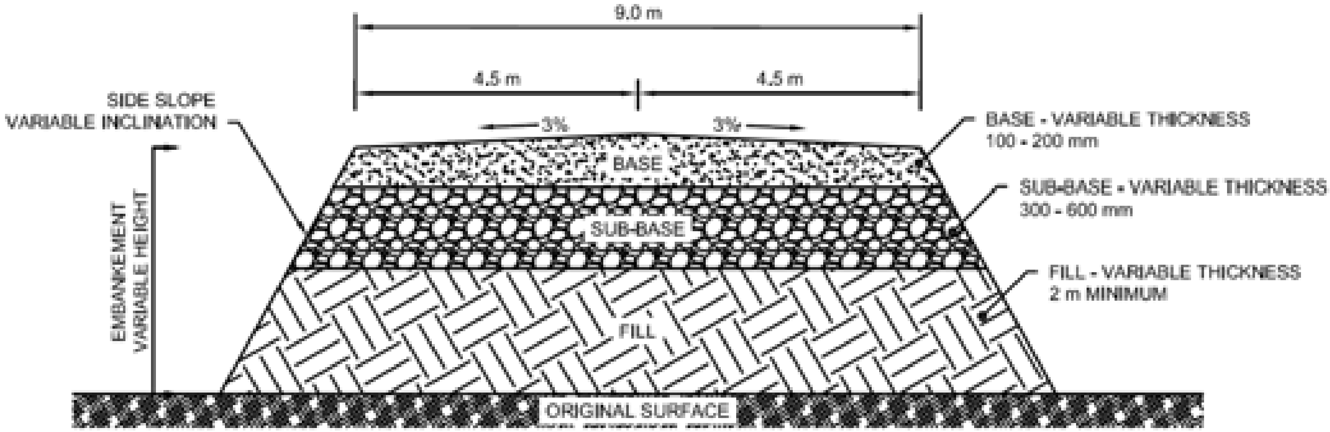
### 3.4.1 Design Embankment

The Highway operations will require a two lane gravel roadway 9 m wide with variable side slopes. Culverts will be used where appropriate and economical. In southern areas of the Northwest Territories it is common for road designs to incorporate both ‘cuts and fills’ to level terrain along the road alignment. However, in permafrost areas, cutting into the surface vegetation can disturb the permafrost regime, resulting in thaw and unstable ground. It is, therefore, not recommended. As such, the design includes only fills with embankment heights based on terrain type. This will be sufficient to protect the permafrost layer below the road surface. The following table presents the embankment design parameters:

Table 3: Embankment Design Parameters

| Typical material embankment thickness | |
|---|---|
| Base | Varying between 100 and 200 mm |
| Sub-base | Varying between 300 and 600 mm |
| Embankment (fill) | Variable |
| **Embankment height** | |
| Discontinuous permafrost – Ice rich permafrost with high sensitivity | Minimum fill thickness of 2 m |
| Discontinuous permafrost – Thaw stable with a medium sensitivity | Governed by conventional pavement structure considerations |
| **Side slopes** | |
| Discontinuous permafrost – Ice rich permafrost with high sensitivity | 4H : 1V or flatter |
| Discontinuous permafrost – Thaw stable with a medium sensitivity | 2H : 1V or flatter |
| **Cross section** | |
| Desired finish top (shoulder rounding to shoulder rounding | 9 m |
| Minimum finish top (shoulder rounding to shoulder rounding | 8,5 m |
| Lane cross fall | 3% |
| Superelevation | 6% |

The following figure presents the typical highway cross section and variable embankment heights and side slopes.




| APPLICATION | TYPICAL THICKNESS |
|---|---|
| Surfacing Materials | Not applicable in this project |
| Base | Varying between 100 mm and 200 mm |
| Sub-base | Varying between 300 mm and 600 mm |
| Embankment (Fill) | Variable |

| TERRAIN TYPE | DESCRIPTION | EMBANKMENT HEIGHTS | EMBANKMENT SIDE SLOPES |
|---|---|---|---|
| 1 | Discontinuous permafrost<br>Ice rich permafrost with a high sensitivity | Minimum fill thickness of two (2) meters | 4H : 1V or flatter |
| 2 | Discontinuous permafrost<br>Thaw stable with a medium sensitivity | Governed by conventional pavement structure considerations | 2H : 1V or flatter |

*Source :*
*TAC – Transportation Association of Canada*
*Guidelines for development and management of transportation infrastructure in permafrost regions, May 2012*
*Robyn McGregor, Don Hayley, Graham Wilkins, Ed Hoeve, Ed Grozic, Vlad Roujanski, Alden Jansen, Guy Doré.*
*Figure 4.1 page 54*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 2**
**Typical Highway Cross Section**

| | | | |
|---|---|---|---|
| Prepared : | J. Brochu | No : | 068-P0037500-202-001-GO-C112-00 |
| Drawn : | G. Lemay | Scale : | N/A |
| Checked : | D. Aubin | Date : | February 16, 2012 |

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C112-00_CrossSection_20120216.mxd

### 3.4.2 Geometric Design

Taking into account the operational needs for the highway, minimum geometric design parameters have been developed based on the Geometric Design Guidelines published by the Transportation Association of Canada (TAC). The geometric design parameters are presented in the following table:

Table 4: Geometric Design Parameters

| Design parameters | |
|---|---|
| Design speed | 90 km/h |
| Design classification | RAU90 (Rural, Arterial, Undivided) |
| **Horizontal alignment** | |
| Minimum curve radius | 340 m |
| Minimum stopping sight distance | 170 m |
| Minimum decision sight distance (DSD) | 280 m |
| Minimum length of curve | 90 m |
| **Vertical alignment** | |
| Minimum Stopping sight distance (SSD) | 170 m |
| Minimum Sag K Value (to assure SSD) | 40 |
| Minimum Crest K Value (to assure SSD) | 53 |
| Minimum Passing sight distance (PSD) | 605 m |

### 3.4.3 Drainage Structure Design

The alignment will cross many minor diffuse drainage paths and many are likely ephemeral most of the year and potential fish-bearing streams. Based on the hydrology and hydraulic analysis, specific requirements will be defined at a later stage of the design process for the drainage structures such as culverts, simple prefabricated bridges or other drainage structures.

Some bridges have already been constructed for the future all-weather road. Others are in progress and will be constructed during the next year. These bridges are not included in our mandate but their position will be used as an important input to prepare the optimized alignment.

## 3.5 WINTER ROAD

Based on information provided by the PKFN during community consultation activities; the existence of a 20 year old winter road alignment allows only seasonal travel north of Wrigley. The following sections will describe the winter road's geometry and sensitive components.

### 3.5.1 General Description

The alignment of the existing winter road is shown on Figure 3 entitled Winter Road Base Alignment. The segment of the winter road analysed in this PDR begins north of Wrigley, at km marker (KM) 692, and ends at the boundary between the Sahtu Settlement Area and the Dehcho region, at KM 794. The total length of the winter road is 102 km. The winter road is shown at a larger scale in Appendix 1, on Sheets 1-T through 19-T and 1-P through 19-P.

### 3.5.2 Geometry

The geometry of the existing winter road was modeled and analyzed using 3D road design software, more specifically Bentley’s InRoads Suite V8i. Given the limited input data available, only the horizontal alignment was analysed. An inventory of the winter road’s circular curve parameters was generated by the software. A table summarizing the curves with a radius less than or equal to 1 500 m is presented in Appendix 2. The winter road currently has a curve with a radius as small as 36 m at km marker 785+191. In total, there are more that 70 curves with radii smaller than 340 m, the minimum radius for a circular curve established in the previous sections of this PDR.

### 3.5.3 Sensitive Components

Based on the information collected from the PKFN through several community consultation activities, sensitive components have been identified along the existing winter road. Furthermore, the PKFN have provided information regarding numerous trails they use when practicing their traditional activities. Additional analysis concerning the precise location of these trails is required in order to respect the travel routes used by the PKFN people. The community involvement activities are discussed in greater detail in a subsequent section of this PDR entitled Community Involvement.

The following sections will describe the various aspects and components identified as sensitive environmental constraints and refer to maps in Appendix 1, Sheets 1-T through 19-T and 1-P through 19-P. In addition to the components discussed in the following sections, it is important to include the presence of ice-rich permafrost with medium to high sensitivity among the sensitive components of the MVH project. At this stage of the project, the geotechnical investigations have not yet been carried out and for this reason are not discussed further within this section.

#### *3.5.3.1 Hydrology – Presence of Water and Wetlands*

The winter road’s alignment passes close to several bodies of water between km markers 698 and 702. The largest of these is a lake on the west side of the winter road axis (see Sheets 2-T / 2-P). A minimum distance of 30 m between the road and all bodies of water is recommended. Furthermore, the alignment of the winter road passes very close to the banks of the Mackenzie River between km markers 751 and 752 (see Sheets 12-T / 12-P). The realignment of this segment has been suggested by PKFN community.


10cm 5 4 3 2 1 0

- Winter Road - KM Marker
- PKFN Main Traditional Activity Site
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails

Sources :
- © Bing Maps, 2006-2009
- CanVec, Canada Government.
- NTDB, 1 : 250 000, Canada Government
- Northwest Territories, Centre for Geomatics
- © Deh Cho First Nations, 2004
- PKFN, 2011
- Dessau, 2011.

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 3**
**Winter Road Base Alignment**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C102-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\ENV\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C102-00_BaseAlignment_20120227.mxd

Wetlands have been identified close to the winter road at two locations. The first location is located between km markers 766 and 767 (see Sheet 15-T/15-P) and the second is between km markers 789 and 790 (see Sheets 20-T/20-P). It is recommended to avoid wetlands. Also, an important stream cuts the current winter road alignment between km markers 772 and 773. The use of drainage structures, such as culverts or bridges is required (see Sheets 16-T/16-P).

#### 3.5.3.2 *Wildlife – Presence of Moose and Moose Pasture Areas*

The winter road passes through a moose pasture area that may be a potential travel route for moose and wild animals such as caribou, wolves. This area is located in a valley between two elevated land sections near km markers 708 and 709. It is recommended to avoid this area or to develop appropriate mitigation measures. (See Sheets 4-T / 4-P). There is another potential travel route for ungulates and other wild animals (caribou, wolves, etc) between km markers 788 and 789 (See Sheets 19-T / 19-P). Various ungulates observations were registered in the Mackenzie Gas Project EIS, Volume 3, Biophysical Baseline (MPEG, 2004).

#### 3.5.3.3 *Social and Traditional Activities – Presence of Burial, Spiritual, Cultural and Hunting Areas*

The winter road currently passes through several areas used by the PKFN community for social and traditional activities; these areas include burial, spiritual, cultural and hunting sites. Many of these sites are spread over large areas of land, especially the hunting areas where existing hunting cabins and traplines are located. The winter road passes through a hunting area with existing cabins and traplines located on the Mackenzie Riverbank, near the Whitesand River Bridge (see Sheets 8-T / 8-P). Another hunting area with existing cabins and traplines is located near the Dam Creek Bridge (see Sheets 14-T / 14-P). The winter road also passes through a traditional hunting area that has been used by the PKFN community for over 100 years. This area is located between km markers 749 and 755 (see Sheet 12-T). Another hunting area with existing cabins and traplines is located between km markers 772 and 774 (see Sheets 16-T / 16-P). The presence of an important traditional hunting ground covering a large area has been noted between km markers 785 and 789 (see Sheets 18-T / 18-P). This vast area includes the curved section of the Mackenzie River north of the Blackwater River Bridge and Eentsaytoo Lake located northeast of the winter road alignment.

The winter road passes near a burial site located between km markers 783 and 785, on the northern shore of the Blackwater River. Within this area, near km marker 784, there are hunting cabins and traplines. (See Sheets 18-T / 18-P). Furthermore, north of this area, near km marker 786, it is possible that the winter road passes near or on potential archaeological sites. As requested by the PKFN community, these sites are not shown on the maps in Appendix 1. However, further investigations must be conducted to confirm the presence and location of the archaeological sites. The realignment of segments passing through sensitive areas has been suggested by PKFN community.

During the last round of public consultation held in January 2012, PKFN members mentioned that the previously identified traditional sites only represent the main ones. Additional information concerning other traditional activities and sites was provided during the consultation and appears in Appendix 9. This information must be analyzed prior to the subsequent design phases of the MVH extension.

## 3.6 OPTIMIZED ALIGNMENT

The future all-weather road will follow an optimized alignment based on the horizontal alignment of the existing winter road. The vertical profile of the existing winter road and alternatives haven't been studied and analysed. With the exception of the areas of sensitive permafrost, the optimized alignment has taken into account the many sensitive components in the region as well as other key factors such as road safety and the location of several existing and future bridges. Preliminary quantity and cost estimates have been developed based on the conceptual design and the hypotheses described in Section 3.6.6. In a later phase of the project, the optimized alignment will be validated according to the overall project cost and potential environmental constraints. Related project components such as available borrow sources, soil conditions, geotechnical caracteristics and construction methods will be addressed to confirm the optimized alignment of the future all-weather road. At this stage of the project, the geotechnical investigations have not yet been carried out and for this reason have not been considered in the design of the optimized alignment. Once the results of the geotechnical studies will be known, the optimized alignment may require modifications to avoid areas of sensitive permafrost. In the case that the areas of sensitive permafrost cannot be avoided, several mitigation techniques can be used to protect the permafrost from thawing.The optimized alignment is shown in Appendix 1, on Sheets 1-T through 19-T and 1-P through 19-P.

### 3.6.1 Design Considerations

The optimized alignment is essentially an improvement of the existing winter road horizontal alignment based on design considerations established in conjunction with the PKFN community during the first round of public consultation held in July 2011 The PKFN community was presented with a map of the MVH extension Project within Pehdzeh Ki Ndeh - Dehcho region and indicated several realignment proposals (see Appendix 4). The following figure entitled Winter Road and Optimized Alignment presents both alignments; the winter road alignment is shown in red and the optimized alignment is shown in orange. In general, the alignments are very similar; however, there are some important modifications. The segments where the existing alignment and optimized alignment diverge correspond to the areas that required realignment due to the presence of various constraints.

The constraints that have been considered in the design of the optimized alignment included: avoiding bodies of water, reducing potential negative effects of the MVH on the sensitive components, passing over existing bridges and improving the general safety of the road by respecting the design parameters established previously in this DPR.

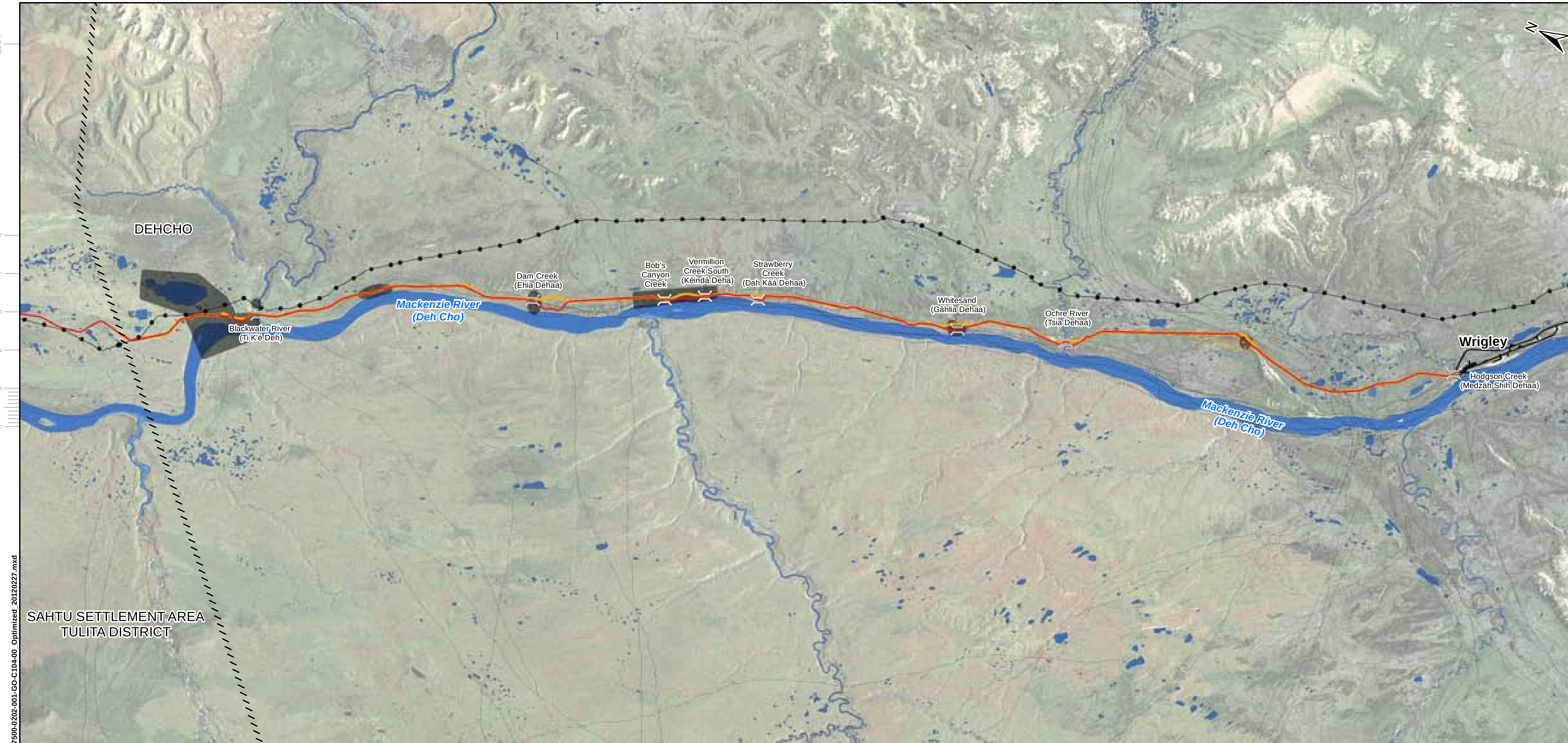
It is important to mention that during the last public consultation held in January 2012, the PKFN community, including the recently elected Band Council members suggested additional realignment proposals. One of the suggestions was to relocate the MVH alignment 5 km in-land, thus distancing it from the Mackenzie River, where many traditional activities are practiced. The other suggestions attempt to distance the alignment from the Mackenzie River, though remaining as close as possible to the optimized alignment corridor. At this stage of the design process, these suggestions have not been considered, however it is highly recommended to take them into account during the later stages. These realignment proposals are presented in Appendix 8.

### 3.6.2 Alternative Alignments Considered

Alternative alignments have been considered for the design of the optimized alignment south of the Ochre River Bridge between km markers 707 and 713. The existing winter road passes within a moose pasture area located between two elevated land sections. Furthermore, a potential travel route for moose and wild animals may be present in this area. As shown on Sheets 4-T and 4-P in Appendix 1, there are three possible alignments for this sector. The first alternative passes east of the moose pasture area and the two elevated land sections. The second alternative follows an existing path; however, it passes through the moose pasture area. The third alternative passes west of the moose pasture area and in between the two elevated land sections. It is important to mention that the PKFN community prefers the third alternative. Further analysis of the natural terrain’s topography and the environmental constraints must be carried out in order to accurately determine which of these three alternatives would be the best option.

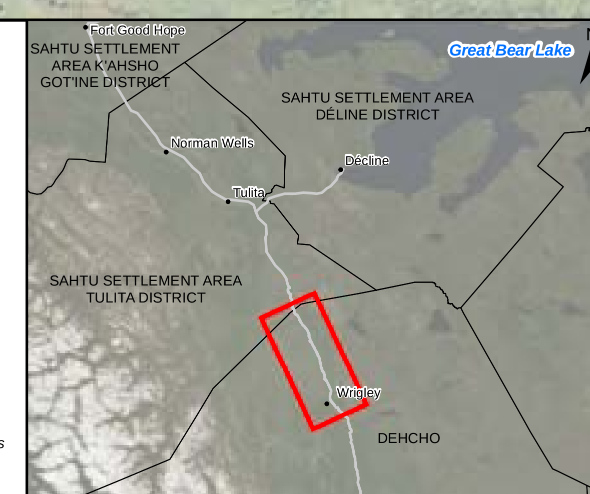
### 3.6.3 Geometry

The geometry of the optimized alignment was modeled and analyzed using 3D road design software, more specifically Bentley’s InRoads Suite V8i. Given the limited input data available, only the horizontal alignment was analysed. An inventory of the optimized alignment’s circular curve parameters was generated by the software. A table summarizing the curves with a radius less than or equal to 1 500 m is presented in Appendix 3. There is only one curve that does not respect the minimum radius of 340 m. This curve is located at the very beginning of the alignment at km marker 692, between the starting point of the new alignment and the Hodgson Creek Bridge. The optimized alignment is an improvement over the winter road’s alignment; however, the maximum radius given the configuration of the bridge is 150 m.




- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- PKFN Main Traditional Activity Site

Sources :
- © Bing Maps, 2006-2009
- CanVec, Canada Government
- Northwest Territories, Centre for Geomatics
- PKFN, 2011
- © Deh Cho First Nations, 2004
- Dessau, 2011.




Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Figure 4**
**Winter Road and Optimized Alignment**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C104-00 |
| Drawn : | G. Lemay | Scale : | 1:275 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 11" x 17"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C104-00_Optimized_20120227.mxd

### 3.6.4 Detailed Description

#### *3.6.4.1 Hodgson Creek Bridge Approach*

The optimized alignment is shown in Appendix 1, on Sheets 1-T through 19-T and 1-P through 19-P.The optimized alignment begins approximately 500 m north of the municipality of Wrigley at km marker 692 with a relatively pronounced curve. In order to improve roadway safety, the radius of the curve has been increased substantially in comparison to the existing curve at the approach of the Hodgson Creek Bridge. Nonetheless, the maximum radius given the configuration does not respect the minimum radius established for the geometric design parameters. However, given the nearby junction with another road exiting Wrigley, it is safe to believe that travel speeds will be relatively low at this location.

#### *3.6.4.2 Hodgson Creek Bridge to Ochre River Bridge*

After the curve, the optimized alignment immediately crosses Hodgson Creek about 700 m upstream from the Mackenzie River. The alignment then moves further away from the Mackenzie River (some 2 to 4 km from its east shore) avoiding several bodies of water between km markers 698 and 702. The largest of these is a lake on the west side of the optimized axis. The optimized alignment has been designed to pass at least 50 m away from all bodies of water.

The optimized alignment then continues north avoiding Mount Gaudet, a small mountain ridge approximately 580 m high. The optimized alignment then approaches a moose pasture area that may be a potential travel route for moose and wild animals such as caribou and wolves. This area is located in a valley between two elevated land sections near km markers 708 and 709. As discussed previously, three alternative alignments are suggested at for this sector. It is important to mention that the PKFN community prefers the third alternative passing west of the moose pasture area. A study should be undertaken in this area to evaluate and validate land use by wildlife. Based on these results, an analysis of the natural terrain's topography and the environmental constraints will determine which alternative is the most appropriate.

#### *3.6.4.3 Ochre River Bridge to Whitesand River Bridge*

The optimized alignment then turns towards the Northwest to gradually return closer to the Mackenzie River as it crosses the Ochre River approximately 500 m upstream from the Mackenzie River. The Ochre River crossing is characterized by relatively steep slopes. The optimized alignment avoids the sharp curves of the winter road alignment and passes in a more rectilinear trajectory. It is important to mention that the realignment of this segment was suggested by the PKFN community. Furthermore, soil erosion is an element of concern in this sector and must be addressed in the design and construction stages. After crossing the Ochre River, the alignment rises to an elevation of 140 m where it remains for 5 km until descending to cross the Whitesand River Bridge where the optimized alignment deviates from the alignment of the winter road to avoid a hunting area where hunting cabins and traplines are located on the Mackenzie riverbank. It is strongly recommended to re-evaluate the location of this the proposed Whitesand River Bridge. The realignment of this segment was suggested by PKFN community.

#### *3.6.4.4 Whitesand River Bridge to Strawberry Creek Bridge*

After crossing the Whitesand River Bridge the alignment continues north almost 12 km, the optimized alignment follows the bottom of a ridge running parallel to the Mackenzie River, while crossing seven smaller unnamed streams. It is important to mention that culverts or other drainage structure must be designed in the later stages of the project. At Strawberry Creek, km marker 745, the optimized alignment avoids the sharp curves of the winter road alignment and crosses Strawberry Creek in a rectilinear trajectory. The new alignment does not pass on the future bridge, but rather 400 m east of the future bridge. It is strongly recommended to re-evaluate the location of this the proposed bridge at Strawberry Creek. It is important to mention that the realignment of this segment was suggested by the PKFN community.

#### *3.6.4.5 Strawberry Creek Bridge to Vermillion Creek South Bridge*

After crossing Strawberry Creek, the optimized alignment continues north and crosses Vermillion Creek South, near km marker 749. There is a moose pasture area close to the optimized alignment; however the alignment avoids the area entirely.

#### *3.6.4.6 Vermillion Creek South Bridge to Bob’s Canyon Creek Bridge*

Between the Vermillion Creek and Bob’s Canyon Creek the existing winter road alignment passes within 50 m of the Mackenzie River. The optimized alignment deviates from the existing alignment to pass several hundred meters from the Mackenzie Riverbank. It would be beneficial to accurately evaluate the potential for seasonal flooding. The presence of an important traditional hunting ground used by the PKFN community for over 100 years is located between Vermillion Creek South and Bob’s Canyon Creek. This area is of significant importance for the PKFN community. However, given the vast area covered by the hunting ground, it is impossible to avoid it completely. For this reason, a study should be undertaken in this area to evaluate and validate traditional activities and wildlife presence. The optimized alignment will be finalized according to results of the study at a later stage of the design process.

#### *3.6.4.7 Bob’s Canyon Creek Bridge to Dam Creek Bridge*

After crossing the Bob’s Canyon Creek Bridge, the optimized alignment follows the winter road alignment until km marker 758, where it deviates towards the East to pass along the summit small mountain ridge. The optimized alignment then descends to cross the existing Dam Creek Bridge. Unfortunately, given the location of the existing bridge and the presence of a mountain ridge, the optimized alignment passes through a hunting area with existing cabins and traplines located near the Dam Creek Bridge. However, the optimized alignment cuts across the hunting area in a less important manner than the winter road alignment. Nonetheless, compensation for or relocation of some cabins may be necessary. The realignment of this segment was suggested by the PKFN community.

#### *3.6.4.8 Dam Creek Bridge to Blackwater River Bridge*

After crossing Dam Creek Bridge, the optimized alignment follows the winter road alignment until km marker 765, where it deviates to avoid wetlands located between km markers 766 and 767. The optimized alignment crosses several small unnamed streams north the Dam Creek, as well as an important stream between km markers 772 and 773. The use of appropriate drainage structures, such as culverts or bridges is required. The optimized alignment crosses a hunting area with existing cabins and traplines between km markers 772 and 774. Compensation for or relocation of some cabins may be necessary.

#### *3.6.4.9 Blackwater River Bridge to Sahtu Settlement Area Boundary*

The optimized alignment then continues north, following the winter road alignment and crossing the Blackwater River Bridge. The area immediately north of Blackwater River has been extensively used for various traditional uses, including burial grounds, and is part of an area known as the Sahtu Private Lands, which extend north from the river to the border between the Dehcho Region and the Sahtu Settlement Area. The optimized alignment avoids the hunting area but passes near a burial ground. Investigations to determine the exact location of the burial ground as well as the traditional and culture activity areas will be very useful in determining the optimized alignment. Public consultations and workshops with the PKFN community may be beneficial. The large flat area north of the Blackwater River is strewn with wetlands of various sizes; two of which are crossed by the optimized alignment between km markers 784 and 790. Construction methods taking into account presence of wetland must be specified during the next phases of the design process. The optimized alignment passes halfway between the Mackenzie River and the Eentsaytoo Lake near km marker 786. Finally, approximately one kilometre before reaching the northern border of the Dehcho Region, the alignment crosses the Mackenzie Valley Pipeline.

### 3.6.5 Terrain Conditions

Terrain conditions along the optimized alignment are described hereafter and include drainage structures and topographic characteristics.

#### *3.6.5.1 Drainage Structures*

In the 12 km north of the Whitesand River Bridge, the optimized alignment crosses seven small unnamed streams. Each of these steams will require the use of culverts. After crossing Dam Creek Bridge, the optimized alignment follows the winter road alignment until km marker 765, where it deviates to avoid wetlands located between km markers 766 and 767. The optimized alignment crosses several small unnamed streams north of Dam Creek, as well as an important stream between km markers 772 and 773. The use of appropriate drainage structures, such as culverts or bridges is required. The optimized alignment passes halfway between the Mackenzie River and the Eentsaytoo Lake near km marker 786.The large flat area north of the Blackwater River is strewn with wetlands of various sizes; two of which are crossed by the optimized alignment between km markers 784 and 790. Construction methods taking into account the presence of wetlands must be specified during the subsequent phases of the design process. Also, it is important to mention that culverts and other drainage structures will be designed in the later stages of the project.

#### *3.6.5.2 Topography*

The optimized alignment avoids Mount Gaudet, a small mountain ridge approximately 580 m high located between km markers 703 and 708. As discussed previously, three alternative alignments are suggested at for the sector south of the Ochre River Bridge between km markers 707 and 713. An analysis of the natural terrain's topography among other aspects will determine which alternative is the most appropriate. The Ochre River crossing is characterized by relatively steep slopes. The optimized alignment avoids the sharp curves of the winter road alignment and passes in a more rectilinear trajectory. Furthermore, soil erosion is an element of concern in this sector and must be addressed in the design and construction stages.
After crossing the Ochre River, the alignment rises to an elevation of 140 m, where it remains for 5 km until descending to cross Whitesand River Bridge. After crossing the Bob's Canyon Creek Bridge, the optimized alignment follows the winter road alignment until km marker 758, where it deviates towards the East to pass along the summit small mountain ridge. The optimized alignment then descends to cross the existing Dam Creek Bridge.

### 3.6.6 Quantity and Cost Estimates

Project costs could be influenced by the amount of material required as a result of the selected construction methods on permafrost, the ease of access to the borrow sources and the level of maintenance required throughout the useful life of the all-weather road. Preliminary quantity and cost estimates based on the conceptual design have been developed for the optimized alignment. The following hypotheses have been considered:

- Granular base course thickness: 200 mm;
- Granular sub-base course thickness: 400 mm;
- Embankment average thickness: 1 800 mm;
- Length of optimized alignment: 100 km.

Table 5: Estimated Quantities and Costs

| ELEMENT | ESTIMATED QUANTITIES ($m^3$) | ESTIMATED COST ($) |
|---|---|---|
| Granular base course | 220 000 | 11 000 000 |
| Granular sub-base course | 600 000 | 30 000 000 |
| Embankment | 3.78 million | 170 100 000 |
| Mobilisation (10%) | | 21 100 000 |
| Engineering design cost (4%) | | 9 300 00 |
| Contingency (20%) | | 48 300 000 |
| | Total cost | 289 800 000 |

## 3.7 ROUTE INVESTIGATION

Successful construction on permafrost in cold regions depends essentially on the quality of the geotechnical data gathered at the time of the route investigation. Although a more detailed investigation will incur additional costs to the project, these initial investments will quickly become profitable. In fact, the data collected from preliminary studies will allow to optimize the design and to maximize the life span of the construction while also reducing long-term maintenance costs.

The results of the route investigation should establish the nature and properties of the soils as well as the type and the properties of the permafrost. Furthermore, the route investigation should identify the thaw-sensitive or unstable areas and evaluate the groundwater conditions.

Considering the presence of discontinuous permafrost in the studied region, it is recommended that field work be more exhaustive in this area as oppose to other areas of the MVH. By its very own nature, discontinuous permafrost implies that there are frequent transitions between frozen and unfrozen soil along the proposed road. The approach taken with regards to route investigation in cold regions can be described in two steps. The first being the preliminary reconnaissance of the site and the second being the investigative work of the problematic areas identified during the first step.

The various steps of a route investigation in cold regions are summarized in the following sections.

### 3.7.1 Preliminary Reconnaissance

#### *3.7.1.1 Gathering of the Existing Information*

The first step of a preliminary reconnaissance in cold regions consists of gathering all the available information on the study site such as meteorological data, satellite imagery, aerial photography, geological maps, as well as the results of geotechnical investigations undertaken in and surrounding the study site.

This data will enable the team to predict the climate change in the studied region as well as the modifications which could be caused on the permafrost thermal regime further the construction of the road. This first step will enable to choose alternate routes to avoid, if the case is possible, high-risk areas which can be easily located.

#### *3.7.1.2 Field Reconnaissance and On-site Validation*

An air reconnaissance at low height complemented by on-site validation along the potential road alignments determined during the first step must be undertaken by an expert in geomorphology in order to select the most favourable alignment for the project.

It is important to remember that this part of the route investigation will reduce the costs of the geotechnical investigation by targeting the areas along the proposed alignment that require further investigation.

### 3.7.2 Investigation Work

#### *3.7.2.1 Geophysical Surveys and Manual Sounding*

The problematic areas identified during the preliminary reconnaissance must be studied by means of manual soundings and geophysical surveys. These techniques have the advantage of being quick and relatively less expensive than other investigative techniques. Furthermore, these techniques cause fewer disturbances to the surrounding environment and help ensure the protection of the site’s natural state, which is often very sensitive.

For the MVH project, the more adapted geophysical methods to use during the investigation work would be the electrical and electromagnetic surveys. These two methods are briefly described in the following paragraphs;

##### *3.7.2.1.1 Electrical survey:*

This geophysical method consists in injecting an electrical current through the ground and measuring the capacity of the soil and its components to resist against the flow of this current, that is to say its resistivity. Considering that the soil resistivity is considerably influenced by its frozen or unfrozen state, this technique could be used to map the approximate limits of the permafrost, in both the vertical and horizontal axes.

#### *3.7.2.1.2 Electromagnetic survey:*

The electromagnetic survey devices, such as the GPR (ground penetrating radar), use the electromagnetic wave properties at low and very low frequency to induce electric and magnetic fields in soils which will vary according to the nature and properties of the encountered materials. For example, this method could localize ice-rich soil areas and massive ice formation.

Nevertheless, experience has shown that geophysical study results are limited and require the execution of mechanical soundings to validate the results. Thus, it is recommended to execute the investigation work in two steps that is to say:

I. The completion of a preliminary geophysical survey to obtain a general understanding of the materials present on the study site;
II. The development of a geotechnical investigation by means of mechanical soundings considering the general understanding of the site.

Additional geophysical surveys could be required to interpolate the information between the soundings.

### *3.7.2.2 Geotechnical Studies*

The geotechnical analysis is the most important step as well as the most expensive step in this type of project. At this stage, geotechnical studies will involve collecting all the necessary information to complete the design work such as the nature and properties of soil and rock, the permafrost distribution, the location of the thaw-sensitive or unstable soil areas, the groundwater conditions, the properties of the active layer and of the permafrost and the evaluation of the thermal ground regime along the proposed alignment. By taking a comprehensive approach to the collection of geotechnical data at this point, the design of the embankments and cuts can be more precise.

The fieldwork connected to the geotechnical investigation will essentially involve the drilling of boreholes and the execution of test pits along the proposed alignment. The geotechnical study success is higher when the soundings are organized in accordance with the preliminary reconnaissance and the geophysical survey results.

According to the recommendations given in Tables 3.3 and 3.4 of the “Guidelines for Development and Management of Transportation Infrastructures in Permafrost Regions” written by the TAC, the boreholes will be drilled to a depth of 3.0 m under the lower limit of the active layer and will be carried out at intervals varying between 40 and 100 m along the proposed alignment. In the boreholes, one (1) disturbed soil sample will be recovered in each horizon of the active layer and one (1) intact frozen sample will be recovered at each meter in the permafrost layer.

The execution of test pits of 2.0 to 3.0 m depth will be carried out between the boreholes. The test pits allow to determine the soil stratigraphy in the active layer, to take representative frozen and unfrozen soil samples from the walls and at the bottom of the excavation and to observe the short term groundwater conditions and the excavation slopes stability. It is to be noted that the use of this technique must be studied before its execution because of the potential for thermal erosion and the creation of thermokarst which may result from excavation.

All the samples recovered from the surveys will be sent to a laboratory for identification, analysis and classification purposes. They will be all submitted to a visual examination by an engineer. According to the ground conditions on the study site, an appropriate test program will be performed on representative frozen and unfrozen soil samples.

Furthermore, considering the presence of discontinuous permafrost in the study region, it is important to collect detailed information concerning the ground thermal regime along the proposed alignment to define the frozen and unfrozen zones. In order to do this, thermistors will be installed in two (2) or three (3) boreholes at strategic places on the study site.

### 3.7.3 Analysis of Results

The results of the geotechnical studies are analyzed to provide geotechnical comments and recommendations in relation with the planned construction activities.

It is important to keep in mind that the data gathered during this phase of study will be used to estimate the risk of permafrost degradation caused by the construction. If necessary, estimates will also be provided regarding the consequences that this degradation could have on the embankments and cuts, the maintenance costs and on the construction durability.

### 3.7.4 Behaviour Assessment of the Road

The construction of the MVH will inevitably create an unbalance in the thermal regime of the ground surface that could cause the progressive degradation of the permafrost. Some sections along the highway will be more sensitive to the thawing of the permafrost, such as ice rich permafrost areas or more localized sections such as massive ice areas. The thawing of the permafrost at those places, which can be caused by the embankments, cuts or by climate change, will generate major changes in the geotechnical properties of the subgrade soils in these precise areas. The road will be subject to serious deterioration which could be manifested as severe settlement and important longitudinal cracks. The permafrost degradation could also manifest itself by isolated major problems such as slope failure of thermal erosion. These phenomena are susceptible to take a part of the embankment and make the road impracticable for a long period.

A more detailed geotechnical study during later phases will allow the team to quantify the apprehended scale of degradation. Cost-benefit analysis must be carried out to determine if mitigation techniques must be developed to reduce a risk considered excessive or to reduce the intensive maintenance work required to maintain the road operational.

## 3.8 MITIGATION TECHNIQUES

In the case that the areas of sensitive permafrost cannot be avoided, several mitigation measures can be used to protect the permafrost from thawing. The objective of these techniques is to protect the thermal regime of the permafrost and ensure its stability. With these techniques, the problematic areas will have a long-term behaviour similar to the road as a whole, which could reduce the cost of maintenance and ensure the functionality of the road and the safety of the users.

### 3.8.1 Embankment

There are three categories of techniques with regards to embankments including (i) reduction of heat intake during summer, (ii) activation of heat extraction during winter and (iii) embankment reinforcement. These existing techniques are summarized below:

- Reduction of heat intake during summer
  - thermal insulation;
  - sun/snow sheds;
  - raising the permafrost line.
- Activation of heat extraction during winter
  - thermosyphon;
  - air convection embankment (ACE);
  - heat drains;
  - air ducts.
- Embankment reinforcement
  - geotextile and geogrid;
  - use of flat slopes;
  - drainage ditches that run away from the embankment.
- Others
  - induced thawing.

According to currently available information, the more likely techniques to be used for the MVH would be the air convection embankment, the heat drains and the thermosyphons. The following table summarizes the scope of each previously mentioned method.

Table 6: Application of Air Convection Embankment, Heat Drains and Thermosyphons

| MITIGATION METHODS | SCOPE OF METHODS | | |
|---|---|---|---|
| | SOIL CONDITIONS | STRUCTURE TYPE | COMMENTS |
| Thermosyphon | ▸ Ice rich permafrost with high sensitivity subject to severe degradation | ▸ Localized severe degradation cases along an embankment<br>▸ Important structures such as bridges | ▸ Requires the presence of a competent rock quarry of good capacity near the site |
| Air convection embankment | ▸ Ice rich permafrost with medium sensitivity | ▸ Embankment | ▸ Requires the importation of voluminous material |
| Heat drain | ▸ Ice rich permafrost with medium sensitivity | ▸ Embankment | |

It is important to mention that the implementation of these techniques must be considered for each specific case in order to optimise the conservation of the thermal and mechanical properties of the permafrost.

These three techniques are described further in the following paragraphs.

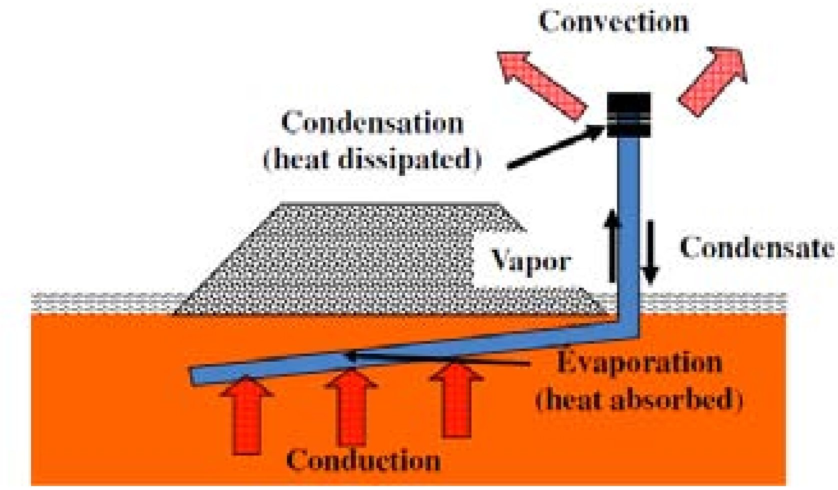
### 3.8.2 Thermosyphon

Photo 3: Thermosyphon – Kuujjuaq Airport

The installation of thermosyphons allows for the extraction of heat from the embankment during the winter. This technique is functional only when the top part of the thermosyphon is at a temperature lower than that of the soil. Considering the high cost of this technique, the thermosyphons are generally used only around important structures such as bridges and also next to localized severe degradation cases along the road, particularly where major problems are anticipated.

Thermosyphons are tubes placed through the embankment, which contain liquids that evaporate at low temperatures, such as carbon dioxide, ammonia and propane. The liquid contained in the thermosyphon evaporates in the bottom section of the system due to the heat of the adjacent soil. This causes a large quantity of heat to be extracted from the surrounding permafrost. The evaporated liquid then travels vertically to the extremity of the thermosyphon located above-ground, where it condenses as it comes into contact with the cold air. The liquid then flows downwards on the thermosyphon's wall, returning to the bottom section of the system where the liquid evaporates and hence, the cycle begins again. The following graph depicts the functioning of a thermosyphon.

Graph 1: Functioning of a Thermosyphon



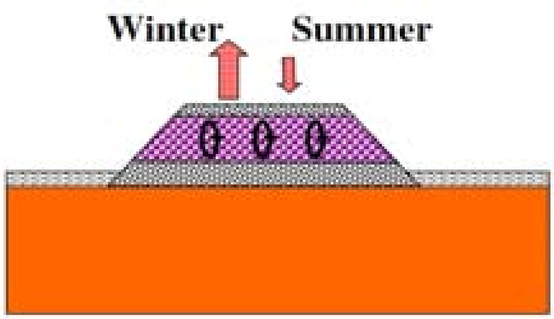

This type of system could be required in some particularly sensitive areas along the proposed alignment based on the permafrost conditions encountered on the site.

## Air Convection Embankment (ACE)

The air convection embankment is a method that can extract the heat in the embankment during winter. The air convection embankment is composed of a granular material such as a crushed stone with a nominal size of 150 to 300 mm. The creation of natural convection cells occurs inside the pores of the material and decreases the air temperature in the embankment. The higher density of the cooler air forces it down and pushes the warmer air upward, where it can escape from the embankment

Photo 4: Air Convection Embankment (ACE) – Fairbanks Alaska

Graph 2: Functioning of an Air Convection Embankment (ACE)



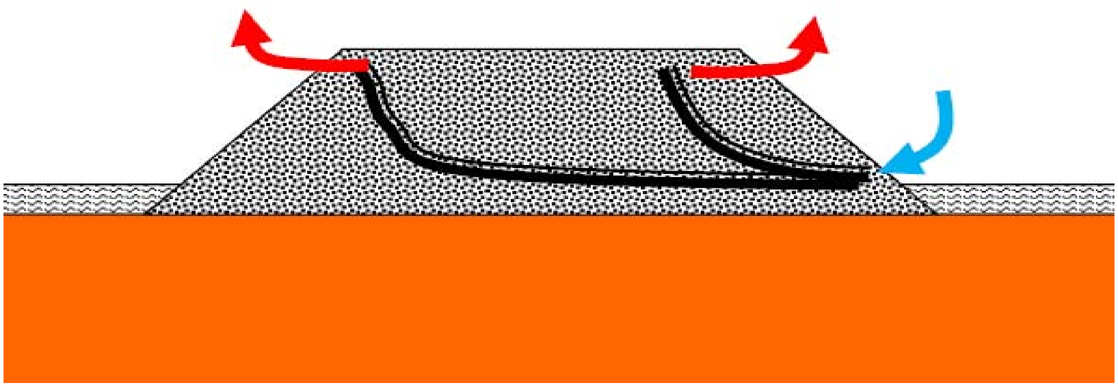
### 3.8.3 Heat Drains

Heat drains involve extracting heat from the embankment during winter. Heat drains are made with high-permeability geocomposites that resist well to high pressure. The following photo presents the construction of a heat drain.

Photo 5: Heat Drain – Beaver Creek, Yukon

The system is composed of at least one air inlet and one air outlet. The inlets are located at the base of the embankment and the outlets, are located at the summit of the embankment. The temperature of the air inside the geocomposite is increased by the heat of the adjacent soil thus lowering its density. It is by this phenomenon that the air moves upwards and draws the cold air into the inlet located at the base of the embankment. The following graph presents one of many possible heat drain configurations. The precise configuration must be designed and adapted to the specific geotechnical conditions on-site.

Graph 3: Functioning of Heat Drains



### 3.8.4 Geotextile and Geogrid

In the case that the methods discussed above are insufficient to keep the permafrost in its initial state, the installation of a reinforcement system to ensure the mechanical stability of the embankment without changing its thermal regime will be required.

The installation of a geotextile or a geogrid is a reinforcement technique that can limit cracking by distributing the settlement of a given embankment on a larger area during the thaw of sensitive permafrost. It also increases the safety factor for potential rupture.

### 3.8.5 Cuts

According to the available cartography, the soils located in the corridor of the proposed road alignment consist most likely of lakeside deposits, and silty and clayey deposits. Therefore, important surface instability problems on the excavation slopes can be expected. These instabilities manifest themselves by solifluxion problems, ground flow or by surface sliding.

The analysis of these problems must be emphasized to design an adequate stabilization, which consists of the implementation of a drainage blanket.

## 3.9 BORROW SOURCES

### 3.9.1 General Information on Borrow Sources in the Area

An inventory of available information and existing documents was gathered and analysed in order to assess the possible borrow sources in the areas surrounding the MVH extension project. At this stage of the project, the scope of the investigation was limited to the information obtained from the Department of Transportation (DOT), GNWT and the Environmental Impact Statement for the Mackenzie Gas Project (MGP EIS). Our firm has requested additional information from the DOT GNWT, so as to further analyse the specific location and characteristics of known and possible borrow sources. This information will be made available for the subsequent stages of the project.

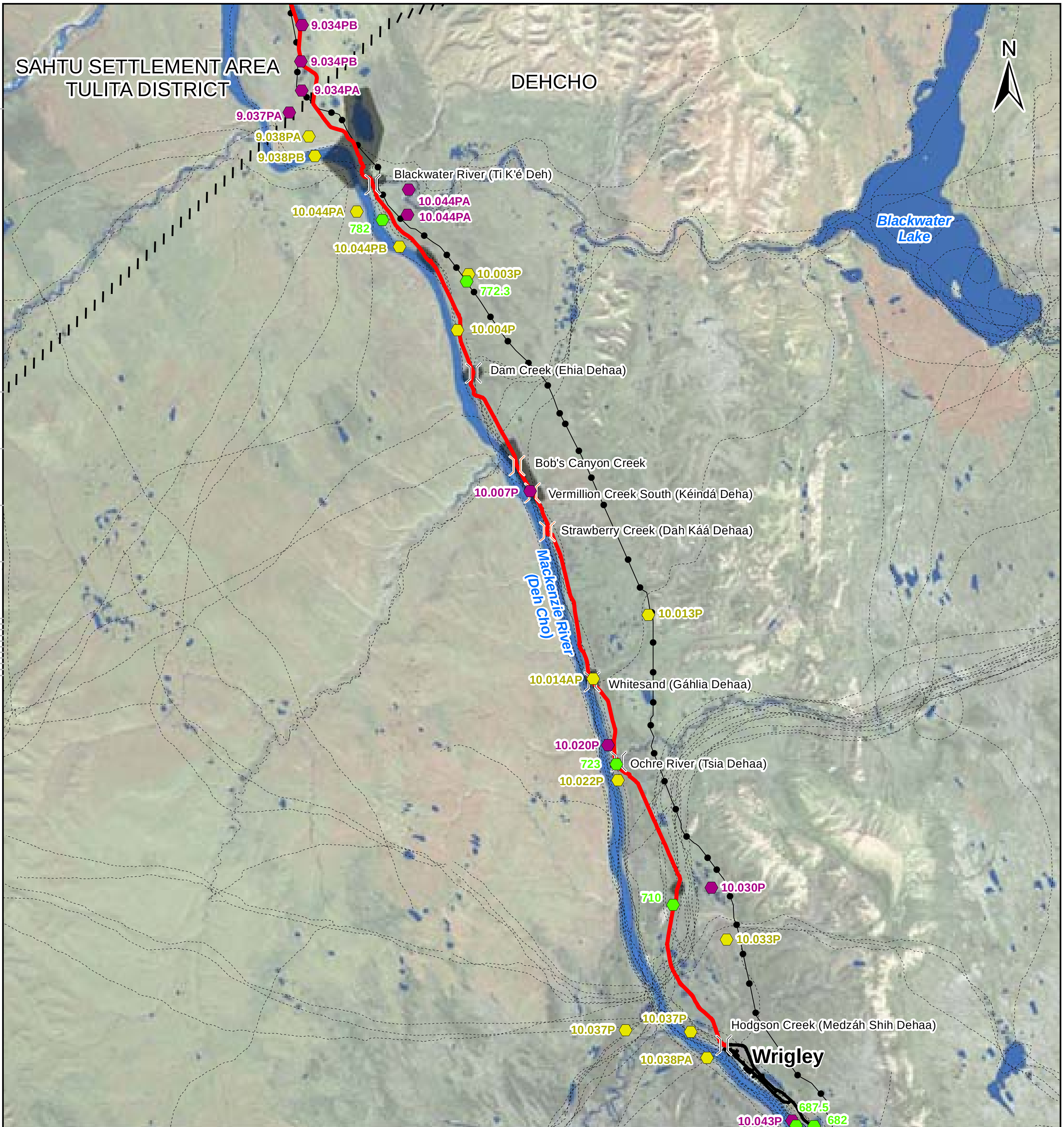
### 3.9.2 Available Information on Borrow Sources in the Area

Based on the information obtained from the DOT, there are four existing borrow sources located along the optimized alignment. The first is located near Mount Gaudet, approximately 16 km north of Wrigley. This site is described as a bedrock quarry, a granular material source and a stockpile site. The second site is located near the Ochre River, approximately 31 km north of Wrigley. This site is described as a granular material source and a stockpile site. The third site is located approximately 10 km south of the Blackwater River. This site is described as a bedrock quarry and a stockpile site. The fourth site is located near the Blackwater River and was exploited for the construction of the Blackwater Bridge. This site is described as a granular material source and a stockpile site. The four sites discussed above are presented in the following table as well as in the following figure entitled Borrow Sources. Two additional borrow sources, located 5 and 10 km south of Wrigley, may be of interest given their close proximity to Wrigley. However, these sites have not be analysed seeing as the characteristics of the borrow source located near Mount Gaudet are superior to those of the two sources south of Wrigley.

Table 7: Location and description of Borrow Sources

| LOCATION | | | APPROXIMATE AREA (ha) | DESCRIPTION | DISTANCE FROM EXISTING WINTER ROAD (m) |
|---|---|---|---|---|---|
| KM | RELATIVE | COMMENTS | | | |
| 710 | 16 km N of Wrigley | Near Mount Gaudet | 4,0 | Granular source, bedrock quarry, stockpile site and temporary construction / work camp | 50 |
| 723 | 31 km N of Wrigley | Near Ochre River | 10,5 | Granular source, stockpile site and temporary construction / work camp | 50 |
| 772,3 | 22 km S of boundary* | Near Blackwater River | 4,6 | Bedrock quarry and stockpile site | 2 500 |
| 782 | 12 km S of boundary* | Near Blackwater River | 6,5 | Granular source, stockpile site and temporary construction / work camp | 30 |

Additional information pertaining to borrow sources was presented in the Environmental Impact Statement for the Mackenzie Gas Project (MGP EIS). In fact, the construction of several borrow sites is forseen to provide the construction materials needed for the Mackenzie Gas Project. The following figure, entitled Borrow Sources, presents the approximate location of the primary and secondary borrow sources identified by the Mackenzie Gas Project in addition to the four borrow sources discussed previously in this section. The alignment of the winter road and the Mackenzie gas pipeline are shown as well.




Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Existing Borrow Source
Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)
PKFN Main Traditional Activity Site

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- NTDB, 1 : 250 000, Canada Government*
*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 5**
**Borrow Sources**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C103-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C103-00_BorrowSites_20120227.mxd

The following table presents the primary borrow sources located along the MVH extension project that were identified by the Mackenzie Gas Project.

Table 8: Information on Borrow Sources along the MVH Extension Project (Primary Sites)

| SOURCE NAME | OWNERSHIP | LOCATION | PIT TYPE | ESTIMATED SUPPLY (1 000 $m^3$) | EXISTING | CONSTRUCTION |
|---|---|---|---|---|---|---|
| 10.043P | Crown | 9 km S of Wrigley | Granular | 19 700 | Yes | |
| 10.030P | Crown | 17 km N of Wrigley | Granular | 684 | Yes | |
| 10.020P | Crown | 31 km N of Wrigley | Granular | 1 600 | Yes | |
| 10.007P | Crown | 56 km N of Wrigley | Granular | 1 200 | No | To be built for the Mackenzie Gas Project |
| 9.044PB<br>9.044PA | Crown | 13 km S of boundary* | Granular | 15 000 | No | To be built for the Mackenzie Gas Project |
| 9.037PB<br>9.037PA | Crown | 2 km S of boundary* | Granular | 4 600 | No | To be built for the Mackenzie Gas Project |
| 9.034PB<br>9.034PB | Crown | 5 km N of boundary* | Granular | 3 800 | No | To be built for the Mackenzie Gas Project |
| 9.024AP | Private | 18 km N of boundary* | Granular | 1 000 | Yes | |

* Boundary between the Dehcho Region and the Sahtu Settlement Area, Tulita District.

The following table presents the secondary borrow sites located along the MVH extension project that were identified by the Mackenzie Gas Project.These sites were considered as alternative sites to the primary sites presented in the previous table.

Table 9: Information on Borrow Sources along the MVH Extension Project (Secondary Sites)

| Source name | Ownership | Location | Pit type | Estimated supply (1,000 $m^3$) | Existing | Construction |
|---|---|---|---|---|---|---|
| 10.044BP | Crown | 12 km S of Wrigley | Granular | N/A | Yes | |
| 10.038PA | Crown | 1 km N of Wrigley | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.0120P | Crown | 9 km N of Wrigley | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.037P | Crown | 3 km N of Wrigley | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.033P | Crown | 12 km N of Wrigley | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.022P | Crown | 29 km N of Wrigley | Granular | N/A | Yes | |
| 10.014AP | Crown | 38 km N of Wrigley | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.013P | Crown | 43 km N of Wrigley | Quarry | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.004P | Crown | 27 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.003P | Crown | 23 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 10.001P | Crown | 17 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 9.091P | Crown | 12 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 9.038PB | Private | 6 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |
| 9.038PA | Private | 3 km S of boundary* | Granular | N/A | No | Alternative source for the Mackenzie Gas Project |

* Boundary between the Dehcho Region and the Sahtu Settlement Area, Tulita District.

### 3.9.3 Borrow Material Requirements

Preliminary material volume estimates will be based on preliminary horizontal and vertical geometric designs using the embankment cross section produced in a previous section of the PDR.

Haul distance from the source to the alignment will be evaluated to meet a cost efficiency ratio. In consideration will be those sources closest to the alignments with appropriate volume and quality.

### 3.9.4 Further Investigation of Borrow Sources

In order to reduce environmental impacts and minimise costs, it is strongly recommended to use existing borrow sites. Several borrow sites were built and exploited for past projects such as the Blackwater River Bridge and the Mackenzie Gas Project.

Many borrow sources were identified by Public Works Canada (PWC) between 1976 and 1980, more specifically along the proposed project in 1977. In the event that more borrow sources should be required, an in-depth analysis of the sites identified by PWC may prove necessary. The later stages of the project must verify and confirm the suitability and availability of these sources for the MVH extension project. The quality of materials will also be evaluated for embankment construction.This PDR does not include a detailed examination of the borrow source areas identified in past projects or by the government. Aerial reconnaissance must be performed to confirm apparent viable areas.

The following aspects require further investigation in order to select the appropriate borrow sources that will be used for the MVH extension project.

Site Evaluation Criteria

Criteria used to identify borrow sources will be described and will govern the choice of sites.

Pit Development Plans

In compliance with local governments, administrations, land use permit requirements or regulations, Pit Development Plans will be developed for each borrow source for the construction of the proposed Highway. Pit development plans will reference the latest version of the Environmental Guidelines: Pits and Quarries, Indian and Northern Affairs Canada.

Winter Access Roads

Temporary winter access roads will be constructed to reach borrow sources. Most activities related to earth moving operations will take place during the winter months when frozen ground is more accessible. This section of the PDR will provide sufficient instructions to prepare the ground and the basic design for the winter access road construction.

## 3.10 CONSTRUCTION

### 3.10.1 Winter Approach to Construction

Construction techniques adapted to northern regions will be used for the construction of the Mackenzie Valley Highway. One of the most typical construction techniques used in northern regions is to build during the winter months in order to take advantage of the winter conditions. In fact, construction during the winter offers numerous advantages as oppose to summer construction techniques. The advantages and disadvantages of winter construction are summarized in the following paragraphs:

Advantages

- Using winter and/or ice access roads is one of the significant advantages associated to winter construction. These access roads will connect the construction site with diverse places of interest, such as borrow sources, without having to spend considerable sums for the construction of permanent roads;
- Construction on frozen ground will reduce the environmental impacts on the adjacent areas. It is essential to reduce to a minimum the construction footprint which could extend over time into major areas of distress with ponding water and thermokarst, which is impossible to avoid during summer construction;
- The installation of culverts may be simplified because of the diminished flow of water in streams during the winter months;
- The frozen surface of a lake or a river crossing may prove useful as a working platform to store construction materials;
- The cuts made in ice-rich soil areas during the winter are easier to control mainly because the exposed surfaces stay in a solid state and can be protected before the thawing period;
- The initial settlements and consolidation occurring when an embankment is placed directly on unfrozen soils can be eliminated if construction works are made in winter. The frozen ground surface can support the weight of the embankment which could not be supported in thawed conditions.

Disadvantages

- Periods of extreme cold will generate difficult conditions for the staff and for the equipment;
- The adequate compaction of the granular fills is impossible in winter;
- Excavating the materials required for the highway construction will necessitate the use of more complex excavation techniques such as dynamiting;
- Considering the limited day light due to the geographic location of the project as well as the short construction period, it will be difficult to find enough personnel and equipment to carry out the work in time.

### 3.10.2 Construction Overview

Considering the presence of discontinuous permafrost along the planned alignment, the construction techniques could vary considerably from one section to another. Furthermore, one must realize that it will be impossible to use the Winter Road during the construction of the MVH extension Project at those places where the alignment of the MVH is identical to that of the Winter Road.

It is important to plan the logistics while taking into account the seasons and the results of the geotechnical study. For example, if the subgrade permafrost is granular, ice-poor and thaw stable, then the preferred time to construct the embankment may be in late summer or early fall, when the active layer has thawed as much as possible. If the permafrost subgrade is thaw unstable, such as silt and fine sand, it is preferable to construct the first fills in winter when the ground is frozen. Nonetheless, the project must be evaluated to determine the most appropriate and cost effective construction techniques and their scheduling.

### 3.10.3 Construction Activities

Due to the absence of a geotechnical study, it is impossible to establish a list of specific construction activities or a detailed construction schedule. Nevertheless, based on the past experiences and on the schedule presented in the PRD report for the construction of the Mackenzie Valley Highway in the Gwich'in Settlement Area, currently under construction, the planning for the studied section should be as follows:

- December – Clearing of right-of-way and construction of winter roads and borrow sites;
- January / February / March – Hauling and placing of embankment material;
- April / May / June – No activities other than production and stockpiling of material assuming equipment has been mobilized to the particular borrow source;
- July / August / September – Completion and compaction of previously constructed embankment; if feasible based on geotechnical conditions;
- August / September / October / November – Any activity that does not require overland access or can be accessed by previously constructed segments of the MVH.

## 3.11 LIFE CYCLE ASSESSMENT

The life cycle assessment (LCA) is a recognized method used to assess the environmental impacts that may occur during the entire life of a product, from raw material production to recycling and final disposal. In order to be compared using this approach, two products or two scenarios must fulfill the same function (ISO 2006). Defining a function with respect to the characteristic performance and duration allows the analysis to reveal whether a product performs well during a given phase of its life cycle because of a real improvement or because additional impacts have been transferred to previous or upcoming phases.

Acknowledging that cold regions will face larger consequences related to global warming than southern regions, such as thawing permafrost, one could argue that durable construction methods should be used for the extension of the MVH. However, such a construction requires more materials, more energy and therefore should have a bigger footprint than a conventional construction approach. This comparison is true when focusing only on the construction phase of the highway. Applying an LCA approach on not only the construction phase but also the maintenance phase, over a period of 40 or 50 years, could yield different results.

LCA is an approach already used in road-building. Several studies have pointed out which phases of the life of a road have the highest impacts on the environment. Huang et al.(2009) gives a overview of a part of these studies. In a study comparing different road surfaces over a period of 40 years, Stripple (2001) has demonstrated that no matter which road surface is used, the construction phase has higher impacts than the maintenance and use phases of the road with regards to the emissions of NOx, $SO_2$ and $CO_2$. In most studies, the use phase does not include the environmental impacts associated with the vehicles using the road; but those associated with the lighting, the traffic control system, the snow clearance and the maintenance of the medians. Among all the materials that need to be prepared for the road construction, the pavement is clearly the element requiring the highest demand in energy (Park et al. 2003), followed by drainage works, some generic works and then the earthmoving work for the preparation of the base layer of the road. As these studies are based mostly on an urban context, caution must be used when considering their application in a cold region, especially in a context where the permafrost is expected to thaw progressively in the future.

As presented in a previous section, the construction methods for the MVH are different in several ways from those used for a classic road construction. Based on the geotechnical conditions, the construction may be undertaken during the winter, and therefore the soil compaction could be more difficult and require more energy than it would if it were undertaken during the warmer months. Where the permafrost is ice-rich, the base layer of the road will require the use of mitigation techniques to prevent settlement of the road if the permafrost were to thaw. Another major difference between the types of road for the MVH in comparison with the roads considered in the studies presented above is that no pavement is necessary is cold regions. The road surface is not constructed of bituminous materials or Portland cement concrete, but rather of compacted granular materials. Finally, most of the activities usually considered in the use phase, such as the lighting, the traffic control system and the maintenance of the medians are not applicable in the MVH project.

LCA is the appropriate tool to determine whether a road that is built with certain mitigation techniques to prevent potential impacts of climate change has more or less impacts on the environment than another alternative. In addition, a more cost-efficient approach can be reached by incorporating potential climate change effects into infrastructure planning (Meyer et al. 2010). Although it is possible to perform an LCA using data available in commercial LCA databases, presented as averages, the geographic context of the MVH is so particular that the quality of results would not be accurate enough to guide PKFN in their decision regarding the type of construction that should be considered from an environmental point of view. At the very least, project-specific data should be used to evaluate the energy required to transport materials to the site as well as the energy required on the construction site.

At this point in the project, it is too soon to perform a complete LCA comparing the different construction approaches for the MHV. However, it is possible to define what should be considered in such a study to assess the environmental benefits associated with a construction approach that takes into account the vulnerability of the permafrost. According to ISO 14044, the standards related to the life cycle assessment methodology, the first step of four to conduct an LCA study is to define the goal and scope of the study. It is the most important step as the next ones, the data collection (inventory), the impact assessment and the results interpretation, will be related to the definition of the study. Within this first step, it is necessary to define the function and the functional unit (the quantification of the function) that must be fulfilled by all the compared construction approaches. In addition to this, the boundaries of the study have to be defined in order to identify which processes are included in the study and which are excluded.

In LCA, the relation between the functional unit, the inventory and the potential environmental impacts is linear. For this reason, the impacts for a 1 km alignment can be extrapolated to a 100 km alignment. Collecting data associated with a smaller portion of the road (i.e. 1 km) might be easier. Then, either the impacts of a 1 km road can be extrapolated to a 100 km road or the inventory of a 1 km road can be extrapolated to create an inventory for a 100 km road before transforming this inventory into impacts. Several LCA studies have been conducted on road construction projects. Hereafter is a list of functional units that some of these studies have considered. As mentioned previously, the context of the MVH extension is completely different from those considered in these studies. However, a review of these studies can help to understand the usual boundaries. This can be the starting point to define the boundaries of a future MVH extension LCA study. Treloar et al. (2004) have considered a 5 km stretch of a road in a rural context with a flow of 10 000 vehicles per day (90% cars, 10% trucks). Mroveh et al. (2000) have considered one km of road with a width of 13 m. Park et al. (2003) have considered one km of a four lanes highway in Korea. NTUA (2006) has considered the impacts of one km of a typical urban road constructed in Cyprus and consisting of two 3.5 m wide lane and two 2.5 m shoulders and having an expected life of 50 years. Finally, Huang et al. (2009) have developed a tool calculating the life cycle environmental impacts for the construction and maintenance of one km of asphalt pavements. All processes related to site clearance, road use (i.e. road markings and traffic signs and lights, regular and seasonal maintenance) as well as traffic emissions have been excluded from a study (Mroveh et al., 2000) as they are similar for all construction scenarios. Park et al. (2003) have considered all the phases from the manufacturing of construction materials to the demolition and recycling of the road after the phases of construction and maintenance and repair. The impacts associated with the vehicle use on a road have been included by Treloar et al. (2004) in addition to those associated with the road construction and its maintenance.

For the comparison of different mitigation techniques for the MHV extension, the functional unit could be the following: “Constructing and maintaining one km of road on ice-rich permafrost with medium to high sensitivity, that is used year round and that must last for 40 years”. Several different construction techniques could be compared is such study:

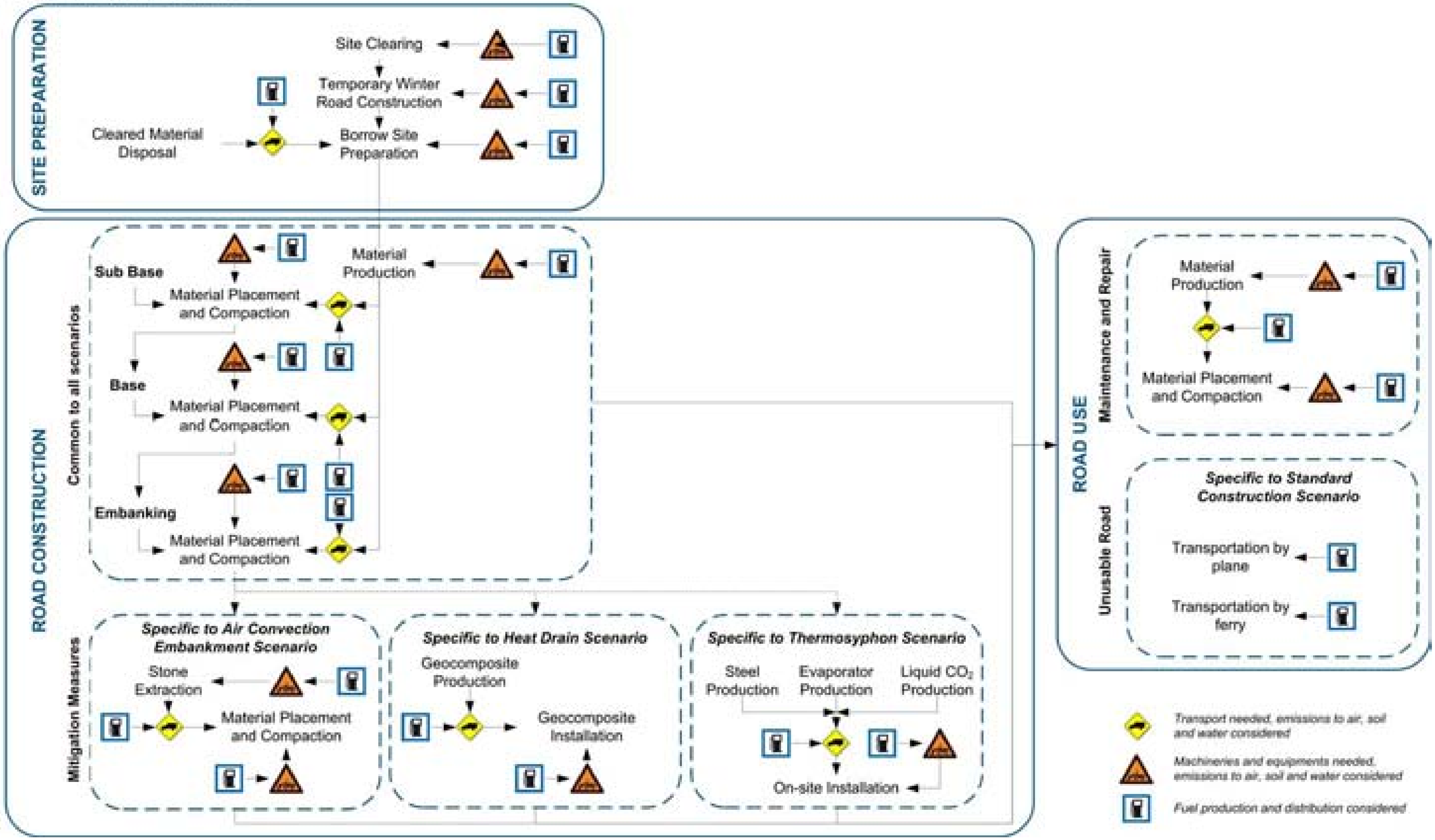
- standard construction with no mitigation method;
- construction with air convection embankment;
- construction with heat drains;
- construction with thermosyphons;
- or a combination of these techniques.

As oppose to studies cited above, many processes are not required for these scenarios in cold regions. Bituminous materials are not required in these scenarios. No traffic lights will be installed on the MVH. As the traffic is insignificant on the road, vehicle emissions during the use phase can be excluded as there are negligible compared to those associated with machinery and equipments and the material transportation during the construction phase.

The first scenario (standard construction), compared to the three others, cannot fulfill the function of providing an access year round. It is highly probable that the road cannot be used during the summer season. Alternative transportation measures should then be considered (i.e. airplane, ferry) in order for this scenario to be equivalent to the others. These alternative transportation measures, which must be repeated every year, may have significant impacts on the environment. Without using an LCA approach, such an impact source would have been ignored. Conducting such an LCA study would help decision-makers compare the higher impacts associated with additional materials required by the mitigation measures during the road construction to the environmental benefits of an all-weather road. Such benefits could come from fewer needs for road maintenance and no need for alternative transportation measures as the road can be used year round.

The following figure depicts the boundaries of an LCA study that could compare these four scenarios all fulfilling the functional unit described above. Performing such an LCA study would be possible after the geotechnical conditions of the MHV will be known and the mitigation techniques will be determined.

Graph 4: LCA System Boundaries



# 4 TRADITIONAL AND OTHER LAND USES

This section examines the land use in the area of the proposed MVH extension in the Pehdzeh Ki Ndeh – Dehcho Region, located within the Mackenzie Valley between the community of Wrigley and the southern boundary of the Sahtu Settlement Area. Most importantly, land uses relating to traditional activities are examined in current and historical periods. Other non-traditional land uses are examined as well in order to determine the potential impacts of the project on permitted land users (such as hunters, trappers and commercial guides) along this section of the Mackenzie Valley corridor.

## 4.1 TRADITIONAL LAND USE AND KNOWLEDGE

It is important to consider information regarding traditional knowledge acquired by Aboriginal communities inhabiting a proposed development area in order to understand how the land and the natural resources are used by the Aboriginal inhabitants and how the project may affect their local cultural ecology. Traditional knowledge represents the body of social, natural and spiritual information gathered and passed on between generations, typically through oral means or through experiences and teachings. This knowledge manifests itself in the form of stories and ecological knowledge that form the fabric of the social and cultural lives of Aboriginal peoples in the Northwest Territories. The formation of traditional culture is a fluid process that occurs over generations with the transfer of spiritual, ecological and social knowledge. In this, traditional culture is not static or characterized by a single period of time, but instead is dynamic and continuously adapting from the historic knowledge within each Aboriginal group. As a result, cultural understandings, the use of natural resources, and the economy and social structure of a group can be expected to adapt to changing social and environmental situations.

Given the small, linear study area, the focus of this assessment is on the community of Wrigley. However, attention is also given to general Traditional Land Use (TLU) information pertaining to Dehcho First Nation. TLU information includes sensitive cultural data such as, local resource harvesting strategies, preferred land occupancy sites (i.e. hunting cabins, temporay shelters, camp sites, trails, teaching sites and important monuments), as well as valued historic and cultural sites (i.e. burials, ritual sites, meeting places) and important natural areas and species. TLU information is of sensitive nature and is often kept confidential to protect first nation communities.

As limited TLU data was available during the preparation of the PDR due to its sensitive nature and to privacy issues, this section is mostly based on secondary public sources available from the Dehcho First Nation government, Government of the Northwest Territories and academic and consultant research in the area of the proposed MVH extension. This includes previous TLU studies conducted within and adjacent to the Pehdzeh Ki Ndeh – Dehcho Region, as well as historical documents and land use planning reports. A video produced by the PKFN, which presents the lifestyle of community-members, practices and traditions, has also been reviewed.

Also, public consultations were held in Wrigley on 3 separate occasions and participants provided information regarding important physical locations (such as preferred hunting areas, wildlife habitats and important monuments) as well as activities and cultural practices. Unfortunately some information was obtained during the last public consultation held in January 2012, and consequently this information was not analysed in the present PDR due to the fact that the it was obtained during the final stages of the its preparation. Nonetheless, a map illustrating the location of various traditional land use activites is presented in Appendix 9. The public consultations are discussed further in Section 5, Community Involvement.

### 4.1.1 Traditional Life-Style and Background

Information regarding the traditional use of the MVH extension route considers both the past and current uses of the area. As evidence from regional archaeological studies and information published by the DLUPC, the area of the MVH extension in the Mackenzie Valley has been used both prehistorically and historically for traditional pursuits. Contemporary Dehcho Region populations in Wrigley (PKFN) also maintain traditional land use practices in the areas north of Wrigley, as well as throughout the surrounding region. Traditional use sites related to cultural and spiritual practices may be located in areas of cultural significance along the MVH extension route, specifically at the confluence of rivers and at other notable landscape features. These locations may relate to the use of a given landscape feature as a seasonal travel corridor, and may be evidenced by the presence of prehistoric trails and habitation sites (Janes, 1983). Spiritual sites related to the presence of burial grounds may also occur along the Mackenzie Valley corridor, with sites potentially having been used for generations. Various forms of traditional land use may include the use of trails, burial grounds, seasonal habitations and other cultural use sites, which have been prevalent in the ethnographic history of Dene groups in the Mackenzie Valley[4].

Presently, the majority of First Nations in the Northwest Territories have adopted a monetary economy to some degree. As traditional land use activities that occur within the Dehcho Region are typically seasonal, this mixed economy is often used by individuals to offset traditional subsistence practices, which include the following: hunting of caribou, moose and waterfowl, trapping of small game, ice fishing, wood hauling and berry and vegetation harvesting. Hunting ungulate species remains one of the most important subsistence harvesting activities. As currently proposed, the MVH extension follows the existing winter road and crosses through previously undeveloped land, and thereby has the potential to impact the traditional land uses of the Pehdzeh Ki First Nation (PKFN) community members, who reside in

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4 Dene refers to Athabascan-speaking First Nations people of Northern Canada and Alaska. The PKFN, who speak Slavey, one of the Athabascan languages, are part of the Dene.

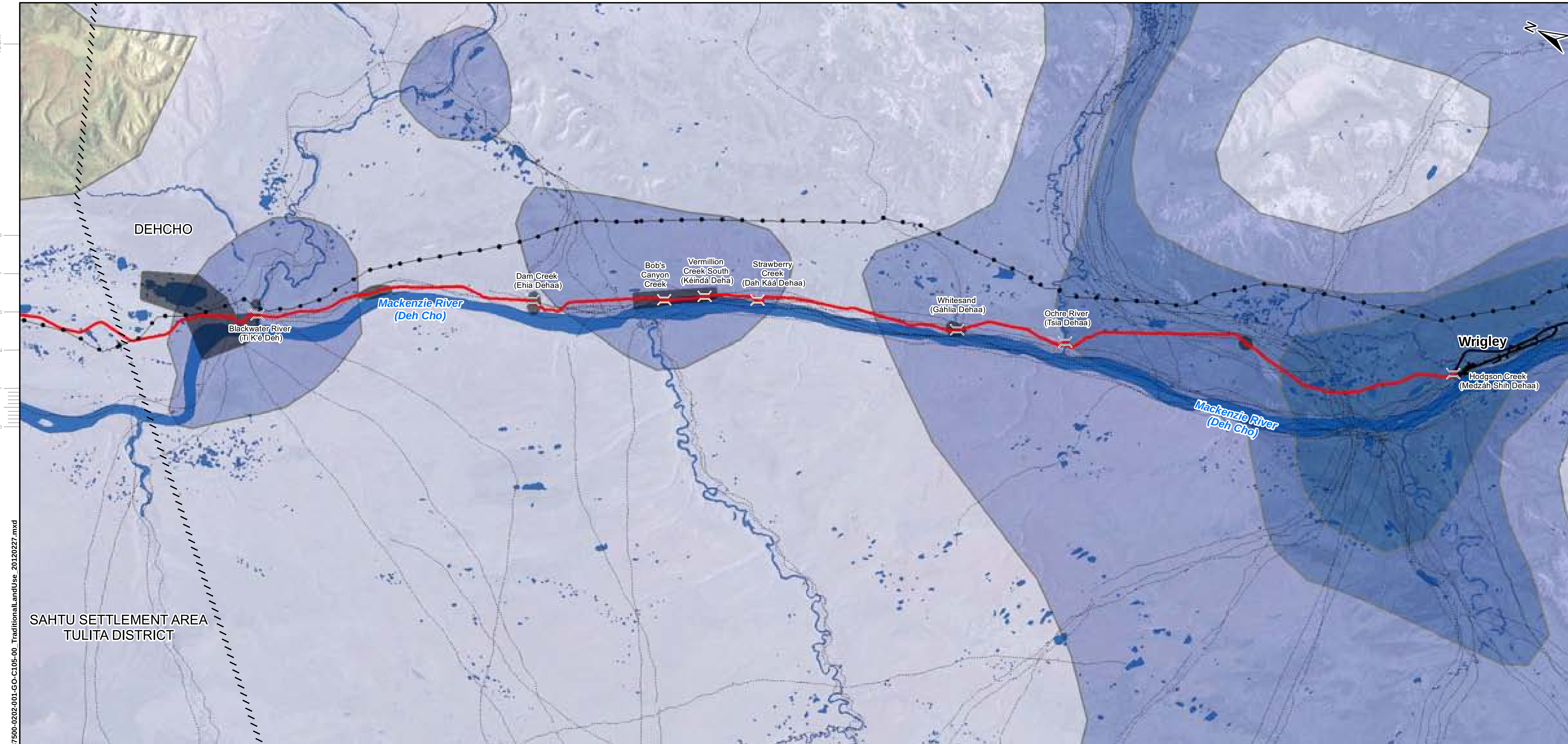
this area. The goal of this section is to identify the traditional practices typical to this portion of the Mackenzie Valley.

The DLUPC has identified areas along the proposed MVH extension between Wrigley and the Sahtu Settlement Area border that contain low, moderate and high densities of traditional land use and occupancy (Figure 6; DLUPC, 2006c). These areas are likely to relate to resource procurement activities and culturally sensitive locations such as burial grounds.

Very pertinent information regarding traditional land uses in the area of the proposed all-weather road was collected from the community through community consultation activities (for further information see Section 5, Community Involvement). In addition, the PKFN provided a documentary video, which included some description of traditional activities and land use (PKFN, 2010). All work relating to the collection of community information was conducted in concordance with a Memorandum of Understanding signed between GNWT-DOT and PKFN in 2010.

During the public consultation process, the PKFN described their practices and the areas they use for traditional activities (see Appendix 4, sheets 1-10). Traditional uses sometimes relate to communicative activities that occur while on the land, with the purpose of transfering traditional knowledge. The traditional use areas that they described include burial grounds, traditional hunting grounds, including hunting cabins, trapline locations, moose pasture areas and moose sensitive areas (moose hunting areas) as well as spiritual and cultural sites. The PKFN also identified some watercourses and river banks among their traditional land use areas.

During the consultations, participants explained that traditional land use areas need to be protected. They feel that once the all weather highway is complete, more people will move through the Pehdzeh Ki Ndeh - Dehcho Region, increasing the risk that wildlife habitats and important sacred spaces will be altered or negatively impacted. The notion of protecting natural areas, especially the ones related to traditional activities, was expressed by the PKFN community throughout the public consultation process, particularly during the last round of public consultation held in January 2012. Most importantly, the PKFN explained that the rivers, creeks and forests should be protected for the future generations and that moose, caribou and fish also need to be protected. Sites that were mentioned as very important to the PKFN include Blackwater River, a special traditional area that is home to a sacred old grave, and Willowlake River, where there is a burial ground (public consultation, November 2011).

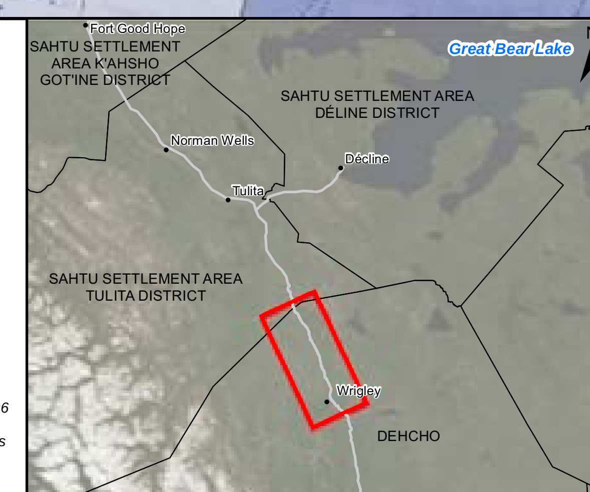



Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

**Density (based on standard deviation)**
- Low
- Moderate
- High
- Very High

PKFN Main Traditional Activity Site

*Sources :*
*- © Bing Maps, 2006-2009*
*- Decho Land Use Planning Committee, 2006*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*




Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 6**
**Density of Traditional Land Use and Occupancy**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : D. Aubin
No : 068-P0037500-202-001-GO-C105-00
Scale : 1:275 000
Date : February 27, 2012

0 10 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 11" x 17"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C105-00_TraditionalLandUse_20120227.mxd

The protection of these areas is a primary concern for the PKFN and was a fundamental element in discussions between the project team and the PKFN community.

Furthermore, the PKFN Chief and the Band Council members mentioned at various occasions the important amount of activities occurring on the territory near the MVH corridor and along the riverbanks of the Mackenzie River. Due to the fact that the proposed all-weather road will somewhat follow the path of the existing Winter Road, which passes relatively close to the Mackenzie River, the proposed road will also pass close to the Mackenzie River. For this reason, as currently proposed, the future all-weather road in the Dehcho section of the MVH extension Project has the potential to directly affect traditional activities along the route, as it will intersect high-use areas identified by the DLUPC. For this reason, additional realignment proposals, relocating the future all-weather road further in-land, were suggested by the Band Council during the last public consultation held in January 2012. One suggestion was to relocate the MVH alignment 5 km in-land, thus distancing it from the Mackenzie River, where numerous traditional land use areas are located. The other suggestions, made by the recently elected Band Council members, attempt to distance the alignment from the Mackenzie River, though remaining as close as possible to the proposed alignment. At this stage of the design process, these suggestions have not been considered, however it is highly recommended to take them into account during the later stages. These realignment proposals are presented in Appendix 8.

### 4.1.2 Natural Resources Harvesting

The harvesting of large ungulates, including moose and caribou, represents an important resource procurement activity. Historically, the movements of the caribou herds were closely related to procurement strategies of subsistence resources and even affected the seasonal movements of Aboriginal populations. The proposed MVH extension is found within the range of both the Woodland Caribou Boreal population and moose (EBA Engineering Consultants, 2003).

Resource harvesting activities include fishing, hunting and vegetation harvesting. The areas where these activities commonly take place are identified in Appendix 4 and Appendix 9, sheets 1-10. Areas utilized for big game hunting have not been identified by the DLUPC, primarily due to the sensitivity of the data.

In modern contexts, these activities remain important aspects of traditional culture in the region. Through their comprehensive investigation of traditional activities in the Dehcho Region, Norwegian and Cizek (2004) found that between 22 and 36% of all dietary protein requirements were fulfilled by wild foods. According to data collected during the MGP EIS, in the Dehcho Region, between 1993 and 2002, the community of Wrigley showed an increase in traditional activities overall (MPEG, 2004). In 1998, a recorded 34% of adults reported to have hunted or fished, while 53% indicated that they consumed country foods (MPEG, 2004).

Trapping in Wrigley was shown to have declined steadily from 100% of surveyed male community members between the ages of 25 and 59 who participated in 1987 to only 24% who participated in 2002. The Pehdzeh Ki Ndeh area of interest represents land used by the PKFN throughout the year for subsistence harvesting and traditional cultural activities. This includes subsistence wildlife hunting and fishing, trapping and snaring, berry picking, medicinal and spiritual vegetation harvesting, fuel wood harvesting and collecting craft materials (IMG-Golder Corporation, 2006; Norwegian, H. and P. Cizek, 2004).

#### *4.1.2.1 Wildlife Harvesting*

Wildlife harvesting information has been compiled based on information provided by the DLUPC and data collected from members of the community of Wrigley during 2011 and 2012. Surveys conducted within the community indicate that areas around creeks are highly valued for the presence of important traditional resources. Surveys results are presented in the section on Community Involvement and the survey questionnaire is found in Appendix 7. The general locations of resources traditionally harvested by the PKFN have been mapped and may be seen in Appendix 4 (sheets 1-10) and Appendix 9 .

Information regarding wildlife harvesting should be considered preliminary and non-absolute, as, given the flexibility of seasonal activities and the varied availability of local knowledge, traditional resource procurement activities are inherently mobile. However, activities that are focused around geographic features such as rivers and creeks tend to provide an abundance of traditionally harvested resources and are likely to remain culturally important. Certain geographic features may act as travel corridors for game and may have been subject to continual use ever since the prehistoric period. Along the MVH extension route, the Blackwater and Ochre Rivers, as well as Whitesand Creek are the areas in which traditional wildlife harvesting activities are focused.

##### *4.1.2.1.1 Caribou*

The MVH extension Project is located within the habitat range of the Woodland Caribou Boreal Population. One suspected Woodland Caribou calving range is located in the terrain north and south of Ochre River, while summering areas are known to exist throughout the Mackenzie Valley, north of Wrigley up to the Sahtu territorial border (EBA Engineering, 2003). The community of Wrigley indicates that ungulates regularly frequent areas north of Blackwater River near traditional hunting grounds (Appendix 4). Traditional hunting grounds in the vicinity of Whitesand Creek may also be used in the harvesting of caribou and are located near concentrations of archaeological sites, which may indicate use of the area as far back as the prehistoric period.

#### 4.1.2.1.2 *Moose*

The MVH extension is located within a year-round moose range and a number of harvesting locations have been identified within and adjacent to the proposed development (EBA Engineering, 2003). Information from the community of Wrigley indicates that at least five moose pasture areas are found along the proposed route. At least one traditional hunting ground overlaps with these pasture areas in the area of Vermillion Creek South and Bob's Canyon Creek, which has been used for the past 100 years for hunting moose. Additional moose hunting areas are located near Whitesand Creek and Eentsaytoo Lake, located north of the Blackwater Creek confluence with Mackenzie River. The Eentsaytoo Lake site is traditionally used during the summer (Appendix 4, sheets 9-10). A spiritual site associated with moose hunting in the Mackenzie Valley area is located just south of Blackwater Creek. The site is important because it is home to a rock to which spiritual offerings are made by PKFN members while hunting.

The locations found on Appendix 4 have been identified as having some of the best moose hunting habitat in the area, and also coincide with concentrations of a number of protected archaeological sites, indicating that use of this area may date back to the prehistoric period.

#### 4.1.2.1.3 *Bears*

The route of the MVH extension is also found within year-round black bear range (EBA Engineering, 2003). Harvesting of bears may occur within the traditional hunting grounds located north of Blackwater River, Vermillion Creek South and Whitesand Creek (Appendix 4).

#### 4.1.2.1.4 *Trapping*

Furbearer habitat is present throughout the area of the Mackenzie Valley, including along the MVH extension route (EBA Engineering, 2003). Traditional trapping activities, which focus on furbearing animals such as the martin, the beaver and the muskrat, occur along the route and are centred on trapline cabins. Some trapline cabins have been identified along the proposed MVH extension Project by members of the Wrigley community; in the areas of Whitesand and Dam Creeks, and Blackwater River (refer to Appendix 4).

Photo 6: Trapping – PKFN

Source: PKFN

##### *4.1.2.1.5 Fish*

As reported in the Dehcho Land Use Plan, as of 2003, nine known fish spawning sites are located near the MVH extension route (EBA Engineering, 2003). Spawning sites are located near the mouths of the Ochre and Blackwater Rivers, as well as in other tributaries along the route. The procurement of fish resources, particularly Whitefish, is an important subsistence harvesting activity that may be tied to traditional use, and non-traditional land use (for both subsistence and commercial uses) throughout the Mackenzie Valley.

##### *4.1.2.1.6 Waterfowl*

All of the drainage areas along the MVH extension route are considered potential waterfowl habitat (EBA Engineering, 2003). This includes the Mackenzie, Blackwater and Ochre Rivers, as well as major creeks and other smaller watercourses. Waterfowl such as duck and geese species are traditionally harvested by Dehcho First Nations, including the PKFN, and traditional hunting grounds located near Blackwater River and Vermillion Creek South may be utilized for harvesting this resource.

#### *4.1.2.2 Vegetation Harvesting*

The harvesting of vegetation is an important traditional activity in this area of the Mackenzie Valley for subsistence, medicinal purposes and for art materials. During community interviews, two locations of rare plants were identified along the MVH extension route, south of Blackwater

River and south of Whitesand Creek. However, it is also likely that other locations throughout the valley contain sources of traditionally harvestable vegetation.

Berry picking is known to be a popular activity within the PKFN community, and harvesting activities may occur throughout the Mackenzie Valley (Golder Corporation, 2006). Not only are the berries used for subsistence, but some berries, along with other vegetation types such as birchbark, wood and lichens are used for art materials.

### 4.1.3 Land Occupancy

The notion of land occupancy arises from the ideology that land can be used in different ways. Land occupancy describes the areas used by the Aboriginal people for shelter, travel, teaching and other cultural or spiritual activities. Areas of land occupancy differ from natural harvesting areas in the sense that these areas are occupied exclusively for a given use where as natural harvesting areas can be utilized for several uses simultaneously. For example, an area used for wildlife harvesting can be used for vegetation harvesting at the same time. Unfortunately, limited data on land occupancy was available during the preparation of this PDR. Further information was obtained during the public consultation held in January 2012. However, this information was not analysed in the present PDR due to the fact that the informaton was obtained during the final stages of the its preparation. A map illustrating the location of various types of land occupancy including cabins, lean-tos, campsites, tent-frames, tent sites, open fires, snow caves, and other cultural and spiritual sites, as well as Dene trails is presented in Appendix 9. Information on land occupancy was collected from the PKFN community during two rounds of public consultations and through a video produced by the PKFN, which presents the lifestyle of community-members, practices and traditions. The public consultations are discussed further in Section 5, Community Involvement.

#### *4.1.3.1 Shelter and Gathering Sites*

In current times, the PKFN people live primarily in Wrigley, however they regulary carry out traditional activites in the areas north of Wrigley and the surrounding regions. Traditional land use sites related to cultural and spiritual practices are often located in areas far from Wrigley. For this reason, the PKFN people will spend days away from their primary residence in order to participate in traditional activities. While away from their homes, PKFN people will use cabins, low-wall cabins, lean-tos, lean-to tepees, tents, caves and snow caves for shelter. Camp sites generally include an open fire, a gathering place for the community members and nearby food caches, used for hiding food both above and on ground.

#### *4.1.3.2 Travel (Trails)*

Trails have been used for travel by many generations of PKFN people. These trails are illustrated on all the maps prepared for this PDR, The trails are primarily concentrated along the Mackenzie, Blackwater and Ochre Rivers and lead to various points of interest such as

Wrigley, Blackwater Lake, Fish Lake where many cultural and spiritual sites are located. Members from the PKFN also use those trails when practising natural resources harvesting activities such as fishing, hunting, trapping, snaring and gathering of medecinal plants and other types of vegetation.

#### 4.1.3.3 *Teaching*

Traditional knowledge is a fundamental element of information that is gathered and passed on between generations. As shown through the video prepared by the PKFN, the community elders teach and transmit their knowledge to the younger generations by organizing camp-outs. Traditionally, camp-outs last several days and take place at specific sites away from the primary residence. During these camp-outs, the community elders transmit the knowledge that they have acquired over their life time, through their personal experiences or from their respective elders. Typically, traditional knowledge is communicated through oral means or through experiences and teachings. It manifests itself in the form of stories and ecological knowledge that form the basis of the community's spiritual and cultural life.

### 4.1.4 Archaeology and Heritage Resources

The archaeological component of traditional land use in the Mackenzie Valley, in the area of the MVH extension, includes a historic and prehistoric record that extends back approximately 11 000 years. The importance of understanding the archaeological prehistory of the area is tied to the understanding of its significance for the Aboriginal groups that inhabit the region. The Study Area used for the overview assessment of the archaeology and heritage resources is a corridor approximately 1 km wide, which includes the proposed road. This archaeological overview assessment was restricted to a desktop review of site data files held by the GNWT and readily available published references. No field work was conducted during this phase.

The archaeology and heritage resources study had two goals; first, to determine if any previously recorded sites are located in the immediate vicinity of the highway alignment; and, second, to assess archaeological potential within the project area as far as possible. This overview study represents the first phase of project assessment for heritage resources.

Heritage resources are defined as archaeological or historic sites, burial sites, artifacts or other objects of historical, cultural or religious significance (PWNHC, n.d.). Heritage resources are non-renewable and finite. These resources are important sources of historical knowledge and cultural identity.  As such, they are considered of value to local communities and to the Northwest Territories in general, as well as to scientists working to document and understand the human past in the north.  Consequently, they are protected by legislation. It is illegal to disturb an archaeological site, burial or artifact, and no land use activity is permitted within 30 m of a known or suspected heritage site.  Only qualified persons can conduct archaeological research under permit granted by the Government of the Northwest Territories (PWNHC, n.d.).

Archaeological sites are the physical remains of past people's activities. They can be altered by any activity that causes ground surface disturbance and they are often not readily identifiable by the untrained eye. In this study area in particular, where there is soil development and vegetation growth, potential for buried sites exists, and such sites often have no visible remains on the surface. It is important to ensure proper consideration of heritage resources prior to initiation of any ground disturbing activities.

#### *4.1.4.1 Methods*

The major objective of an overview study is to compile sufficient information to determine the potential for heritage resources to occur within the proposed development area. This typically involves a combination of research of documentary data and examination of terrain features. The latter usually comprises a combination of topographic map interpretation, examination of aerial photographs, and visual assessment (often by helicopter overflights). The resulting archaeological potential assessments can be used to determine the scope of further work that may be required.

#### *4.1.4.2 Principles of Heritage Resource Potential Assessment*

Heritage resource potential assessments are typically based on a combination of topographical, environmental and historical information. It should be noted that potential ratings are simply estimates of the chances of encountering heritage resources based on available data. It does not imply that sites will definitely be found in high potential areas or that no sites will be found in low potential areas. The emphasis in field investigations is generally placed on areas judged to exhibit moderate to high potential for heritage resources. However, since human behaviour can be unpredictable, it is acknowledged that sites can occur in unexpected locations. Consequently, examination of a sample of areas rated as low potential is generally included in the research strategy.

An important component of the determination of heritage resource potential in any region is assessment of natural resources, environment and landscape features and how these combine in any specific area to provide possibilities for meeting basic human needs of food, water and shelter. The following factors are of primary importance to human location (not listed in any particular order):

- Fresh water;
- Level camping area of suitable size or other shelter possibilities, such as caves, rock overhangs;
- Animal and plant resources;
- Wood or other fuel for heating and cooking;
- Reasonable travel routes;
- Exposure (south facing often preferred);

- View of surrounding area, both for game sighting and defensive purposes;
- Sources of flakeable stone or other specific raw materials needed.

Generally speaking, the more of these factors that combine in any particular location, the higher the potential for archaeological remains. In this region, large lakes and rivers are of high potential due to the presence of a wide range of food sources, as well as serving as travel routes and identifiable landmarks. Given that big game hunting was one of the primary pursuits, the locations that would offer the highest heritage resource potential would be elevated landforms such as terraces or knolls providing dry ground (for camping) overlooking shallow lake or river narrows or grassy meadows preferred by game. Convenient travel routes such as gentle river valley terraces or long, continuous ridges would also be rated as good potential, as are lakes or rivers containing fish, particularly at stream outlet/inlets. Waterlogged or sloped land or very high, irregular rocky outcrops would present low heritage resource potential. The range of landforms and ground types between these extremes would be variously rated low, moderate or high potential, depending on the location's specific features and setting.

Topographic assessment is combined with historical background knowledge gleaned from research of documentary sources to determine archaeological potential for various sections of the study area under consideration.

Documentary research generally involves consultation of the following sources:

- Recorded heritage site files of the Government of the Northwest Territories;
- Historic journals of early explorers, fur traders and travelers;
- Ethnographic studies;
- Previous archaeological studies in the general area,
- Traditional knowledge information, when available.

These sources provide information on past human settlement patterns and activities that can be used to focus archaeological field investigations as well as to aid in interpretation of study findings.

#### *4.1.4.3 Study Specific Methods*

This overview assessment was based on examination of contours shown on a topographic map depicting the winter road alignment at a scale of 1:25 000 and ortho photos. The alignment is to largely follow the existing winter road within a 1 km corridor and no specific areas of deviations were identified. Wherever possible, existing permanent bridges are to be incorporated; therefore, this was a major routing consideration.

It must be emphasized that the terrain archaeological potential assessments included here are considered preliminary. Visual examination of terrain in the field is by far the most reliable method of terrain assessment. This permits identification of the archaeological potential of specific terrain features with a high level of confidence. A second method is interpretation of aerial photographs; although somewhat less accurate, aerial photos do provide depth perception, a crucial element for determination of archaeological potential.

Only baseline documentary information directly relevant to the description of heritage resources of the general study area has been included here. Documentary research was limited to recorded site files, past archaeological studies, and previously gathered knowledge of past people's activities in the general region. More extensive background information concerning land use in the specific study area will be required in any report prepared to document field work. Traditional knowledge should be incorporated in both the heritage resource potential ratings and in site significance assessments, where possible.

In this case, no significant level of terrain assessment was possible. Therefore, this archaeological overview should be considered a partial assessment. It is based on existence of known heritage resources, knowledge of past people's settlement and use patterns of the region, and topographic map assessment.

At this preliminary stage, this overview assessment must be considered fairly general. Landforms with some potential for archaeological resources in the immediate vicinity of the corridor were identified at a fairly coarse level. These assessments must be field tested. Furthermore, known heritage sites must be field located and compared to the proposed alignment and all associated infrastructures.

#### *4.1.4.4 Study Limitations*

It is important to note that a specific alignment was not identified for this study; rather, the existing winter road was used as the base alignment. Any deviations from the winter road alignment will require further assessment and probably some level of field investigation.

Reliable assessment of the potential of specific terrain features to have archaeological resources requires one of two data sources: on-site visual examination of terrain or stereoscopic pairs of large scale aerial photographs. Neither of these was available for this study. Minor variations in terrain could result in very different potential ratings; therefore, a very fine level of assessment is required. Consequently, terrain potential assessment for this road could only be completed to a general level. Further archaeological studies should be completed during snow free conditions for areas along the final alignment and orthophotographic imagery data should be collected along a 1 km wide corridor that follows the preferred alignment before construction.

At the time when this study was undertaken, no borrow sources or other infrastructure components were confirmed. Any potential material sources that have not been covered during previous work by GNWT or MGP should be studied for archaeological potential during the snow free months of 2012 previous to highway construction.

Coordinates for existing site locations (virtually all recorded in the 1970s) were originally roughly approximated from 1:50 000 topographic maps since GPS units were not used in archaeological field investigations at that time. Consequently, site locations could be inaccurate by as much as several hundred metres. Therefore, potential for impacts to already recorded sites cannot be estimated with any degree of certainty without field proofing the locations. For the same reasons noted above in regard to terrain potential assessment, only a small deviation of the disturbance area can totally reverse impact assessment for a specific site.

More time for more focused background research would have permitted more detailed comments on areas of heritage relevance. Particularly lacking is traditional knowledge, which would indicate historic trail routes and various areas of past uses.

#### *4.1.4.5 Summary of Human History*

Documentary research is directly relevant to this study in a number of ways:

- It provides knowledge of past subsistence patterns and lifestyles necessary to develop archaeological resource types and location expectations;
- It provides the basis to design appropriate study methods and focus field investigations;
- It provides a context in which to place study findings;
- It warns of possible site conflicts or significant areas.

The following summary is based on research of readily available documentary data. Sources that were consulted include: archaeological site inventory records held by the Northwest Territories government, early fur trader/explorer accounts, ethnographic/anthropological studies, and reports on past archaeological investigations. Pertinent topographic, palaeogeological, palaeoenvironmental and traditional knowledge information will be incorporated to form a detailed knowledge base in order to assess the potential for heritage resources at the next study stage.

##### *4.1.4.5.1 Prehistory*

Archaeological investigations in northwestern North America have long been focused on trying to determine timing and travel routes for the first people entering North America. The Mackenzie Valley was thought by some to be one of the possible routes used (Clark, 1981) to populate the continent from Alaska and the Yukon; however, no very early sites have yet been found. In fact, despite over 50 years of archaeological research, the cultural history of the Mackenzie Valley is not well defined. Below is a preliminary cultural history sequence that has not been substantially revised in two decades.

The early Prehistoric Period (~10 000-6 000 years B.P.) is not well represented in the Mackenzie Basin. The Paleoarctic Tradition has been dated as early as 11 000 years B.P. (before present) in the Yukon and Alaska west of the Mackenzie, to as late as 4 500 years B.P. in other areas. Distinguishing characteristics in these site assemblages are presence of notched burins and microblades and occasional unnotched lanceolate bifaces (Morrison, 1987). There are as yet no dated sites that have been assigned to this Tradition in the Mackenzie Valley. Several tools recovered from Chick Lake, west of this study area, are very similar to the Acasta Lake complex found east of Great Bear Lake, which dates back to 7 000 years ago (Millar and Fedirchuk, 1974).

The Middle Prehistoric Period (6000-2000 years B.P.) is characterized by blending of Northern Cordilleran lanceolate point technology from the south with Paleoarctic microblade technology from the west. This has been termed Northwest Microblade Tradition (Clark, 1991). Artifact assemblages dated to this tradition typically contain flake burins, microblades, lanceolate notched points and stemmed points. The Esker Bay site on Fish Lake southeast of Wrigley has a lower component that likely dates to this period (Morrison, 1984).

The Late Prehistoric Period (1 500 to 200 years B.P.) is represented in the Mackenzie region by a complex called Spence River, first identified in a site on the upper Mackenzie (Morrison, 1984). Artifacts characteristic of this assemblage are small, triangular and leaf shaped side to corner-notched points, small end scrapers and gravers, coarse lithics such as chi-thos and cobble choppers, and an elaborate bone and antler technology comprising such tools as metapodial fleshers and bone awls (Clark, 1991). Microblades are typically absent. The small notched points suggest the appearance in the north of the bow and arrow hunting method (Morrison 1984). Most of the prehistoric sites recorded in the Mackenzie Valley thus far appear to date to Late Prehistoric times (Pilon, 1988). A notched point was found in the upper component at the Esker Bay site east of Wrigley (Morrison 1984). Several of the prehistoric sites within the study corridor may also have tools representing this period, but they have not yet been intensively and systematically excavated.

##### *4.1.4.5.2 Historic Period*

A number of explorers travelled the Mackenzie River and recorded observations of the environment and of their encounters with the aboriginal people they met. First was Alexander Mackenzie who, in 1789, travelled down the river to the Delta from Great Slave Lake and then back up (Mackenzie, 1801). He briefly described his contacts with aboriginal people (Mackenzie, 1801). In 1826, Sir John Franklin's second polar expedition travelled down the Mackenzie River and then back up to Great Bear River and up that river to winter at Great Bear Lake (Franklin, 1828). Thomas Simpson (1970) travelled down the Mackenzie River in 1836 on his way to explore the Arctic coast. Sir John Richardson, a member of the 1826 Franklin expedition, made his second trip down the Mackenzie in 1850 (Richardson, 1851). Although they provided some descriptions of the environment and the people they encountered, these early explorers essentially did not venture far from the banks of this portion of the Mackenzie River. That was also the case for later travellers and adventurers, e.g., Russell (1898) who travelled the river by canoe on a scientific expedition in 1894, and Waldo (1923) who travelled by steamboat in 1922. Fur traders and missionaries who actually lived in the region did explore more of the country and had more contact with aboriginal inhabitants. This primary focus on the Mackenzie River valley continued throughout the historic period.

The fur trade in the Mackenzie Valley began shortly after Alexander Mackenzie's historic voyage in 1789. Posts were established at strategic locations to intercept the First Nations people. This began in 1795 with the establishment of Trout River Post by the Northwest Company 80 miles downstream from the river's outlet (Keith, 2001). From this post, trading expeditions occasionally travelled some distance downriver to meet and trade with other Slavey and Hare groups. Fort Alexander was built at the mouth of the Willowlake River (a short distance upstream on the Mackenzie from the current study area) by the Northwest Company in 1817 and operated until 1822 (Keith, 2001).

The first fur trade post relating to the current study area was Fort Wrigley, built on the east shore of the Mackenzie (south of the current site) by the Hudson's Bay Company around 1887 and operated there until 1904 (Usher, 1971). In 1902, independent traders established a post on the west bank a short distance north (probably near the mouth of the Wrigley River) in 1902. In 1904, the Hudson's Bay Company built a post there, followed by two other groups of independents in 1911 and 1926 (Usher, 1971). The Hudson's Bay Company operated at that site until 1966 when the fort moved to the current site at Hodgson Creek. Between 1928 and 1932, two independent traders operated posts at the mouth of the Blackwater River (Usher, 1971).

In the 1850s, missionaries from both the Anglican and Catholic churches arrived in the Mackenzie District and travelled the region from missions at Fort Simpson and Fort Good Hope. Steamboats began to travel up and down the Mackenzie River in 1887. The RCMP began patrols in the Mackenzie region in 1903 (Robinson and Robinson, 1946) and established a post at Fort McPherson that year. In 1913, a detachment was built at Fort Simpson, and in 1916, one was established at Fort Norman/Tulita (Robinson and Robinson, 1946:13).

Oil and gas exploration began in the vicinity of Norman Wells in the early 1900s. The existence of oil was known from the earliest explorations; its presence oozing from the river bank was noted by Alexander Mackenzie (1801) in 1789. The first productive oil well was drilled in 1920 and a small refinery was built. The 1930s saw the development of a winter road in the Mackenzie Valley to bring construction supplies from Edmonton to the oil fields. This road was occasionally built as needed in the next few decades. Since the 1970s, it has been built and used annually.

#### 4.1.4.5.3 *Mackenzie Dene Ethnography*

This general study area was occupied at the time of contact by a group of Athabaskan speakers called Slave or Slavey (Asch, 1981). Traditionally, this group was not organized into any cohesive unit such as a tribe; rather they functioned in small semi-nomadic groups, who differentiated each other by geographic locations or some variation in behaviour, speech or cultural feature (Asch, 1981). Membership was fluid and all groups had access to the entire land area. It may be most reasonable to refer to all the people making use of this study area by the designation that Janes (1983) and Helm (2000) used: Mackenzie Basin Dene. The lifestyles and subsistence patterns were very similar for all people using the central Mackenzie basin (Asch, 1981).

Much of the following information is summarized from Robert Janes (1983) and June Helm (2000), two anthropologists who lived with two of the Mackenzie Basin Dene groups for periods of time. Janes spent two summers in the 1970s with the Willow Lake people who ranged from the mouth of the Great Bear River northeast to Willow (now known as Brackett) Lake, just north of the current study area. Helm spent much of 1951 and 1952 with a group of people at Jean Marie River, a short distance south of the current study area.

Mackenzie Basin Dene were necessarily semi-nomadic; the limited availability of food resources required travelling to different parts of their range via a network of well-used, interconnecting trails with changes in seasons to take advantage of all available animals and plants. According to Asch, Slavey people typically conducted their subsistence activities during most of the year within a small area around a good fish lake in order to have a dependable food source (1981:339).

Mackenzie Basin Dene would typically spend the winter in small family groups at a good fishing lake and make short hunting forays into surrounding areas as necessary. In early spring, people began to move to larger lakes or rivers in search of more plentiful supplies of fish, smaller mammals such as muskrats and the arriving migratory waterfowl. Longer hunting trips were also conducted at this time since people had often depleted all their preserved foods over the winter. In summer, the Mackenzie Basin people of the study area congregated at the larger river mouths on the Mackenzie River (Hanks and Winter, 1986). This was when intensive fishing and fish drying was done, as well as visiting and dancing. Other important activities carried out at this time included making and repairing tools, boats, fishnets, clothing and skin shelter covers. Autumn was the time for another major hunting and trapping period in order to obtain enough meat for the winter.

The most important food resources for the Mackenzie Basin Dene were moose, small mammals and fish. Hunting large mammals was done at any time of the year. Hunting moose was most commonly done by individual or pairs of hunters since the animals are typically solitary. To the northeast, barren ground caribou were found in larger groups during winter, since this was part of their winter range (Savishinsky and Hara, 1981).

Large games were taken with bow and arrows, spears, snares and deadfalls. Smaller game such as hares and ptarmigan were snared: “The snare was an important hunting device for all northern Athabaskans and was used for all animals” (Janes, 1983:10). Fish were caught with hooks and willow bark nets and by using weirs at river mouths and narrows. Rosehips, several types of berries, medicinal plants and roots were gathered in bark baskets. Besides being eaten fresh, berries were pounded with meat, fish and fat to make pemmican. Cooking methods primarily comprised roasting and stone boiling. In summer, surplus food was preserved by smoking and drying, in winter by freezing and caching.

Two main types of dwellings were used. One was a structure with log walls chinked with moss and covered with a roof of spruce boughs. A squat type of tipi with a moose or caribou skin covering was used in summer and when travelling. A temporary overnight shelter was often built by bending small trees and covering with moose hide and/or brush. Travel was primarily by boat or canoe or on foot in summer and snowshoes in winter, with belongings being pulled on toboggans. Traditionally, boats were made out of moose skins, while canoes could be of spruce or birch bark.

Plant and animal materials formed a large component of tools and implements. Snares, snowshoes and fishnets were made of babiche and sinew or spruce or willow roots. Baskets and dishes were made of birch bark or spruce root. Tools such as knives, arrows, spears, hide scrapers or fleshers were made of combinations of stone, animal bones and wood.

#### *4.1.4.5.4 Previous Archaeological Studies*

Archaeological investigations in the Mackenzie Valley began in the early 1950s (e.g., MacNeish in 1953) as part of a search for the routes used by early colonizers of North America. In 1972, the first of several archaeological surveys relative to a possible multipurpose utility/road corridor in the Mackenzie valley was completed; twenty sites were found on Blackwater Lake just to the east (Millar, 1972) and from which the Blackwater River comes. In 1973, an archaeological research study of the Mackenzie Valley two miles to either side of the river between Fort Providence and the Arctic Red River found 376 “occupations” (Millar et al., 1973). Within this study corridor, four archaeological sites were recorded.

Millar also led a survey of a highway route between Wrigley and Inuvik in 1973 (Millar and Fedirchuk, 1974). The route was to parallel the Mackenzie River, only deviating where necessary to use more favourable terrain or tributary drainage crossings. As a result of this survey, 27 archaeological and historic sites were recorded within the Wrigley to Blackwater River area. The project included some construction monitoring in the southern section. In 1981, several of the sites were investigated further (Fedirchuk, 1982).

In 1973, the first of a number of archaeological studies of potential pipeline corridors in the Mackenzie Valley was completed between Fort Simpson and Fort Good Hope (Losey, 1973). Access was from the river, thus, this survey was largely confined to a narrow band along the east bank with some examination short distances up some major rivers. The one area intensively examined within the current study area was the vicinity of the Blackwater River where three sites were recorded, comprising historic cabins, trading post remains and a possible grave.

In 1999, archaeological studies were conducted of proposed upgrades to the existing winter road between Wrigley and Fort Good Hope. These involved field assessments of 17 proposed bridges and 12 potential culvert locations (Ronaghan, 2000). Seven larger creek and river crossings (including the Blackwater and Ochre rivers) and six smaller drainages that were assessed fall within the current study area; these have likely all since been built. No new sites were found and several of the previously recorded sites could not be relocated (Ronaghan, 2000).

In 1983, a survey was conducted along the Mackenzie River to find and study historic aboriginal camps (Hanks and Winter, 1986). Four sites were recorded within in the vicinity of the Blackwater River. These sites contain tent frames, cabin remains, cache and a grave.

Most archaeological investigations since the mid-1980s have been related to Mackenzie Valley oil and gas pipeline proposals. These studies were predominantly surveys to locate sites and provide recommendations for avoidance or mitigation.

Beginning in 2002, four field seasons of archaeological investigations were completed for the Mackenzie Gas Project (MGP) (Clarke et al., 2003; Clarke et al., 2004; Clarke and Webster, 2005; Webster et al., 2007). The first three years of these studies consisted of examination of selected high archaeological potential portions of a 1 km wide possible pipeline corridor as well as specific borrow sources and infrastructure locations. The entire pipeline routing was not assessed. The 2006 season focused mainly on revised borrow and infrastructure locations. Two archaeological sites and five traditional sites were recorded within the Blackwater to Wrigley section, three of which are close to the current road corridor. Previously recorded sites that were in close proximity to the proposed pipeline developments were also revisited over the four field seasons.

In summary, previous regional archaeological studies focused on high potential terrain features, that is, the Mackenzie River terraces, mouths of major rivers and several large lakes. Outside of these areas, only specific development zones have been examined. Such focus has left substantial portions of the region unexamined.Thus far, these studies have contributed a substantial body of data relating to the early human settlement patterns in the Mackenzie region. No detailed site specific investigations have been completed relative to the current Highway project to date.

#### 4.1.4.5.5 *Recorded Heritage Resources*

Thirty-five archaeological sites have been previously recorded along the east side of the Mackenzie River within 1.5 km of the existing winter road between Wrigley and southern border of the Sahtu Settlement Area. The sites are shown in Figure 7 at a large scale in order to safeguard the integrity of the sites. Most of these sites have been recorded at the mouths of creeks and rivers along the Mackenzie River or short distances upstream from those confluences. This distribution is undoubtedly at least partly due to the narrow focus of past archaeological studies. The majority of these sites have only been recorded to a preliminary level, and several have been subjected to some subsurface testing. The known sites were primarily recorded during the surveys noted above related to the original utility corridor and road and bridge assessments conducted in 1972, 1973 and 1999.

The site types recorded in this site assemblage are representative of the full range of cultural history postulated for this Mackenzie region. They include prehistoric stone tool making sites, prehistoric camps, historic aboriginal camps, cabins, trails, graves and recent camps/cabins.

### 4.1.4.6 *Archaeological Overview Assessment*

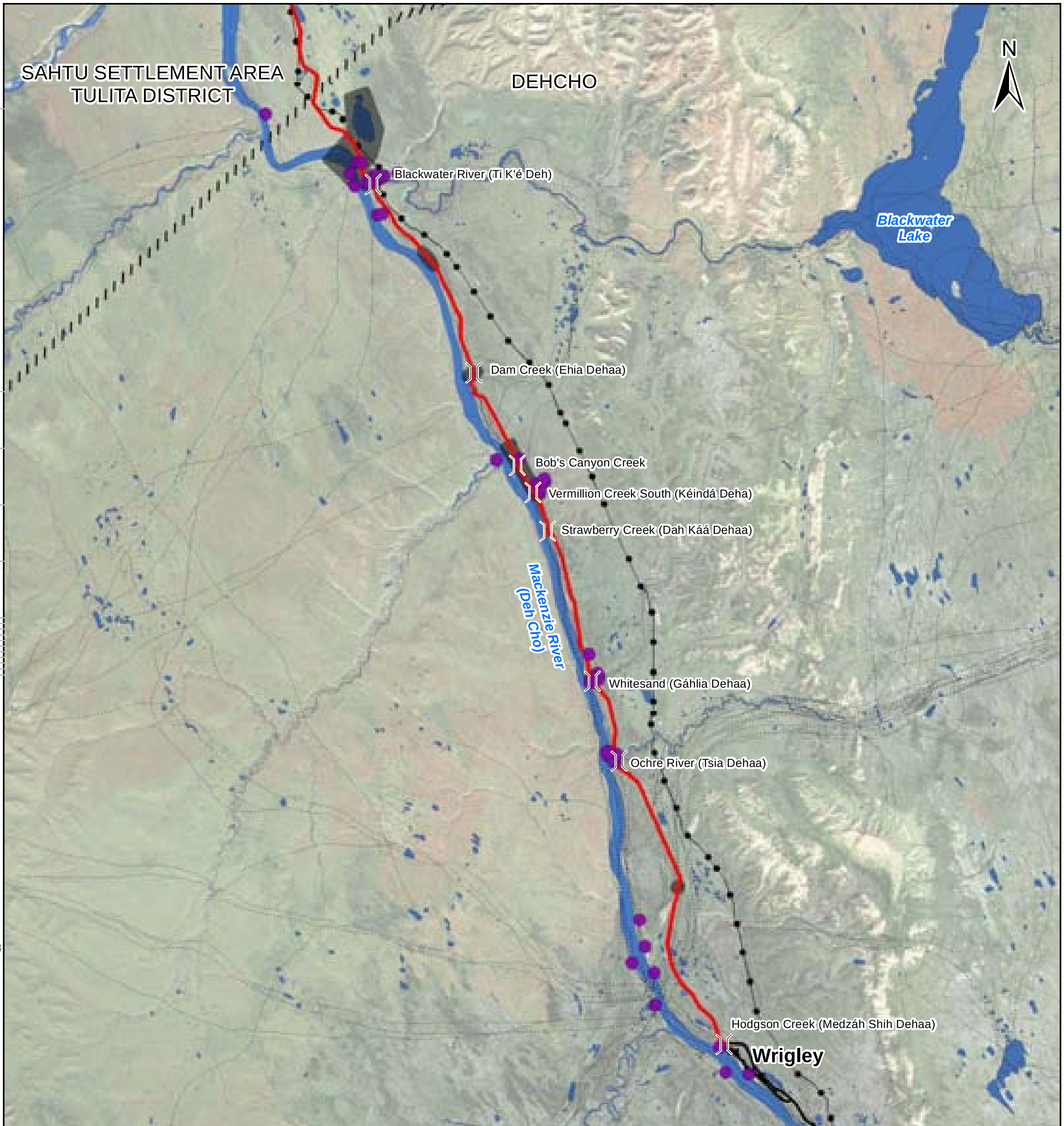
Locations of archaeological sites are strongly dictated by locations of resources and terrain types, as noted above.

#### 4.1.4.6.1 *Terrain Potential*

This study corridor appears to be characterized by a variety of terrain features and vegetation cover. Until the ortho imagery is produced and planned field studies have been conducted, only general terrain potential statements can be made.

1. The closer to the Mackenzie River, the higher the archaeological potential.
2. River and creek terraces and elevated lake shores have high archaeological potential.
3. Elevated knolls and ridges have moderate to high archaeological potential, depending on associated water features or surrounding terrain.

It is important to bear in mind that the archaeological records could extend back as far as 11 000 years. Over that period of time, climate and vegetation have varied dramatically, and there have been significant changes in drainage patterns (i.e. creeks and rivers have meandered and downcut, lakes have expanded and contracted). Therefore, terrain features with good potential for archaeological resources could be situated considerable distances from current bodies of water.




Winter Road

Other Road

Gas Pipeline

Settlement Boundary

Existing bridge

Bridge to be built or re-built

PKFN trails

Archaeological and Heritage Sites

PKFN Main Traditional Activity Site

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Figure 7**
**Archaeological and Heritage Sites**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C106-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km

Projection UTM zone 10N, WGS84

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Since most of the all-weather highway alignment is proposed to follow the existing winter road, a high proportion of the route is already disturbed. In general, creek and river crossings represent the best archaeological potential, but virtually all the bridges for this proposed highway have been built as part of the winter road. Consequently, most of the best potential areas have already been impacted. Although most of the larger stream crossings in this section were assessed for archaeological resources (Ronaghan, 2000) prior to construction of the existing bridges, it is virtually certain that no archaeological assessments of these specific areas were conducted prior to that time. Therefore, with regard to the drainage crossings, it is only likely that impacts to intact archaeological sites could occur in those instances where it may be necessary to revise the approaches to a bridge or to relocate a bridge.

Besides water crossings, several sections of the proposed highway alignment traverse terrain suggestive of good archaeological potential, that is, apparently level, elevated, dry ground with a defined landform edge or other terrain feature such as knolls or ridges. Of particular interest are sections close to the Mackenzie River upper terrace edge, such as near locally named “Dam” Creek, north and south of Vermillion Creek South, and north of Whitesand Creek.

#### *4.1.4.6.2 Recorded Site Proximities*

Although the all-weather highway is expected to largely follow the existing winter road, some revisions are anticipated, particularly at some of the drainage crossings where approaches may need to be revised. Due to the fact that the alignment is not yet finalized, it is not certain whether any of the recorded archaeological sites are within the proposed right of way. This is further compounded by the fact that recorded site coordinates may not be accurate (see discussion below). No site proximity assessments can be completed for any other project components (such as borrow sources, laydown areas) since those locations have not yet been identified.

Thirty-five archaeological sites appear to fall within approximately 1.5 km of the current winter road alignment (Table 9), and 21 sites are within 500 m, based on the locations provided with the site data and georeference data Figure 7. Some of the sites may already be disturbed or destroyed by the ongoing maintenance and use of the winter road or by past construction of nearby utility lines.  It is possible that one or more historic trails may be crossed, since they generally follow the drainage valleys.  Archaeological and heritage resources may also exist in the locations that will be used for the associated components of the MVH extension project (such as borrow materials sites, construction camps, staging areas and access roads).

Archaeological sites were previously recorded at the locations listed below, which are found within the project corridor.  With the provison that site location plots may be inaccurate, most sites are some distance from the current used/proposed crossings, except where noted:

- Blackwater River; ten sites, two on or near alignment;
- Unnamed creek opposite Johnson River; one site;

- Vermillion Creek South; four sites;
- Whitesand Creek; seven sites;
- Ochre River; nine sites;
- Hodgson Creek; one site.

One significant problem is that coordinates for some of the previously recorded sites are inaccurate. For those sites recorded prior to the standard use of GPS (that is, before the late 1990s), site locations were approximated from topographic maps. Indeed, from simply plotting the site coordinates onto current project maps, it is clear that the plotted locations for some sites are not the same as the descriptions on the site forms. For example, the site form states that KiRl-4 is on a lower terrace at the mouth of the Ochre River, but the coordinates plot the site approximately 500 m north of the river. Furthermore, those sites that were reported in the 1970s to be near or on the winter road alignment or one of the existing pipeline/Canadian Northern Telecommunications cutlines may already have been destroyed. Therefore, the current condition of all previously recorded sites needs to be confirmed.

Table 10: Recorded Archaeological Sites near Project Components

| SITE | LOCATION | ESTIMATED DISTANCE* | TYPE |
|---|---|---|---|
| KhRk-5 | Hodgson Creek /Mackenzie confluence | within 500 m | historic camp |
| KiRl-1 | Ochre River/ Mackenzie confluence | within 300 m | lithic scatter |
| KiRl-2 | Ochre River upper terrace | within 250 m | cache pits |
| KiRl-3 | Ochre River upper terrace | within 200 m | lithic workshop |
| KiRl-4 | Ochre River lower terrace | within 200 m | historic cabin |
| KiRl-5 | Ochre River lower terrace | within 600 m | lithic scatter/camp |
| KiRl-6 | Ochre River / Mackenzie confluence | within 300 m | lithic scatter |
| KiRl-7 | Ochre River upper terrace | within 250 m | lithic scatter |
| KiRl-8 | Ochre River upper terrace | within 600 m | historic cabin |
| KiRl-9 | Ochre River / Mackenzie confluence | within 700 m | historic trap |
| KjRl-1 | Whitesand Creek lower terrace | within 700 m | lithic scatter |
| KjRl-2 | Whitesand Creek upper terrace | within 800 m | lithic scatter |
| KjRl-3 | Whitesand Creek upper terrace | within 700 m | lithic scatter |
| KjRl-4 | Whitesand Creek upper terrace | within 700 m | lithic scatter |
| KjRl-5 | Whitesand Creek lower terrace | within 500 m | lithic scatter |
| KjRl-8 | Whitesand Creek / Mackenzie confluence | about 250 m | camp |
| KjRl-9 | Whitesand Creek upper terrace | within 800 m | trail |

Table 10 (cont'd): Recorded Archaeological Sites near Project Components

| SITE | LOCATION | ESTIMATED DISTANCE* | TYPE |
|---|---|---|---|
| KjRl-6 | unnamed creek lower terrace | within 300 m | prehistoric lithic |
| KkRl-2 | Vermillion Creek South lower terrace | within 700 m | historic trap |
| KkRl-5 | Vermillion Creek South lower terrace | within 500 m | prehistoric lithic |
| KkRl-3 | Vermillion Creek South base of terrace | within 1.4 km | historic camp |
| KkRl-4 | Vermillion Creek South upper terrace | within 1.5 km | historic hearth |
| KkRl-1 | Unnamed creek bank | within 300 m | prehistoric lithic |
| KlRm-1 | Blackwater River | within 1.2 km | historic cabin |
| KlRm-2 | Blackwater River lower terrace | within 500 m | historic cabin |
| KlRm-3 | Blackwater River | within 1.1 km | historic hearth |
| KlRm-4 | Blackwater River lower terrace | within 100 m | historic camp |
| KlRm-5 | Blackwater River lower terrace | within 200 m | cache |
| KlRm-6 | Blackwater River | within 1.1 km | cache pit |
| KlRm-7 | Blackwater River | within 200 m | historic shelter |
| KlRm-9 | Blackwater River lower terrace | On winter road? | trading post |
| KlRm-10 | Blackwater River lower terrace | within 300m | historic camp |
| KlRm-12 | East of Mackenzie River | On winter road? | grave(s) |
| KlRm-11 | Mackenzie River shore | within 500 m | trading post |
| KlRm-13 | Blackwater River upper terrace | within 500 m | lithic scatter |

*Distance estimated to winter road alignment, based on georeference data provided for each site

Confirmation of the individual sites' status and location relative to proposed project components by field investigation is necessary in order to permit appropriate site specific recommendations, as is required by NWT Archaeological Regulations. Future studies related to archaeological and heritage resources would necessarily involve examination of not only those sites located near/within the proposed highway alignment, but also those sites identified for associated works (i.e. staging areas, temporary access roads, etc.).

#### *4.1.4.6.3 Heritage Expectations*

The background research results provide the basis for some preliminary statements on locations and types of heritage resources that can be expected.

The Mackenzie Valley understandably has a large number of recorded archaeological sites and more should be anticipated. Potential for archaeological resources generally decreases as one moves away from the river, except along specific drainage systems, such as the Blackwater River, and associated lakes. Based on the distribution of recorded archaeological sites and documentary research, sites can be expected in those sections that are close to the Mackenzie Valley, near confluences, on creek terraces and slightly elevated terrain adjacent to larger lakes. Upper terraces and long ridges would provide good potential for trails.

Background research indicates that the types of archaeological resources to be expected could include various types of structural remains, hearth remains, stone tools and flakes, a variety of bone and wood artifacts, and bone concentrations. Depending on their size, humanly made pits could represent semi-subterranean houses, or caches for food or belongings, or for cooking. As a result of the rapid deterioration of wood remains in this region, only more recent sites may be represented by wooden traps, snares, platforms, caches, or dwelling remains. Further, because of the high proportion of organic material used as tool components, most of older sites would likely only contain stone tool parts. Historic trails may be identified by blazes, cut stumps or lobsticks.

## 4.2 OTHER LAND USE AND MANAGEMENT AREAS

### 4.2.1 The Draft Dehcho Land Use Plan

The DLUPC has submitted to the GNWT and Indian and Northern Affairs Canada (INAC) the Draft Dehcho Land Use Plan that identifies specific land management goals and policies throughout the Dehcho Region. As of 2006, the land use plan has been in draft form and under review by the Government of the Northwest Territories. If the land use plan is accepted, it will be used to assess proposed land developments within the Dehcho Region. The plan includes specific guidelines directed at preserving natural and cultural resources (DLUPC, 2006b). The most recent version of the plan is referenced here in order to reflect the goals and values of the DLUPC as they pertain to traditional land use in the area. Eventually the Dehcho Board will be responsible for implementing the DLUPC under the authority of the MVRMA.

Until the plan is accepted, all lands within the Pehdzeh Ki Ndeh – Dehcho Region are subject to land and resource management regulations defined in the Dehcho Interim Measures Agreement, signed in 2001, and managed by the Dehcho First Nations and Governments of Canada and the NWT (AANDC, 2010). Currently the permitting of lands within the Dehcho Region is overseen by the Mackenzie Valley Land and Water Board (MVLWB).

### 4.2.2 Management and Conservation Areas

The Draft Dehcho Land Use Plan identifies 38.3% of the Dehcho territory as conservation zones (See Figure 8). Within conservation zones, traditional uses and tourism are the only permitted activities that are not subject to the permitting requirements set within the Dehcho Land Use Plan (DLUPC, 2006b). This includes sections along the proposed MVH extension that are located in areas within the proposed Pehdzeh Ki Ndeh Area Conservation Zone (DLUPC, 2006b). Additionally, the DLUPC has identified a Special Infrastructure Corridor zone (encompassing a total 0.77% of the Dehcho Region) that follows the proposed route of the Mackenzie Valley Pipeline. Each of these areas is described within the Draft Dehcho Land Use Plan.

### 4.2.3 The Pehdzeh Ki Ndeh Conservation Zone

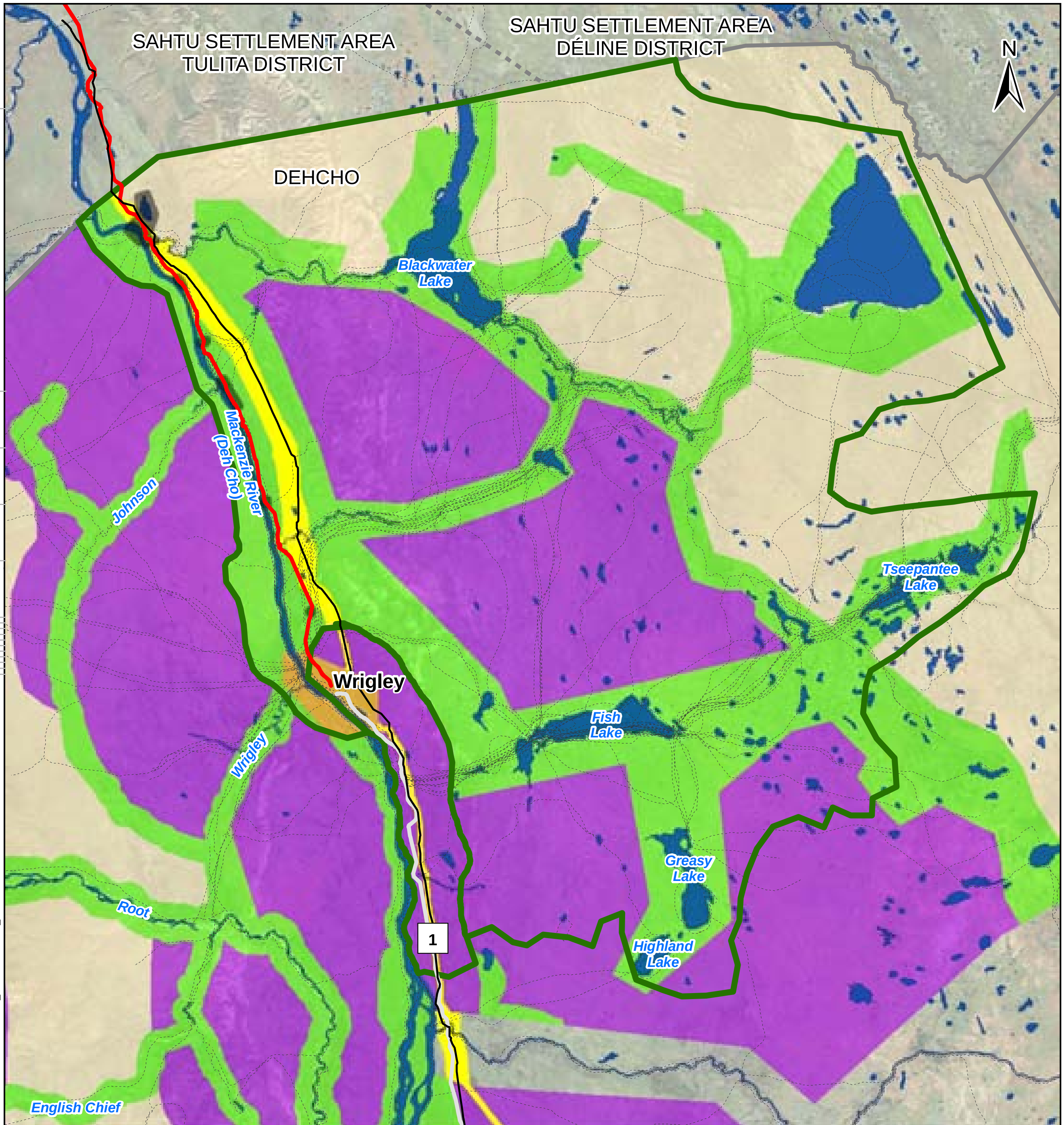
As of 2008, the proposed Pehdzeh Ki Ndeh Conservation Zone is a 16 400 $km^2$ portion of land located to the northeast of Wrigley. The proposed Conservation Zone is a part of the Dehcho Land Use Plan and is intended to protect the local PKFN's subsistence harvesting needs (PAS, 2009). The area provides habitat for moose, woodland and barren-ground caribou, black bears, wolves, migratory birds and fish, and represents an important cultural area for the community of Wrigley. Currently the PKFN is attempting to protect the area through the NWT Protected Areas Strategy (PAS), a territorial process directed at creating development and environmental protection guidelines for sensitive ecological and cultural areas in the NWT (PAS, 2009). As of November 2011, the Pehdzeh Ki Ndeh is at step three of the eight step process for PAS designation, in which assessment work is being conducted.

The Draft Dehcho Land Use Plan explains that the area is home to, “significant ecological and cultural values.” The Pehdzeh Ki Ndeh Area contains the Old Wrigley town site, as well as burial sites and traditional travel routes near its western boundaries. Within the Draft Dehcho Land Use Plan, the Pehdzeh Ki First Nation has identified numerous sacred sites in the proposed Pehdzeh Ki Ndeh Area (DLUPC, 2006b). Additionally, there are a number of cabins and traplines found in the area around the lakes that connect to Wrigley by traditional trails, several of which are found along the winter road alignment (DLUPC, 2006c; Appendix 4, sheets 1-10). Special allowances for the construction of the Mackenzie Valley Pipeline are also included within the Draft Dehcho Land Use Plan for the Pehdzeh Ki Ndeh Area.

### 4.2.4 The Mackenzie Special Infrastructure Corridor

The Mackenzie Special Infrastructure Corridor is a proposed area that follows the proposed Mackenzie Valley Pipeline route (see Figure 8). The corridor zone is designed to permit special access for the construction and maintenance of the pipeline through the Dehcho Region, while minimizing potential key cultural and ecological impacts and securing access to traditional resources for the Dehcho First Nation (DLUPC, 2006b). The Mackenzie Special Infrastructure Corridor is considered to “float” over other identified areas and zones within the Draft Dehcho Land Use Plan, and add additional permitted uses for the pipeline within these areas. The Mackenzie Valley Pipeline would run through the proposed Pehdzeh Ki Ndeh Conservation Zone, and be subject to conservation guidelines identified there upon the approval of the land use plan.

The Mackenzie Special Infrastructure Corridor is identified as containing critical habitat for woodland caribou and wolverine, which are both protected under the Species at Risk Act, as well as critical habitat for waterfowl and moose (DLUPC, 2006b). Additionally, culturally significant traditional land use areas, as identified by the DLUPC, are located within the proposed corridor area.




| | |
|---|---|
| Winter Road | Conservation Zone |
| Gravel Highway | Special Management Zone |
| Gas Pipeline | Special Infrastructure Corridor |
| District Boundary | General Use Zone |
| Settlement Boundary | Wrigley Community Boudary |
| PKFN trails | Pehdzeh Ki Ndeh Area of Interest |
| 1 Highway Number | PKFN Main Traditional Activity Site |

Sources :
- © Bing Maps, 2006-2009
- Decho Land Use Planning Committee, 2006
- CanVec, Canada Government.
- NTDB, 1 : 250 000, Canada Government
- Northwest Territories, Centre for Geomatics
- PKFN, 2011
- © Deh Cho First Nations, 2004
- Dessau, 2011.

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 8**
**Other Land Use Zones**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C111-00 |
| Drawn : | G. Lemay | Scale : | 1:1 000 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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### 4.2.5 Past and Existing Non-Traditional Land Uses

The Dehcho Land Use Plan identifies a number of tenured land use types existing along and adjacent to the proposed MVH extension route. Given the natural environment of the Mackenzie Valley north of Wrigley, a variety of land use categories may be found in the region including uses related to tourism and the availability of natural resources such as timber, mineral and oil and gas deposits. Non-traditional wildlife harvesting along the MVH extension route may include subsistence hunting and trapping by non-Aboriginal individuals, or by commercial guide outfitters. It is likely that the areas identified in Appendix 4, sheets 1-10 may also be utilized for these purposes. Field investigation will be required in order to obtain more specific information on non-traditional land uses along the MVH.

## 4.3 PROPOSED FUTURE LAND USES

Proposed future land uses in the area of the proposed MVH extension are permitted according to the Mackenzie Valley Land Use Regulations (MVLUR). Currently the Mackenzie Gas Project (MGP) represents the only potential major development; however the DLUPC has indicated an interest in developing tourism infrastructure in areas along the proposed MVH, including some areas north of Wrigley.

It is likely that with the development of the MVH extension, future land use activity, including both traditional and non-traditional land uses, will increase in frequency and intensity due to the improved access to land surrounding the route.

Tourism potential along the MVH extension route is considered to be very high, as the Mackenzie River is identified by the Dehcho Land Use Plan as an important natural attraction (DLUPC, 2006b). Given that tourism activities tend to be concentrated around communities that provide access to scenery and wilderness experiences, the plan identifies Wrigley as a hub in the area, however, tourism infrastructure is currently not well developed.

The Dehcho Land Use Plan indicates that the MVH extension route is located within lands expected to have low or uncertain mineral potential. However areas of moderate to high potential, including two zones of very high development potential, are identified to the east of the route (DLUPC, 2006b). Oil and gas potential is estimated to be low in the Mackenzie Valley area north of Wrigley.The potential for agricultural and forestry developments in the area of the MVH extension route is limited to pockets around Wrigley, and may be considered generally low. It should also be noted that other land use permit applications may currently be pending with the MVLWB and may only become apparent at a later stage in the approval process.

### 4.3.1 The Mackenzie Gas Project

The MGP represents an important project in the development of the natural resources in the NWT. The proposed project includes the construction of three onshore natural gas fields in the Mackenzie Delta, which will transport natural gas by a 1 196 km long pipeline to the North American market (Imperial Oil et al., 2011). It is the first proposal of its kind to pass through an EIA in the NWT. The proponents of the MGP include Imperial Oil Resources Ventures Limited Partnership, the Mackenzie Valley Aboriginal Pipeline Limited partnership, Conoco Phillips Canada (North) Limited, Exxon Mobil Canada Properties and Shell Canada Limited.

The MGP is the largest proposed project in the NWT, which, if developed, may lead to spin-off projects in each of the territorial sub-regions it passes through.

# 5 COMMUNITY INVOLVEMENT

This section details the consultation process that has taken place as part of the development of this PDR. The consultation program involved three rounds of meetings with community members of the Pehdzeh Ki Ndeh – Dehcho region. Each of the three rounds is detailed below, including an examination of the results of the meetings. The consultant team was in touch with some community members throughout the process of researching and writing this PDR, in order to hear comments and concerns from the community, and to obtain information.

## 5.1 CONTEXT

Meetings and consultation sessions for the proposed highway were held during the environmental screening process for the Pehdzeh Ki Ndeh – Dehcho region section. The Environmental Impact Assessment Guidelines issued in March 2004 by the Mackenzie Valley Environmental Impact Review Board (MVEIRB), stress that the preliminary screening process should be open, transparent and participatory.[5] In order to develop a project that fulfills its initial purpose while also providing some benefit to those affected by its development, local communities and stakeholders need to play a prominent role in the design of the project. Community participation is the tool through which this can be achieved.

Community involvement is of the utmost importance during the preliminary screening process. According to the MVRMA, the party to be consulted must be provided with (i) notice of the matter in sufficient form and detail, (ii) a reasonable period of time to prepare and (iii) the opportunity to present views. The consultants must consider fully and impartially any views presented (Minister of Justice, 2005:s.3).

The objective of public consultation is to share information on the methods and predicted impacts of the Project and to collaborate with local residents, aboriginal groups and authorities on finalizing an appropriate project design. Public involvement can take the form of solicitation, public meetings, facilitated and mediated community engagement sessions, workshops and public notices (newspapers, internet, etc.) (MVEIRB, 2004). These exercises provide participants with opportunities to give their views and opinions on the proposed Project, ask questions, express concerns and provide recommendations according to their different backgrounds and experiences.

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5 Section 120 of the Mackenzie Valley Resource Management Act (MVRMA) provides the MVEIRB with the capacity to produce guidelines for Environmental Impact Assessments for projects to be undertaken in the Mackenzie Valley (Minister of Justice, 2005).

## 5.2 BACKGROUND

Discussions on the MVH Extension Project started at the end of the nineties. Almost ten years prior to entering the preliminary screening process, some consultation and participative activities were held:

- An initial Stakeholder Workshop was held in Norman Wells on June 8, 1998. The workshop was attended by approximately 60 stakeholders and generated considerable discussion on the need-for, and benefits-of, an all-weather road;
- A meeting with the Sahtu Secretariat and the Sahtu Regional Land Corporation Presidents was held on November 12, 1998;
- Interviews with Elders regarding traditional knowledge as well as consultations with technical experts and stakeholders were undertaken during 1999;
- Formal public consultations were undertaken as part of the Environmental Scoping Study during 1999. A public meeting with the Wrigley community was held on March 29, 1999. The principal concerns identified during the Wrigley public consultation were the following:
  - Community should be empowered to choose whether or not they want a road;
  - Outstanding disputes with government and industry over lands and resources should be settled before development is undertaken(including land claim agreement for Dehcho);
  - All-weather road should bring in more people and jobs. The community wants training and employment from the road;
  - Tourism benefits could be major, but require planning at the community level;
  - The economic and social benefits of the road should be planned to trickle down to the grass-roots level;
  - Wrigley should be compensated for social problems brought by the highway, as well as the loss of wildlife occasioned by an increased outside access to traditional hunting grounds (hunting must be controlled, wildlife protected and social programs implemented).

Details and results from these consultations can be found in the document titled Mackenzie Valley Highway Extension Environmental Scoping Report of September 1999 (Geonorth and Golder Associates, 1999).

## 5.3 METHODOLOGY

The MVH Extension Project community involvement program for Pehdzeh Ki Ndeh – Dehcho Region from Wrigley to the Sahtu Settlement Boundary involved two phases; early community engagement and public involvement throughout the preliminary process.

## 5.4 EARLY COMMUNITY ENGAGEMENT

### 5.4.1 Approach

Following the approach outlined in the Environmental Impact Assessment Guidelines, prior to beginning the screening process, a consultation was organized to engage parties that could potentially be affected by the development. The consultation session was held in Wrigley in November 2010. The purpose of the meeting was to inform the community about the proposed highway extension project. The session was hosted by the PKFN and the Pehdzeh Ki Contractors Ltd. (PKCL). Representatives of the Dessau/HTES team as well as representatives of the Government of the Northwest Territories Department of Transportation (GNWT-DOT) were present. The Mackenzie Valley Highway Extension was presented with an emphasis on the Dehcho Segment, which is located between Wrigley and the Sahtu Settlement boundary. During the meeting, participants were invited to ask questions and make comments on the Project.

### 5.4.2 Community Consultation Process

The early consultation session was held on Monday November 22nd, 2010, in the community of Wrigley at 3h00 pm. The session took place at the Band office, in the Pehdzeh Ki Community Complex Gym.

#### *5.4.2.1 Invitation and Communication*

Invitations for the early consultation were prepared by PKFN in collaboration with the Dehcho First Nation government. Information concerning the date, the venue, the time, and the agenda for the first consultation were transmitted to the Dehcho government, who identified communities and organizations to be invited.

The communication strategy included five components: a newspaper notice, a public notice, a radio announcement, a general project location map, and a multimedia presentation.

##### *5.4.2.1.1 Newspaper, Public Notices and Radio Announcement*

A notice about the public consultation (see Appendix 5 – Annex 1) was published in Wrigley's main newspapers. It was also posted on the Community Complex Public Bulletin Board, two weeks prior to the consultations. The notice was published in the following newspapers:

- Deh Cho Drum;
- NWT News/North.

In addition to the notices, a radio announcement was recorded to broadcast the information included in the public notice.

*5.4.2.1.2 General Project Location Maps*

Photo 7: Location Map

A general project map showing the entire Mackenzie Valley Highway extension Project was posted on the wall next to the presentation screen with the intention of enabling participants to visualize the whole project.

*5.4.2.1.3 Multimedia Presentation*

A multimedia presentation was prepared for the early consultation session (see Appendix 5 – Annex 2). It contained general information on the Mackenzie Valley Highway Extension. The presentation included an in-depth look at the players in charge of the environmental impact screening process for the Pehdzeh Ki Ndeh – Dehcho Region. Objectives to be achieved, regulatory agencies involved, benefits of the project as well as the role of communities were examined and discussed.

### *5.4.2.2 Agenda*

The early consultation process entailed four parts: an opening prayer; an introductory word; a multimedia presentation; and a discussion session.

The format of the session was as follows:

- Opening Prayer
- Introductory word: Understanding of the Purpose of the Meeting
- Presentation of the Mackenzie Valley Highway Extension Project
  - Introductions: PKCL, HTES and Dessau
  - A look at the MVH Project
  - The Project Description Report (PDR)
  - The Community Consultation Process
- Discussion session

*5.4.2.2.1 Opening Prayer and Introductory Word*

The early consultation session began with an opening prayer done by one of the elders of the Pehdzeh Ki First Nation (PKFN): Elder Gabe Hardisty.

Following the prayer, the PKFN Chief, Tim Lennie opened the session in both English and Slavey and presented the Mackenzie Valley Highway Extension Project. He talked about local socioeconomic benefits for Wrigley Community.

*5.4.2.2.2 Presentation of the Mackenzie Valley Highway Extension Project*

In order to reach the audience and ensure that all attendees were able to gain a good understanding of the project, a presenter known by the PKFN community, Mr. Bradley Enge, gave the multimedia presentation (20 to 30 minutes).

*5.4.2.2.3 Discussion Session*

Following the MVH Presentation, participants were invited to ask questions and make comments or suggestions. Ms Tannis Cli-Moses, Office Management/Financial Clerk at Pehdzeh Ki Contractors also made a short address and gave her contact information in order for participants to send any further comments.

## 5.4.3 **Results**

### *5.4.3.1 Meeting Dynamics*

Throughout the meeting, the ambience at Community Complex Gym was upbeat. People were very positive and curious. There were approximately 65 attendees including many families and young children. Participants were interested in seeing the presentation and hearing from the presenters. They were very quiet and attentive. The audience showed enthusiasm toward the project; however, they did not ask any questions after the presentation

The presentation was conducted within the recognized protocol (tobacco offering), and a table with snacks, beverages, and fresh fruit from Yellowknife was also set up to welcome participants. The PKFN Chief and Band Council, the board of directors of Pehdzeh Ki Contractors, representatives of Government of Northwest Territories department of transportation, and representatives of Dessau sat at the head table.

Photo 8: Public Consultation of November 22nd, 2010 – Community Complex Gym, Wrigley

#### 5.4.3.2 *Key Comments, Questions and Concerns*

PKFN Chief Tim Lennie expressed, during his opening word, the Wrigley community's main concerns regarding the MVH:

- Local economic and social benefits should be maximized;
- PKFN community participation during the preliminary screening is critical;
- Skills training and job creation are expected within the community;
- There is a need for heavy equipment training; and,
- The Mackenzie Valley Highway Extension Project represents a unique opportunity for the development of the Wrigley community.

No further comment or question was raised by the audience following the informative early consultation session. Participants were invited to send their views, comments, and concerns by email to the representative of Pehdzeh Ki Contractors: Ms Tannis Cli-Moses.

## 5.5 PUBLIC INVOLVEMENT THROUGHOUT THE PRELIMINARY SCREENING PROCESS

### 5.5.1 Approach

As mentioned in the Environmental Impact Assessment Guidelines, preliminary screening must be an open, transparent and consultative process. Therefore, two rounds of public consultation sessions were held during the preliminary screening of the Mackenzie Valley Highway Extension Project for the Dehcho Section.

The primary goal of the first round was to present the preliminary screening process steps and progress to date. A secondary goal was to discuss the winter road alignment, the possible impacts of a new all-weather highway, sensitive components, potential impacts and mitigation measures.

The purpose of the second round was to present the preliminary screening findings including impacts, mitigation measures and optimization measures. During the second round, all questions and comments that had been raised previously were addressed, and participants were invited to make any final comments. The optimized alignment, which had been adjusted in response to comments and recommendations from the first public consultation, was presented and there was an open question period following the presentation, where participants were invited to comment and ask any remaining questions.

### 5.5.2 First Round

The first round of public consultations was held on Thursday July 7, 2011, in the community of Wrigley at 1h30 pm. The session took place at the Band office, in the Pehdzeh Ki Community Complex Gym. People were invited to arrive earlier as a lunch was served at 11h30 am.

### 5.5.2.1 Invitation and Communication

Invitations for the first round of public consultations were prepared by PKFN in collaboration with the Dehcho First Nation government. Information concerning the date, the venue, the time, and the agenda for the consultation was transmitted to the Dehcho government, who identified communities and organizations to invite.

The public consultation communication strategy for the first round was composed of six components: a factsheet, a newspaper notice, a public notice, project location maps, a multimedia presentation, and comments sheets.

#### 5.5.2.1.1 Factsheet

The Project Information Factsheet (see Appendix 6 – Annex 1) is a 1 page pamphlet that contains key relevant information about the proposed Mackenzie Valley Highway Extension for the Dehcho Section. It includes a summary of the technical details of the Project, a list of potential benefits, and a review of the environmental impact assessment process.

The factsheet was distributed to attendees at the meeting and extra copies were available at the PKFN Band office.

#### 5.5.2.1.2 Newspaper and Public Notices

A notice of public consultation (see Appendix 6 – Annex 2) was published in Wrigley's main newspapers and posted on the Community Complex Public Bulletin Board, two weeks prior to the consultations. The notice was published in the following newspapers:

- Deh Cho Drum;
- NWT News/North.

#### 5.5.2.1.3 Project Location Maps

Two project location maps showing the Mackenzie Valley Highway alignment for the Pehdzeh Ki Ndeh - Dehcho region were used at the first public consultation session with the intention of allowing participants to consult them at anytime. The maps showed the location of the MVH and participants were invited to identify traditional, cultural and spiritual areas on them. The information collected from the forementioned mapping activity was transcribed to a map found in Appendix 4, sheets 1-10. They were installed in accessible zones inside the Community Complex Gym and helped participants to visualize the Mackenzie Valley Highway Extension Project within the Pehdzeh Ki Ndeh – Dehcho region.

#### 5.5.2.1.4 Multimedia Presentation

A multimedia presentation was prepared for the consultation session (see Appendix 6 – Annex 3). It contained much of the same information as the Factsheet, but the information was more detailed and presented in a visual, animated way, to assist the audience to understand the characteristics of the proposed Project. The presentation included some additional elements, such as an in-depth look at the various steps of the environmental impact screening process, the progress to date and some of the technical challenges of building on permafrost. Also, the presentation included an explanation of the participation with the affected communities and the importance of the participatory process.

##### 5.5.2.1.5 Comments Sheets

Comments sheets were distributed to participants in order for them to write down observations, concerns or questions related to the MVH Project (see Appendix 6 – Annex 5). Comments sheets allowed for a greater participation by giving to those who are less comfortable with asking questions out loud, a way to express themselves and to give their remarks or concerns on the Project.

#### 5.5.2.2 Consultation Process

##### 5.5.2.2.1 Agenda

The agenda for the first round of public consultations included five elements; an opening prayer; an introductory word; a multimedia presentation; a mapping activity, and a discussion session.

The format of the session was as follows:

- Opening Prayer
- Introductory word
- Presentation of the Mackenzie Valley Highway Extension Project and Progress to date
  - Project location and details
  - Benefits of the Project
  - Environmental Impact Assessment Process
  - The Community Consultation Process
- Mapping Activity
- Discussion session

##### 5.5.2.2.2 Opening Prayer and Introductory Word

Like the early consultation, the first public consultation session began with an opening prayer given by one of the elders of the PKFN: Elder Gabe Hardisty. Following the prayer, the PKFN Chief, Tim Lennie said a short introductory word.

##### 5.5.2.2.3 Presentation of the MVH Extension Project

The multimedia presentation was given by the same presenter as the early consultation: Mr. Bradley Enge. He is well-known by the PKFN community, which helps participants to feel at ease. The presentation length was approximately thirty (30) to 40 minutes. Details were provided on the technical aspects of the MVH Extension Project, the environmental impact assessment process and road building techniques on permafrost. Priority was given to discussion of public participation and community involvement.

*5.5.2.2.4 Mapping Activity*

In order to identify areas of particular concern, traditional land use areas and gain obtain more information on traditional practices and knowledge, a mapping activity was organized with the PKFN community. The activity involved identifying the locations where traditional activities are practised on a map pinned on the wall. Participants added comments, concerns or suggestions on the map as well (see Appendix 4, sheets 1-10).

*5.5.2.2.5 Discussion Session*

Following the presentation and during the mapping activity, participants were invited to pose questions and make comments or suggestions. Ms Tannis Cli-Moses, Office Management/Financial Clerk at Pehdzeh Ki Contractors also made an allocution and provided her contact information in order for participants to send any further comments.

### *5.5.2.3 Results*

*5.5.2.3.1 Meeting Dynamics*

The public consultation held on July 7th, 2011 was attended by 20-30 persons, including several Pehdzeh Ki elders and the chief. Many of the individuals in attendance were young adults and teenagers (see attendance sheets in Appendix 6, Annex 4). There was a table with snacks and fried chicken (KFC), as well as recognized protocol offerings (tobacco offering). The turnout for the meeting was somewhat disappointing, considering the large turnout for the previous meeting held on November 22nd, 2010; however, the intimacy of the meeting offered attendees more opportunity to speak and participate. In order to have a larger turnout at future meetings, attendees suggested offering rewards or door prizes such as multi-media systems, which would motivate members of the community to participate.

Most members of the group were actively involved in the discussion, offering opinions on the proposed project as well as feedback on the public consultation process. Participants showed some fatigue with regards to the consultation process, as they have been involved in consultations for other projects and have discussed their traditions with various groups in the recent past. They seemed to have some reservations regarding consultations as their past experiences were not always positive and in some cases they felt left out of the decision-making process and that their comments and concerns were not taken into consideration. Despite their reservations, all participants showed interest in learning about the progress of the MVH Extension Project.

The hesitant attitude of the group towards the consultation process resulted in some tension early in the meeting. As the session progressed and the group became more engaged, the tension lifted and attendees showed a more positive outlook towards the highway extension project. Participants were attentive and focused throughout the meeting and showed particular enthusiasm during discussions of the opportunities that the project may bring to the community.

Among the participants, the Chief of the Pehdzeh Ki First Nations was the most vocal. Prior to the meeting, he had reviewed the draft work program for the preliminary screening report and offered comments and edits. In addition, he suggested that a door-to-door survey be undertaken within the community to obtain perceptions and concerns from all members of the band (see door-to-door survey results below for more details). The elders also played a key role in the consultation, as they worked together to produce a map of traditional land use areas and the main areas where traditional activities take place. They also commented on the winter road alignment and proposed modifications to the alignment in response to traditional and environmental considerations.

*5.5.2.3.2 Mapping Activity*

Attendees at the consultation were invited to participate in a mapping activity, which involved identifying sensitive areas and cultural or historical locations on a map that was pinned to the wall. Mainly community elders were involved in the activity. Within the region between Wrigley and the Sahtu Settlement Border, they identified the general locations of burial areas, hunting cabins and traplines, moose pasture areas, moose sensitive areas, spiritual and cultural sites, traditional hunting grounds and areas where proximity to water presents a concern for the construction of an all-weather road (see Appendix 4, sheets 1-10).

*5.5.2.3.3 Key Comments, Questions and Concerns*

Based on the information gathered during the public consultation held on July 7th, 2011, the main concerns regarding the MVH extension project in the Pehdzeh Ki Ndeh – Dehcho Region are related to the following elements:

- Training and job opportunities;
- Socioeconomic impacts;
- Surface and land claims;
- Traditional land use and knowledge;
- Sensitive heritage and cultural considerations;
- Alignment;
- Community participation.

In general, members from the PKFN see the project as an opportunity for training and employment. Their members would like to be involved in the construction of the new bridges and of the MVH extension project, as well as its maintenance once constructed. The PKFN members have questions and are concerned about the various issues which may potentially impact their day-to-day lives as well as the future of their children. Furthermore, it is very important to PKFN members that their traditional land use sites and knowledge be protected. Surface rights and claims is also a major concern for the PKFN members. .

The summary table below presents in detail the main areas of interest discussed as well as the comments and questions raised during the community consultation:

Table 11: Wrigley Community Consultation Summary (July 7th, 2011)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | BY (COMMUNITY) |
|---|---|---|
| Training and job opportunities | Training people before the highway is built. | PKFN |
| | We want to acquire work. | PKFN |
| | Would have liked to be involved in the construction of the new bridges. | PKFN |
| | We already do maintenance for the Mackenzie Valley Highway from N'Dulee to Wrigley. We would like to be in chargeof the maintenance of the new extension as well. | PKFN |
| | Put people to work. | PKFN |
| | Young group should be trained for a sustainability objective. | PKFN |
| | We would like to have training on heavy equipment. | PKFN |
| Training and job opportunities | It's important to look at the whole procedure in order to see where we can be involved. We are capable of executing the whole thing. We would like to know what the phases are and where we can be involved in order to work (capacity building). | PKFN |
| Socioeconomic impacts | Should have positive benefits. | PKFN |
| | PKFN did not receive any socioeconomic benefits from the pipeline as promised. People were tricked. They did not receive scholarship or training opportunities. | PKFN |
| | PKFN should be compensated for the long term benefits that the 4 season road will bring to Pehdzeh Ki Ndeh - Dehcho Region as it is passing through their territory. | PKFN |
| | We have lots of drop outs and therefore we need adult education in the community. In particular, we need training packages for the young people that have finish grade 12 to further their education or go back to school to train for careers. | PKFN |

Table 11 (cont'd): Wrigley Community Consultation Summary (July 7th, 2011)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | BY (COMMUNITY) |
|---|---|---|
| Surface right and land claims | We do not have control over the surface rights of the gravel pits. | PKFN |
| | Need to work towards resolving who has surface rights to mine the gravel pits. | PKFN |
| | We want to have a clear picture of what are the rights we have. | PKFN |
| | Why expropriate if the land belongs to PKFN? There should not be expropriation. | PKFN |
| Traditional Land Use and Knowledge | Need to protect traditional knowledge and be careful on how traditional information is used. | PKFN |
| | An effort has been made to collect traditional knowledge in a study. The document includes 40 years of traditional knowledge. | PKFN |
| | People will be free to roam on our territory, restrictions should be considered. There will be too many people on our land. | PKFN |
| | Protect all our rivers, creeks and forest for our future generations. The community members are very concerned about protecting our land, moose, caribou and fish along river and timbers. | PKFN |
| Sensitive cultural and heritage considerations | Vermillion Creek Bridge is too close to the Mackenzie River, to moose pasture areas and to hunting grounds. The bridge should be moved further east to avoid negative impacts on sensitive areas. | PKFN |
| | There is an important burial ground close to Willowlake River. The Mackenzie Valley Highway up to Wrigley already had some negative impacts on that sacred ground. The extension to the north would result in more people passing through this burial ground. Restrictions or compensation should be considered. | JMRFN |
| | Blackwater area is a very important traditional place. There is an old grave that should be protected. | |
| | Enbridge pipeline is very close to sacred ground. | PKFN |
| Alignment | The CN alignment is preferred for the 4 season road. | PKFN |

Table 11 (cont'd): Wrigley Community Consultation Summary (July 7th, 2011)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | BY (COMMUNITY) |
|---|---|---|
| Community participation | Public consultation sessions should be done in the evening to allow for a greater participation. | PKFN |
| | Food should be given only at the end to avoid people eating and then leaving without listening to the presentation | PKFN |
| | Chief and councillors could pay people to attend meetings or offer some door prizes, which could help participation. | PKFN |
| | It would be good if a presentation could be organized in the school to involve the higher grades. It's their future. | PKFN |

### 5.5.3 Survey

Following the public consultation held in July 2011, Chief Tim Lennie requested that a door-to-door survey be conducted within the community to obtain individual opinions and  to educate the community as to the project's benefits and potential impacts. The survey's main objectives were to promote greater community involvement in the preliminary screening process by gathering information pertaining to people's perception of the project as well as their primary concerns regarding the potential impacts of the all-weather highway on the community and their traditional activities. It seeked to identify the various points of view of the community members in order to guide the leadership towards a productive and representative role in this proposed project and obtain a consensus regarding the design and alignment of the future all-weather road.  Several questions regarding traditional land use and activities were added to the survey in order to collect more precise information, thus allowing to better anticipate and mitigate the potential impacts (see Appendix 7).

The survey was conducted by the PKFN in November 2011. Unfortunately, only six individuals chose to participate. It is believed that the resistance towards the survey could be attributed to the fact that some community members expected compensation for their participation in the process.

#### *5.5.3.1 Survey Results*

According to the six individuals who participated to the survey, the main concerns regarding the MVH extension project in Dehcho are the potential impacts of the project on Pehdzeh Ki community's wellness as well as its traditional activities. The fact that their territory will be more accessible and exposed to outsiders was identified as a major preoccupation by all of the respondents. They associated new incomers with a potential increase in social problems and challenges. Most of them mentioned an easier access to hard drugs and alcohol as an expected effect of the MVH project. Another important concern for respondents is the protection of their territory's resources as well as their traditional activities. They would like them to be protected from users of the MVH (hunting ground, trapping lines, burial ground, fishing sites, ancestral sites, etc.).

The questions asked in the survey as well as a summary of the answers received are presented hereafter. Unfortunately none of the respondents used the map attached to the questionnaire to locate information which could have potentially been used as part of the baseline (Appendix 7):

What positive aspects do you expect the Mackenzie River Valley Highway project will bring to the Pehdzeh Ki First Nation community?

- Employment opportunities (contract);
- Training opportunities (skill development);
- Economic development;
- Business opportunities;
- Easier access to resources;
- Reduced cost of living;
- Tourism industry development.

What negative aspects do you expect the Mackenzie River Valley Highway project will bring to Pehdzeh Ki First Nation community?

- Increase in traffic;
- Increased presence of outsiders/strangers;
- Increase in social problems and addiction (alcohol, drugs, etc);
- Speeding problem;
- Possible outward migration of women in particular.

How do you think that a new all-weather highway will affect or change your personallife?

- Loss of traditional language and lifestyle;
- Increase in drinking;
- Family separation due to outward migration;
- New lifestyle for future generations;
- Increased access to opportunities in the Pehdzeh Ki Ndeh – Dehcho region;
- Greater participation in the project (be involved);

How do you think that a new all-weather highway will affect or change your family's life?

- Increase in social problems and addictions (violence, drinking, drugs);
- Family separation due to outward migration;
- Better access to family members living north of Dehcho;
- Family business will benefit (booming);
- Better mobility to visit family.

How do you think that a new all-weather highway will affect or change your community's life?

- Increase in traffic;
- Increase in social problems and addiction (alcohol, drugs, etc);
- Increased presence of outsiders/strangers;
- Loss of traditional language and lifestyle;
- Migration (outward and inward) of population.

What position do you think the Council should adopt regarding the highway project? (Should they be for or against it. Should they require conditions and if so what conditions?)

- Among the six respondents, three stated that the Council should be against the project;
- Among the six respondents, three stated that the Council should be in favour of the project with the following requirements:
  - Hunting/trapping control (especially for southern hunters);
  - Speeding patrol (speed check stops);
  - Check stops for drugs and alcohol;
  - Protection and preservation measures for the Dene's traditional way of living;
  - Specific programs and regulations should be set for alcohol.

Are there measures, precautions or conditions you think should be taken prior to, while and after the highway is built?

- Maintenance of the highway should be given to Pehdzeh Ki Contractors Ltd.(PKCL);
- Hunting/trapping conditions (especially for southern hunters);

What activities do you think will be affected by the new all season highway, (hunting, berry picking, fishing, spiritual and ancestry sites)?

- Hunting (highway crosses many moose pastures);
- Berry picking;
- Traditional trails;
- Fishing;
- Burial sites;
- Traditional lifestyle;
- Trees (many will be cut down);
- Destruction of ancestral sites;
- Wildlife;
- Traditional constructions.

Are you for or against this project?

- Among the six respondents, four are against the project, one is in favour, and one is undecided.

Please list up to 10 important resources (for example, caribou, fish species, waterfowl, etc) for you in order of priority?

- Berries;
- Creeks;
- Fish;
- Caribou;
- Moose;
- Waterfowl;
- Rabbits;
- Trees/plants;
- Wildlife;
- Traditional trails;
- Hunting and trapping;
- Water (rain and snow);
- Soil;
- Natural medecine;
- Ancestry sites;
- Burial sites.

Which streams contain fish within 200 m upstream or downstream of the existing crossings of the winter road? Please identify them on the attached map where possible.

- Blackwater River;
- Mackenzie River;
- Wollowlake River;
- All streams down the MVH.

Are there important heritage or archaeological resources that must be avoided and, if so where are they located? Please identify them on a map.

- Campsites;
- Grave sites;
- Old cultural site.

Which parts of the highway in your territory most interact with each of these resources (Please identify them on the attached map where possible)

- No answer for that question

List up to 10 touristic resources and locations that will be important for you (Please identify on the attached map where possible)?

- Hotels;
- Motels;
- Stores;
- Crafts;
- Carving;
- Gas station;
- Hiking trails;
- River boating;
- Blackwater;
- Mountains.

### 5.5.4 Second Round

The second round of community consultations was held in Wrigley on January 25th and 26th, 2012. The sessions took place at the Band office, in the Pehdzeh Ki Community Complex Gym. A two-day activity was organized in order to dedicate one day to introduce the MVH Project to the newly elected Band Council and allow them to fully participate to the process. The second day of consultation was open to the whole community.

#### *5.5.4.1 Invitation and Communication*

Invitations for the second round of public consultations were prepared by PKFN in collaboration with the Dehcho First Nation government. Information concerning the date, the venue, the time, and the agenda for the consultation was transmitted to the Dehcho government, who identified communities and organizations to invite. People invited were mostly the same as those invited for the first round of public consultation held in July 2011.

The public consultation communication strategy for the second round was composed of nine components: a factsheet, an executive summary, a newspaper notice, a public notice, a radio broadcast announcement, project location maps, a multimedia presentation, and comment sheets.

##### *5.5.4.1.1 Factsheet*

The Project Summary Factsheet (see Appendix 8 – Annex 1) is a 1 page pamphlet that contains key relevant information about the proposed Mackenzie Valley Highway Extension for the Dehcho Section. The pamphlet distributed to participants during the two days of consultation activities was the second one produced. The first one had been prepared for the public consultation of July 2011(see Section 5.5.2.1) and was giving a general glance of the MVH Project, whereas the second one, prepared for the second round of public consultation, was oriented towards the identification of impacts and benefits as well as the proposition of mitigation measures. It includes the optimized alignment and the guiding principles for its design.

The factsheet was distributed to attendees at both meetings and extra copies were available at the PKFN Band office.

##### *5.5.4.1.2 Executive Summary*

The executive summary of the Project Description Report (PDR) was specially edited and released for the two days of consultation activities. It allowed the Band Council to better understand the MVH extension Project without reading the complete draft version of the PDR. The 70 page document contains the main elements from the report. A total of 40 copies of the executive summary were distributed during the public consultations held the 25th and 26th of January 2012.

#### 5.5.4.1.3 Newspaper Notices, Public Notices and Radio Announcement

A notice of public consultation (see Appendix 8 – Annex 2) was published in Wrigley's main newspaper, the Deh Cho Drums and posted on the Community Complex Public Bulletin Board, two weeks prior to the consultations.

A radio announcement inviting people to the public consultation of January 26th was also broadcasted twice a week during the two weeks preceding the consultation on the CKLB radio station (101.9FM – Yellowknife).

#### 5.5.4.1.4 Project Location Map

Two project location maps showing the optimized alignment of the Mackenzie Valley Highway and the information collected during the consultation of July 2011 for the Pehdzeh Ki Ndeh - Dehcho region were used at the second public consultation session.

The first map was used during the consultation activity with the Band Council on January 25th with the intention of allowing participants to validate the traditional, cultural and spiritual areas that had been identified during the public consultation of July 2011, add additional information and discuss the proposed optimized alignment for the MVH extension in the Pehdzeh Ki Ndeh – Dehcho region. The information collected from the forementioned mapping activity was transcribed to a map found in Appendix 9, sheets 1-10.

The second map was installed in accessible zones inside the Community Complex Gym during the public consultation of January 26th, 2012 and helped participants to visualize the Mackenzie Valley Highway Extension Project within the Pehdzeh Ki Ndeh - Dehcho region.

#### 5.5.4.1.5 Multimedia Presentation

A multimedia presentation was prepared for the consultation session of January 26th, 2012 (see Appendix 8 – Annex 3). It contained much of the same information as the Factsheet, but the information was more detailed and presented in a visual, animated manner, to help the audience understand the characteristics of the proposed Project and especially the optimized alignment. The presentation included an in-depth look at the main realignment propositions and at the identification of possible impacts and benefits of the Project. Proposed mitigation measures were also presented in order to reduce or eliminate potential negative impacts of the MVH extension Project. The presentation included an explanation of the participation with the affected communities and the importance of their participation. The presentation ended with a special slide including questions for the audience and designed to encourage participation.

#### 5.5.4.1.6 Comment Sheets

Comment sheets were distributed to participants, during both consultation activities, in order for participants to write down observations, concerns or questions related to the MVH Project (see Appendix 8 – Annex 4). Comment sheets allowed for a greater participation by giving to those who are less comfortable with asking questions out loud, a way to express themselves and to share their remarks or concerns on the Project.

### 5.5.4.2 Consultation Process

#### 5.5.4.2.1 Activity of January 25th, 2012

Agenda

Both activities of consultation (January 25th and 26th, 2012) were part of a three-day agenda prepared by the Pehzeh Ki First Nation Band Council (see Appendix 8, Annex 5). The format of the session held on January 25th was as follows:

- Mackenzie Valley Highway PDR (10h00 am)
  - Introductions
  - Overview of Draft Report
  - Maps
  - Community Discussion
- Lunch (12h00pm)
- Socio Economic Impacts (1h00 pm)
  - Funding
- Recap Day Discussions (4h00 pm)
- Feast (5h30 pm)
- Youth Handgames and Drum Dance

Mackenzie Valley Highway PDR

The first day of activity began with a traditional tobacco offering protocole from the MVH project team to the PKFN community followed by an opening word from Chief Tim Lennie explaining the importance for the PKFN to participate in the MVH screening process. During the opening word, all participants were presented (MVH project teams, members of the Band Council, Representative from the Government of Nortwest Territories) and copies of the executive summary and the factsheet were distributed to each member of the Band Council. Following the introductory word, some members of the MVH project team left for a field recognition along the winter road, while others stayed with the Band Council. A short presentation of the MVH extension project was given to the newly elected Band Council members by Gina Potts-Alexis and Armin Alexis in order to help them better understand the project and the different steps of the preliminary screening.

Maps and discussion

Following the project presentation, the Band Council members were invited to participate in a mapping activity which involved validating sensitive areas and cultural or historical locations that had been identified by the PKFN community during the first round of consultation (July 2011), and discussed the optimized alignment route (see Appendix 9, sheets 1-10).

Socioeconomic impacts

After lunch, the PKFN Band Council members prepared a list of the cumulative effects of pursuing the highway on a short and long term basis. Economic, social, political and environment potential effects were examined as well as potential immediate impacts on education and training. Priorization and examination of next steps, more specifically the needs for developing the human resource requirements and training for entry level surveying and engineering were discussed among participants. A list of pros and cons was also created and discussed as well as potential needs for funding (see Appendix 8, Annex 6).

Recap Day Discussion and Feast

The first day of consultation ended with a supper and a recap of main elements discussed among participants. The MVH team members who participated in the field recognition joined the Band Council for this recap activity and shared their observations. Two members from the MVH project were interviewed and explained briefly the preliminary screeening process and the main concerns regarding the MVH project in the Pehdzeh Ki Ndeh – Dehcho Region. The entire activity session was recorded as well as the interview[6]. Pictures of the consultation activity were also taken (see Appendix 8, Annex 7). No youth handgame and drum dance was performed because the youth were out of town due to a last minute invitation show in Yellowknife.

##### 5.5.4.2.2 *Activity of January 26th, 2012*

Agenda

The agenda for the second day of activity included the following elements. In order to encourage participation, the activity day schedule included several short breaks during whichdoor prizes were drawn.

- Mackenzie Valley Highway PDR – Dessau LVM (10h00 am)
- Lunch (12h00 pm)
- Mackenzie Valley Highway – Community Roundtable
  - Family Benefits and Impacts
  - Community Benefits and Impacts
  - Cultural Benefits and Impacts
  - Socio and Economic Benefits and Impacts
  - Following Steps
- Recap Day Discussions
- Feast
- Men / Youth Open Handgames and Drum Dance

[6] The audiovisual materials are PKFN ownership.

Mackenzie Valley Highway PDR – Dessau-LVM

The second day of public consultation session began with an opening prayer given by Gina Potts-Alexis, who acted as the facilitator throughout the presentation. Following the prayer, she gave a short introductory word, welcomed participants and presented the meeting purpose. The technical part of the multimedia presentation was given by transportation engineer, Daniel Aubin, director of the preliminary screening report of the MVH project in the Pehdzeh Ki Ndeh - Dehcho Region. He presented the MVH project steps, located the project and discussed the optimized alignment as well as the design considerations. Finally, Frederic Faustin, an environmental specialist, presented potential impacts of the MVH Project and proposed mitigation measures. The presentation length was approximately 50 to 60 minutes. Priority was given to the discussion of issues engaging public participation and community involvement.

Mackenzie Valley Highway – Community Roundtable

After lunch, Gina Potts-Alexis animated a roundtable community activity on benefits and impacts of the MVH extension Project. Nevertheless, as the remaining participants were mostly the same as the ones present during the day of the 25th and as the subjects included in this activity were already covered the previous day, the session was limited to a short discussion with the participants in order to recap and confirm the information already gathered.

Recap Day Discussion and Feast

The second day of consultation ended with a supper and a recap of main elements discussed among the participants. Participants were invited to ask questions and share comments or suggestions. Ms Tannis Cli-Moses, Office Management/Financial Clerk at Pehdzeh Ki Contractors also made a speach and provided her contact information in order for participants to send any further comments.The entire activity session was recorded[7]. Pictures of the consultation activity were also taken (see Appendix 8, Annex 7). No men / youth handgame and drum dance was performed because the youth were out of town due to a last minute invitation to participate in a show in Yellowknife and Chief Tim Lennie had to leave early as well.

### *5.5.4.3 Results*

#### *5.5.4.3.1 Meeting Dynamics*

Activity of January 25th, 2012

On January 25th, 2012, the Dessau team and Mr. Jim Stevens, of the DOT, met with the newly elected Pehdzeh Ki Band Council to present the technical components of the proposed MVH extension project and discuss the alignment of the futur road (see attendance sheets in

[7] The audiovisual materials are PKFN ownership.

Appendix 8, Annex 8). The council members were elected in December and therefore, were not aware of previous phases of work/study that had been undertaken in regard to the proposed Highway extension. In order to avoid influencing the discussion or the opinions of the council members, Chief Tim Lennie left after participated in introducing the council, Mr. Stevens and the Dessau Team.

The council members were interested in learning about the Project and also in understanding the Environmental Studies program and the different phases of study involved. Overall, the reaction towards the Project was positive, and the group highlighted numerous benefits that the all-weather road may bring to the community. However, the negative aspects were discussed as well. The council encouraged further study of the potential impacts and specifically impacts on traditional and cultural activities.

Given the intimate setting of the meeting, all members of the council shared ideas and opinions and were engaged in the discussion. The setting was informal and there was a relaxed atmosphere.

Activity of January 26th, 2012

A public consultation was held on January 26th, 2012, which included a presentation to the attendees followed by a participatory exercise, similar to the one held on January 25th, 2012 and animated by Gina Potts-Alexis. All of the Band Council members and other community members participated in the public meeting. In total, an average of 20 people were in attendance throughout the day; however, due to the presence of the Doctor in the community that day, some individuals could only participate in part of the day's activities (see attendance sheets in Appendix 8, Annex 8). The group included elders, adults and a few children. Due to a last minute invitation to participate in a show in Yellowknife, there were no teenagers or young adults in attendance. The turnout for the meeting was somewhat disappointing, as the PDR team aimed to obtain the opinions and comments of as many residents as possible. Door prizes such as baseball caps, tuques, winter jackets, and fleece jackets had been drawn during the activity in order to encourage public participation, as suggested by the community during the last consultation.

Nevertheless, the session was a success in terms of meeting the PDR team's goals of transmitting information about the project and the potential impacts on the community, and re-examining the proposed alignment.

During the presentation, the audience showed non-verbal agreement (head nodding) with many of the statements and ideas that were presented, such as proposed re-alignments in consideration of natural or cultural elements. Everyone was attentive and paid close attention in order to visualize the specific location of the proposed alignment. In general, the mood was positive, although the participants continue to show a very stong interest and assertiveness during discussions regarding impacts on traditional land use and activites.

#### 5.5.4.3.2 *Mapping Activity*

During the mapping activity of January 25th, 2012, members from the Band Council confimed that main sites of traditional activities and sensitive components were correctly identified on the map and didn't add any new items. However, the newly elected Band Council proposed some realignments to the optimized route which differ from the ones proposed by the PKFN community, and more particularly by the elders, during the first round of consultation held in July 2011. The propositions, though trying to remain as close as possible to the optimized alignment and the winter road, tended to move the highway as far possible from the Mackenzie River. The Band Council members realignment proposals are presented in Appendix 9.

#### 5.5.4.3.3 *Key Comments, Questions and Concerns*

According to the two-day consultation activities held in Wrigley on January 25th and 26th, 2012, main concerns regarding the MVH extension project in the Pehdzeh Ki Ndeh - Dehcho Region are related to the following elements:

- Education and Training;
- Employment opportunities;
- Youth;
- Economic growth;
- Protection of traditional land and activity sites.

In general, members from the PKFN are not against the MVH extension on their territory, but they are concerned about the future of their children. They would like to have better access to education and training opportunities for their children in order for them to get good jobs and to benefit from the economic growth accompanying the MVH project. Essentially, the PKFN people hope that the project will bring about an improvement in their quality of life. The need for grade 12 level education in Wrigley as well as specific training in heavy equipment operation (HEO) was mentioned several times during the consultations. Youth involvement throughout the MVH project is of utmost importance for the PFKN and the community members as they would like to see them take part of the entire process.

The fact that their territory will be more accessible and exposed to outsiders, as pointed out during the door-to-door survey, is also a major preoccupation for the public consultation participants. The PKFN would like its traditional lands and resources to be protected from outsiders. The PKFN shared with the MVH Team Members data regarding the location of several important traditional land use sites and ancestral areas and trails where its members practice their activities. Though this information is of sensitive nature and is usually kept confidential, the PKFN thought it best to share this information in order to ensure that their traditional and ancestral sites will be respected and taken into account within the mitigation measures. This additional information have been included in a map in Appendix 9 and represents sensitive components that will have to be assessed and taken into account during the next stages of the MVH Project.

A most-valuable comment coming from consultations with the PKFN community was the fact that most traditional activities occur along the Mackenzie River banks. Therefore the majority of participants proposed to move the MVH extension in the Pehdzeh Ki Ndeh - Dehcho Region the furthest as possible from the Mackenzie River. A 5 km wide protection corridor was proposed by the Band Council and the public. This would avoid disturbing traditional activities sites and natural resources harvesting along the river. The PKFN would prefer the MVH extension to be constructed outside of this 5km protection corridor (see Appendix 9).

Main results from the activities held with the Band Council members and the PKFN community on January 25th and January 26th are listed below. A list of pros and cons was also created during the participation exercise led by Gina Potts-Alexis, as well as a list of priorities identified by the community for next steps and funding are presented in the following table:

Table 12: Wrigley Community Consultation Summary (January 25-26th, 2012)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | DATE | BY |
|---|---|---|---|
| Education, Training and Job Opportunities | Training for youth – heavy equipment operator (HEO), mechanics, and welders. | January 25th, 2012 | PKFN (Band Council) |
| | Employment during and after the project. What about highway maintenance? What is this budget and cost? | January 25th, 2012 | PKFN (Band Council) |
| | Youth to attain grade 12, through education they will carry on the work for the community | January 25th, 2012 | PKFN (Band Council) |
| | Members move away because of a lack of job opportunity. I work within the community for a mining company, only 20 hired from the north and 60 are from the south, this work is right in our backyard. | January 25th, 2012 | PKFN (Band Council) |
| | A lot of things involved, we need to look at tourism and training. We would like that the 90 km highway project be used to train our people as heavy equipment operators (HEO), camps at the Ochre River, we should look at building this during this summer. | January 25th, 2012 | PKFN (Band Council) |
| | We would like the members from Jean Marie River First Nation (JMRFN) to be invited to participate in any training that becomes available in preparation for the MVH Extension Project. | January 10th, 2012 (comment sent via fax) | JMRFN |
| | We would like the JMRFN to be able to participate in some of the work that will become available through the MVH Extension Project. | January 10th, 2012 (comment sent via fax) | JMRFN |
| | When the Enbridge Pipeline went through, the project team promised that the people from PKFN would get benefits and training from it, which didn't happen. What can assure us that if the MVH project goes through; PKFN will really get the benefits and the training the project team are talking about? | January 26th, 2012 | PKFN |
| | PKFN members should get ready to start education and training, especially the youth. | January 26th, 2012 | PKFN |

Table 12 (cont'd): Wrigley Community Consultation Summary (January 25-26th, 2012)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | DATE | BY |
|---|---|---|---|
| Economic Development | Highway opportunities available, build houses, develop business through joint ventures, mining, highway maintenance, and go into partnership with other communities to work with them to make things work for us. Learn from our mistakes to make it better for our youth and younger generation. When the highway was stopped in 1970's, it took opportunities away. Now we have a second chance to maximize on this opportunity. PKFN should have a process to make businesses for the members. Help them to build businesses. Share business development, and share the wealth. Help the members have business, members owning businesses will give community members ownership and pride. | January 25th, 2012 | PKFN (Band Council) |
| | Are we really going to benefit from the economic development? What guarantee us that we won't be left out? | January 26th, 2012 | PKFN |
| | The All-Weather Road will be used particularly by the industry. It will be very important that those users pay a kind of fee. A mechanism will have to be proposed by the DOT in order for those users to pay for the highway. They should pay for their use. The project needs to have a close discussion with the industry about financing. | January 26th, 2012 | PKFN |
| Environment | Environment and safety is a priority for this project. | January 25th, 2012 | PKFN (Band Council) |
| | What are the negative effects of the highway on our natural wildlife in the near future? | January 26th, 2012 | PKFN |
| | What is the effect of the MVH project on the Mackenzie river? What are the mitigation measures in case of spill? | January 26th, 2012 | PKFN |
| | How much more land do you want to destroy from the PKFN to construct the MVH? | January 26th, 2012 | PKFN |
| | Compensation measures included in the PDR should insist on the importance of reforestation for the zones where there will be a separation from the existing winter road alignment (i.e. revegetate areas that were cleared by the winter road that will not be included in the All Weather Road). | January 26th, 2012 | PKFN |
| | If it is decided that the highway is to go through the Pehdzeh Ki Ndeh - Dehcho Region, will our natural resources such as water, land, wildlife and forest areas be protected? Are these resources guarantee not to be contaminated or destroyed by the chemicals and other resources that will be transported for the construction of the highway? | January 26th, 2012 | PKFN |

Table 12 (cont'd): Wrigley Community Consultation Summary (January 25-26th, 2012)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | DATE | BY |
|---|---|---|---|
| Social considerations | This highway is going to bring all kind of drugs to the community. It's going to be a challenge for PKFN. | January 26th, 2012 | PKFN |
| | In the past, PKFN elders fought in order to halt the MVH project. What are the benefits from the MVH for the PKFN? Is the MVH going to be positive for the future generations? | January 26th, 2012 | PKFN |
| Sensitive traditional, cultural and heritage considerations | Will the highway affect culturally sensitive areas, and how will they respect these areas? | January 25th, 2012 | PKFN (Band Council) |
| | Try to avoid to the maximum possible the zone localized in the north part of Backwater River as it is of major importance for the PKFN culture heritage. | January 26th, 2012 | PKFN |
| | The Blackwater River area must be protected. | January 26th, 2012 | PKFN |
| | Suggestion by the Council Band to construct a monument at Blackwater River Bridge to underline the importance of the site for PKFN community. | January 26th, 2012 | PKFN (Band Council) |
| | PKFN is hunting on this land since many years. My grandfather hunted on this land, how do you think the PKFN members feel about having a highway running over those ancestral lands? | January 26th, 2012 | PKFN |
| | If the highway goes through (extension), it may destroy our traditional land such as burial ground, hunting, camp ground and cabins. | January 26th, 2012 | PKFN |
| Alignment | When we make decisions about the alignment it is important to keep in mind the teachings of the elders / ancestors, we did not surrender or release our lands. | January 25th, 2012 | PKFN (Band Council) |
| | The road is too close to the river, the general public will have access. For the entire PDR study, the section we are studying is the closest one to the river. The road should be a minimum 5 km from the river. | January 25th, 2012 | PKFN (Band Council) |
| | In the fall time, the moose go to the rivers and creeks; the alignment is too close to rivers and creeks. | January 25th, 2012 | PKFN (Band Council) |
| | The community should be provided with alignment options, and allow the community to make a choice through a vote. | January 25th, 2012 | PKFN (Band Council) |
| | Less access directly into Wrigley | January 25th, 2012 | PKFN (Band Council) |
| | No highway through town, it will disrupt community life, use existing back road. | January 25th, 2012 | PKFN (Band Council) |
| | Localize the All-Weather Road Alignment the furthest as possible from the Mackenzie River banks. PKFN members don't use the winter road but the river for their mobility needs. | January 26th, 2012 | PKFN |

Table 12 (cont'd): Wrigley Community Consultation Summary (January 25-26th, 2012)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | DATE | BY |
|---|---|---|---|
| Alignment | What is the Right-of-Way of the winter road? | January 26th, 2012 | PKFN |
| | Add a fourth option for the optimized alignment near Mont Gaudet. | January 26th, 2012 | PKFN |
| | The alignment must avoid as much as possible the area located in the north part of Blackwater River. | January 26th, 2012 | PKFN |
| | The all-weather highway should not pass through Wrigley for the elders won't be able to sleep because of the traffic. | January 26th, 2012 | PKFN |
| | The choice of the best alignment alternative must be done in respect of the environmental constraints and the traditional land uses; however, in addition to those constraints, the chosen alignment must imperatively pass on the existing new Blackwater River Bridge. Other existing or planned bridges throughout the alignment may be relocated. | January 26th, 2012 | Government of Northwest Territories - Department of Transportation (GNWT-DOT) |
| Community participation | We need community involvement | January 25th, 2012 | PKFN (Band Council) |
| | On the existing map, we need to talk about it. In Providence, we were asked to make a wish list for the highway, where is this information? | January 25th, 2012 | PKFN (Band Council) |
| | Look into MGP community input, we identified community benefits | January 25th, 2012 | PKFN (Band Council) |
| | The young people have ideas of developing a city / town in Wrigley, in a class project; they drew pictures of the future (high rises / infrastructure); | January 25th, 2012 | PKFN (Band Council) |
| | PKFN need to control the project and the studies, more involvement is required | January 25th, 2012 | PKFN (Band Council) |
| | Should allow the community to make their choice through a vote | January 25th, 2012 | PKFN (Band Council) |
| | Add traditional names and land on all maps of the PDR in order to help people from PKFN to better locate themselves and increase participation. | January 26th, 2012 | PKFN |
| | The MVH Project should try to better involve the youth for it's their future. There is not enough youth in the attendance. | January 26th, 2012 | PKFN |
| | Have translation in Dene for the next Public Consultation Meeting. | January 26th, 2012 | PKFN |

Table 12 (cont'd): Wrigley Community Consultation Summary (January 25-26th, 2012)

| INTEREST, CONCERN OR ISSUE | QUESTION, COMMENT OR INTEREST (AS STATED BY THE PARTICIPANT) | DATE | BY |
|---|---|---|---|
| Services and Infrastructures | Need a new store, this has been recommended by the membership. | January 25th, 2012 | PKFN (Band Council) |
| | At one time we had access to community health, but these services were removed; | January 25th, 2012 | PKFN (Band Council) |
| | We would like to have a full time Royal Canadian Mounted Police (RCMP) station | January 25th, 2012 | PKFN (Band Council) |
| | We need a better access to health care; there is a housing need; we would like to have more training; a better education for the young people (youth success in education), and career development support services. | January 25th, 2012 | PKFN (Band Council) |
| | Establish grade 12 level education in Wrigley. | January 25th, 2012 | PKFN (Band Council) |
| | Transportation and access to the mine across the river possibly by a ferry | January 25th, 2012 | PKFN (Band Council) |
| Other | As a PKFN member, I would like the highway to remain a winter road. | January 26th, 2012 | PKFN |
| | Is the Government of Northwest Territories going to take the responsibility for the impacts the MVH may bring to the PKFN community? | January 26th, 2012 | PKFN |

Pros and cons expressed during the consultation are presented in the following table:

Table 13: Wrigley Community Consultation Pros and Cons Summary (January 25-26th, 2012)

| PROS | CONS |
|---|---|
| ▸ Business opportunities;<br>▸ Jobs;<br>▸ Training;<br>▸ Entrepreneurship;<br>▸ Increase in Tourism;<br>▸ Access not affected by weather;<br>▸ Increase access to services;<br>▸ Increase in health and services;<br>▸ Infrastructure improvements (improve and expand infrastructures, lagoon, waste management and water); | ▸ Increase in traffic;<br>▸ Easy access by general public;<br>▸ Migration to area by none PKFN members;<br>▸ Lose job opportunities to competitors;<br>▸ Impact on water quality;<br>▸ More dust;<br>▸ Lack of control of the area to accessible by others;<br>▸ Increase in social issues, crime and violence; |

Table 13 (cont'd): Wrigley Community Consultation Pros and Cons Summary (January 25-26th, 2012)

| PROS | CONS |
|---|---|
| ▸ Influx in population;<br>▸ Governance and administration capacity;<br>▸ Utilize equipment for maintenance;<br>▸ Encourage business development and enterprises;<br>▸ Creating wealth (financing businesses, mortgage through Nation trust, reinvestment into PKFN, development of a 10 year plan, etc.);<br>▸ Benefits to the membership from generating revenue;<br>▸ Invest in having homes for our people;<br>▸ Health, life insurance and death benefits for every member;<br>▸ Elders home and home care services;<br>▸ Investments into community needs;<br>▸ Have as a practice to put money away in a trust to support the community for youth education and housing. Start this now for long term benefits to the people;<br>▸ Access to traditional territory;<br>▸ Parks and conservation areas to be identified as protected areas (More research required);<br>▸ Potential to build residential areas;<br>▸ Plan for long term infrastructure, communications, etc.;<br>▸ Establish regular dialogue on highway development;<br>▸ Build capacity with staff to carry out objectives, be involved in long term strategic plan for PKFN;<br>▸ Decrease in cost of food;<br>▸ Decrease in freight and fuel prices;<br>▸ Increased and easier access to neighboring communities. | ▸ Current work in Ochre River – they could have given a notice to PKFN (Provide list of needs in services, so that the people got the opportunity to get involve in the work);<br>▸ Influx of visitors;<br>▸ Increase in resource development in the area;<br>▸ Industry will have easier access;<br>▸ Contaminates hauled through the land, more pollution on the road;<br>▸ Sharing resources due to access for harvesting. Case example, in existing traditional areas;<br>▸ Willow River is contaminated; we need to protect the Blackwater area;<br>▸ Competitive bidding - out right sole source opportunity for maintenance. |

Mackenzie Valley Highway Next Steps and Funding

The following is a list of priorities identified by the community for next steps and funding:

- Training;
- Elders Home;
- Community based higher education;
- Grade 12 to be integrated in school;
- Traditional Land Use Study;
- Community PDR Committee for Study;
- Elders Senate;
- Youth Committee;
- Interagency committee;
- PDR Community Workshops;
- PDR Community Liaison – short and long term;
- Feasibility Study;
- Community gathering for reporting;
- PKFN  Canada relations – PDR is a component;
- Communication with Dehcho communities;
- TUS Archive.

Following to the last public consultation, the Band Council resolved that the PKFN Chief and Council reviewed the MVH Project Preliminary Screening Report Draft and accepted it as prepared and presented during the consultation activities. The resolution, adopted on February 8th, 2012, mentions that the Project Description Report must be submitted to the Department of Transportation of the Government of Northwest Territories (GNWT); and requests resources for further environment and traditional in-depth studies (see Appendix 8, Annex 9):

(...) “THEREFORE BE IT RESOLVED, that the Pehdzeh Ki First Nation Chief and Council reviewed the said MVH PDR, and accepted in principle the draft report as prepared by PKCL and Dessau LVM.

BE IT FURTHER RESOLVED, that the MVH PDR be submitted to the Department of Transportation GNWT, and request GNWT to identify and provide resources for Phase Two of the MVH PDR which will further examine Environment and Traditional Use Study”.

# 6 ENVIRONMENTAL OVERVIEW

The purpose of this section is to present the existing environment in the study area including the physical environment (i.e. water, soils), the biological environment (i.e. plants, animals) and the socioeconomic environment (i.e. humans and the built environment). Each of these three environments is examined in detail in the following sections.

## 6.1 PHYSICAL COMPONENTS

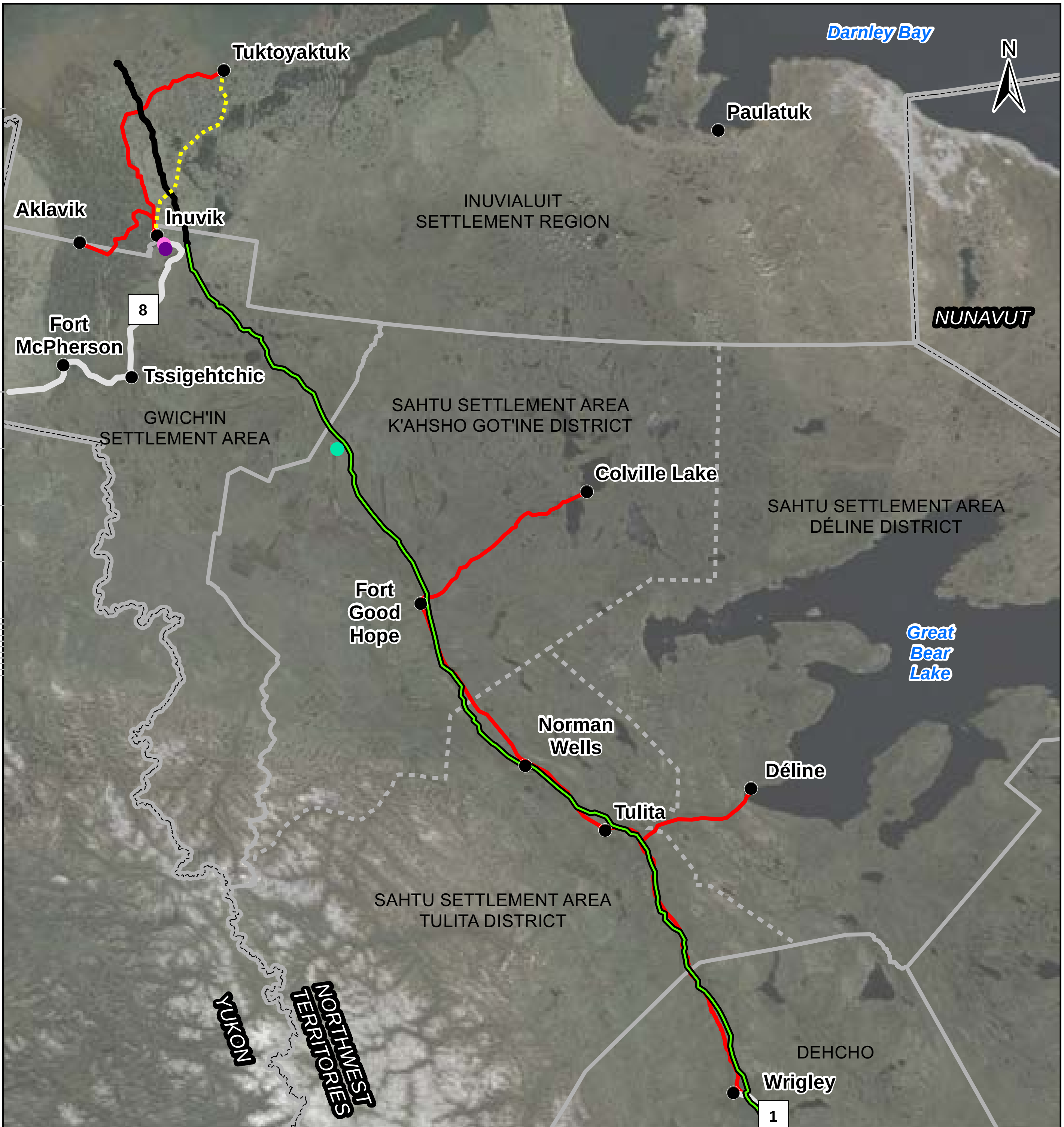
### 6.1.1 Climate

This description relies on data provided by weather stations located in the Mackenzie Valley. Various parameters are described including air temperature, relative humidity, wind speed and direction, precipitations and solar radiation.

Available baseline air quality information and previous environmental studies conducted for projects such as the proposed MGP were used as a basis for an air quality overview.

The Dehcho section of the proposed Highway, the focus of this study, is situated north of Wrigley. The climate of this segment of the proposed Highway is described using meteorological data recorded by Environment Canada at Wrigley Airport (63°12'34’’ N 123°26'12’’ W; Climate ID: 2204000) and St. Charles Creek (64°47' N, 124°13' W; Climate ID: 2203656), near the northern end of the Highway (Figure 9) (Environment Canada, 2011a)

Twenty year climate normals for Wrigley over the period 1988 to 2007 have been created using a combination of monthly, daily and hourly data, which are summarized in Table 11. Temperature observations recorded at St. Charles Creek for the period of 1998 to 2002 have been summarized in Table 12. To provide a comparable data set, Wrigley temperature and wind data have also been summarized for the same five-year period in Table 13.




- Community
- Winter Road
- Mackenzie Highway Concept
- Gravel Highway
- Proposed Inuvik to Tuktoyaktuk Highway (2009)
- Gas Pipeline
- District Boundary
- Settlement Boundary
- Territorial Boundary
- 1 Highway Number

**Meteorological Station**

- Inuvik A
- Inuvik Climate
- Little Chicago

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Mackenzie Gas Project, 2007*
*- Northwest Territories, Centre for Geomatics*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 9**
**Location of Meteorological Stations**

| | | | |
|---|---|---|---|
| Prepared : | G. Pothier | No : | 068-P0037500-202-001-GO-C108-00 |
| Drawn : | G. Lemay | Scale : | 1:4 000 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 100 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\v5_cad\GO\01-MXD\068-P037500-0202-001-GO-C108-00_MeteoStations_20120227.mxd

Table 14: Climate Data, Wrigley A Station, NWT (1988 – 2007)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | | | | | | | | | | | | | |
| Daily Maximum (°C) | -21.8 | -16.8 | -8.1 | 4.6 | 14.6 | 21.8 | 23.5 | 20.3 | 11.9 | 0.2 | -14.2 | -19.2 | 1.4 |
| Daily Average (°C) | -26.1 | -21.9 | -14.9 | -2.5 | 7.9 | 15.0 | 17.1 | 13.8 | 6.7 | -3.6 | -18.0 | -23.5 | -4.2 |
| Daily Minimum (°C) | -30.8 | -27.3 | -21.7 | -9.0 | 1.2 | 8.1 | 10.7 | 7.4 | 1.5 | -7.1 | -21.7 | -27.6 | -9.7 |
| Extreme Maximum (°C) | 6.5 | 10.0 | 12.7 | 25.0 | 34.0 | 37.0 | 35.5 | 32.5 | 27.2 | 21.2 | 6.2 | -1.7 | 37.0 |
| Extreme Minimum (°C) | -50.0 | -48.0 | -43.0 | -32.6 | -20.9 | -3.3 | -1.0 | -3.5 | -12.2 | -27.0 | -48.0 | -46.1 | -50.0 |
| Precipitation | | | | | | | | | | | | | |
| Total Precipitation (mm) | 16.5 | 14.6 | 11.4 | 6.6 | 23.6 | 38.4 | 65.2 | 41.9 | 34.4 | 26.4 | 21.1 | 17.8 | 318.1 |
| Snowfall (cm) | 19.8 | 15.7 | 13.1 | 6.7 | 3.8 | 0.0 | 0.0 | 0.0 | 2.1 | 20.1 | 25.5 | 18.8 | 125.6 |
| Rainfall (mm) | 0.0 | 0.0 | 0.0 | 0.3 | 20.2 | 38.8 | 65.2 | 41.9 | 32.2 | 6.3 | 0.0 | 0.0 | 204.9 |
| Snow Depth at Month End (cm) | 39.3 | 47.5 | 43.7 | 6.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 9.3 | 22.4 | 30.5 | 16.7 |

Source: Environment Canada, 2011b. Wrigley A Station: 63°12' 34"N, 123°26'12" W; Elevation: 149 m ; Climate Station ID: 224000

Table 15: Summary of Meteorological Data, St. Charles Creek, NWT (1998- 2002)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | | | | | | | | | | | | | |
| Daily Maximum (°C) | -15.5 | -10.9 | -11.1 | -1.9 | 9.3 | 19.2 | 20.5 | 17.0 | 10.8 | -1.5 | -10.3 | -14.2 | 1.0 |
| Daily Average (°C) | -19.3 | -15.5 | -16.3 | -8.0 | 3.3 | 13.3 | 14.8 | 11.9 | 6.3 | -4.8 | -13.9 | -17.9 | -3.8 |
| Daily Minimum (°C) | -23.5 | -20.0 | -21.4 | -14.0 | -3.0 | 7.3 | 9.0 | 6.8 | 1.8 | -8.3 | -17.4 | -21.3 | -8.7 |
| Extreme Maximum (°C) | 5.0 | 6.8 | 10.9 | 13.6 | 19.5 | 32.0 | 33.7 | 30.4 | 22.2 | 11.4 | 9.5 | 11.1 | 33.7 |
| Extreme Minimum (°C) | -39.0 | -32.6 | -35.0 | -33.1 | -20.2 | -1.5 | 1.0 | -2.8 | -9.2 | -19.3 | -32.1 | -37.8 | -39.0 |

Source: Environment Canada, 2009. St Charles Creek Station: 64°47 N, 124°13' W; Elevation: 341 m ; Climate ID: 2203656

Table 16: Summary of Meteorological Data, Wrigley A Station, NWT (1998- 2002)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | | | | | | | | | | | | | |
| Daily Maximum (°C) | -20.5 | -13.6 | -6.8 | 4.1 | 15.0 | 21.4 | 23.6 | 19.0 | 12.1 | 0.2 | -9.9 | -16.8 | 2.3 |
| Daily Average (°C) | -25.2 | -18.8 | -13.6 | -5.3 | 7.8 | 14.8 | 17.2 | 12.6 | 6.5 | -3.3 | -13.0 | -21.1 | -3.4 |
| Daily Minimum (°C) | -30.2 | -25.8 | -20.9 | -13.1 | 0.7 | 7.7 | 10.7 | 6.1 | 1.0 | -6.7 | -16.2 | -24.2 | -9.2 |
| Extreme Maximum (°C) | 6.5 | 6.5 | 8.5 | 19.5 | 26.6 | 29.4 | 32.1 | 32.5 | 24.5 | 10.4 | 6.2 | -1.7 | 32.5 |
| Extreme Minimum (°C) | -47.0 | -45.5 | -38.8 | -32.6 | -20.9 | 0.4 | 0.2 | -3.5 | -10.1 | -22.3 | -35.2 | -40.8 | -47.0 |
| Wind | | | | | | | | | | | | | |
| Average Hourly Speed (km/hr) | 6.9 | 8.5 | 10.2 | 10.0 | 10.6 | 10.2 | 9.3 | 8.0 | 8.5 | 8.5 | 6.1 | 7.2 | 8.7 |
| Predominant Wind Direction | W | E | W | W | W | W | W | W | SSE | ESE | E | W | W |

Source: Environment Canada, 2011b. Wrigley A Station: 63°12' 34"N, 123°26'12" W; Elevation: 149 m ; Climate Station ID: 224000

#### 6.1.1.1 General

The general climate of the study area is sub-arctic (also called Boreal), characterized by long, usually very cold winters, and short, cool summers, as well as extreme annual temperature variations. The climate is representative of *Köppen climate classification* DFC. Snow and ice cover typically persists between October and May. Annual precipitation is typically moderate to low, occurring more frequently in the warmer summer months (June through August) than during the winter. Summers usually last at least one month and do not last more than three.

With 5 to 7 consecutive months where the average temperature is below 0°C, all moisture in the soil and subsoil freezes solidly to depths of many feet. Summer warmth is generally insufficient to thaw more than a few surface feet, so permafrost prevails under large areas.

The frost-free season is generally very short and a freeze can occur during any month in many areas. Vegetation in regions with subarctic climates is generally of low diversity. This is due to the fact that only resilient species can survive the long winters and make use of the short summers.

Agricultural potential is generally poor, due to the natural infertility of soils and the prevalence of swamps and lakes left by departing ice sheets. The short growing seasons prohibit all but the hardiest of crops.

Polerward (toward a higher latitude) the warmest month has usually an average temperature of less than 10°C, and the subarctic climate grades into a tundra climate, which is even less suitable for trees. Equatorward (toward a lower latitude) the climate grades into the humid continental climates with longer summers and usually less-severe winters.

#### 6.1.1.2 Air Temperature

Monthly temperature normals for Wrigley for the period of 1988 to 2007 are summarized in Table 11 in terms of daily average, average daily maximum and minimum, and extreme maximum and minimum. Mean annual temperatures are calculated as an average of all months. Extreme annual temperatures show the highest and lowest temperature recorded over the 20-year period. Environment Canada historical data provides temperature extremes recorded in Wrigley since 194 (2011a).

The average annual temperature at Wrigley is -4.2°C over the 20 year period. Annual temperature distribution is typical for mid-to-high latitudes in the northern hemisphere and for an area with a DFC *Köppen climate classification*, with July as the warmest month (average temperature 17.1°C) and January as the coldest (average temperature -26.1°C). Temperatures are typically below zero between October and April. The highest temperature recorded between 1988 and 2007 was 37.0°C (June 1995). The lowest temperature recorded between 1988 and 2007 was -50.0°C (January 1994). The historical high and low temperatures recorded at Wrigley were 37.0°C in June 1995 and -53.3°C in February 1968 (Environment Canada, 2011a).

Based on five years of meteorological data at St. Charles Creek, the average annual temperature is -3.8°C (Table 12). Over the same period at Wrigley, the average annual temperature is -3.4°C (Table 13). The slightly warmer average temperature at Wrigley agrees with observations of the sub-artic climate, which generally shows increasing annual temperature with decreasing latitude.

#### *6.1.1.3 Precipitation*

Daily precipitation data (including snow and rainfall when available) recorded at Wrigley has been used for the period between 1988 and 2007. Precipitation data has not been recorded at St. Charles Creek for the months of December through March of each year.

Average annual precipitation at Wrigley is 318.1 mm based on available data between 1988 and 2007 (Table 11). On average, Wrigley receives 204.9 mm of rainfall annually, occurring mainly between May and September. Winter rainfall is extremely rare. Average annual snowfall is 125.6 cm and usually occurs in all months except June, July and August. Snowfall represents about 39% of the total annual precipitation.

The highest one-day rainfall over the 20-year period was 48.0 mm (July 18, 1991) which also represents the historical extreme daily rainfall precipitation and the extreme total precipitation recorded in one day at Wrigley, between 1943 and 2007. The largest single-day snowfall between 1988 and 2007 was 25.0 cm (February 7, 1993). The largest single-day snowfall event ever recorded at Inuvik was 30.5 cm on May 21, 1972. Snow depth is measured at the end of each month at Wrigley. Environment Canada's 1988-2007 climate normals for average snow depth at the end of each month are shown in Table 11. The majority of the snow melt typically occurs in May. Snow begins to accumulate in late September or October. The maximum snow depth recorded is 132 cm on April 2nd, 1991. February is the month with the maximum snow depth, with an average of 47.5 cm of snow at its end (Environment Canada, 2011a).

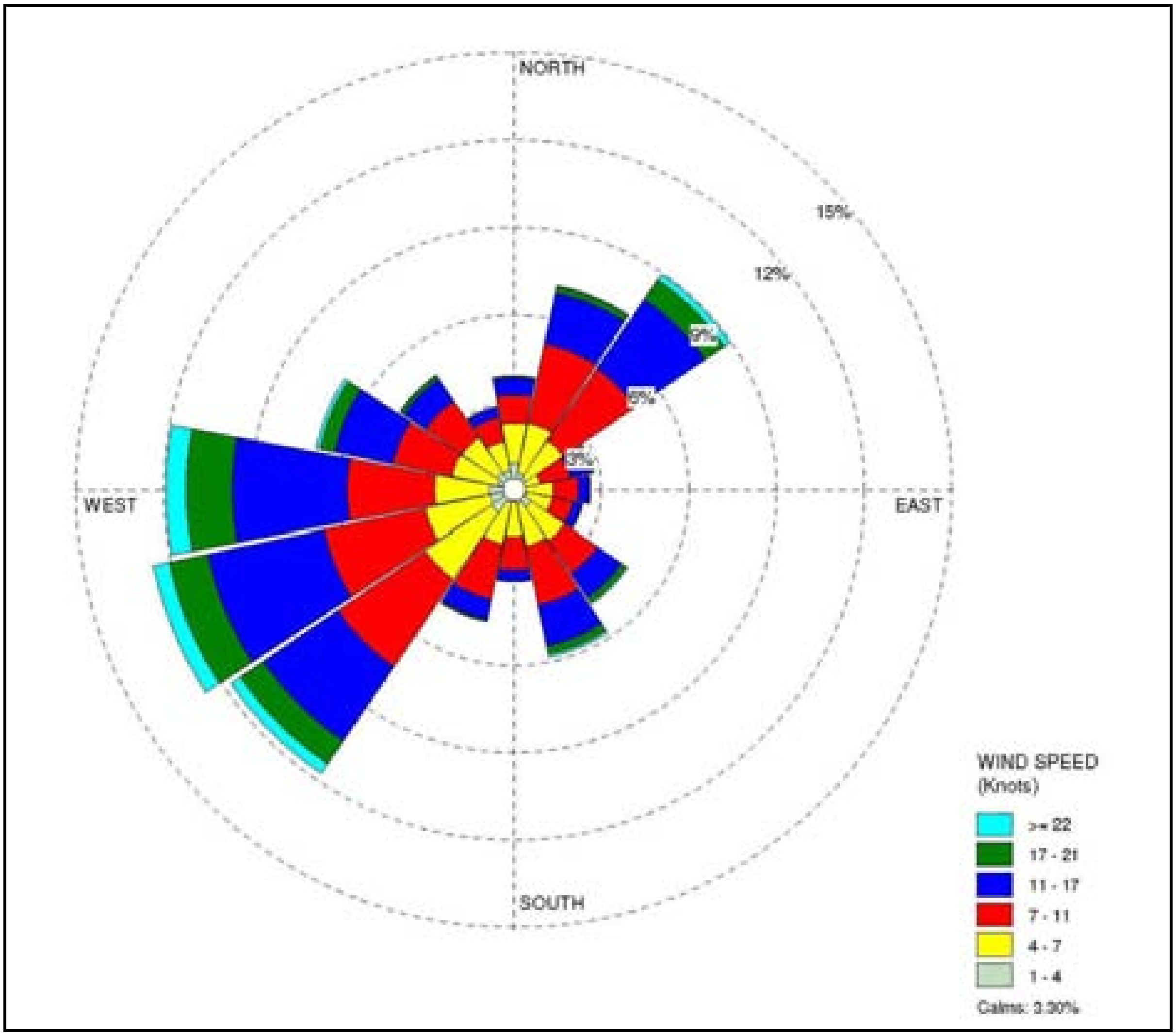
#### *6.1.1.4 Wind Speed and Direction*

The wind rose for the 5-year period between 1998 and 2002 at Wrigley is illustrated on Graph 4. Winds in Wrigley are predominantly from the West (W, WNW; 24.4% frequency of occurrence). Winds from the east and the south-east have secondary predominance. Calm winds (average hourly wind speeds less than 1 m/s) occurred over 24.4% of the record. Winds from the east and the south east are typical throughout autumn; however, west winds occur with higher frequency throughout the year (Table 13).

Winds have an average annual wind speed of 8.7 km/hr in Wrigley. Wind speeds are slightly higher during the summer months, with the highest average wind speeds occurring in August.

However, potential ice affecting the data acquisition during the winter months might have resulted in diminished quality and quantity of measures or non-readings.

Graph 5: Wind Rose for the Wrigley Area – Results from 1998 to 2002




### 6.1.1.5 Air Quality

Ambient air quality is monitored in four air monitoring stations at the Northwest Territories Department of Environment and Natural Resources (ENR). These stations are found in Yellowknife, Inuvik, Norman Wells and Fort Liard. The Norman Wells station is the closest one to the studied site. Results from the 2009 and 2010 Northwest Territories Air Quality Report are presented in Table 14 along with current Northwest Territories air quality standards. National (NAQQO) or Provincial standards have been adopted in the Northwest Territories, which have been denoted with an asterisk.

Table 17: Norman Wells Baseline Air Quality (2009 & 2010)

| SPECIES | NWT STANDARD (*NAQQO , **ALBERTA) | | 2009 MAXIMUM | 2009 EXCEEDANCES | 2010 MAXIMUM | 2010 EXCEEDANCES |
|---|---|---|---|---|---|---|
| | Maximum | Avg. Period | | | | |
| SO2 | 450 µg/m3 | 1 hr | 8 µg/m3 | 0 | 5 µg/m3 | 0 |
| | 150 µg/m3 | 24-hrs | 5 µg/m3 | 0 | 5 µg/m3 | 0 |
| | 30 µg/m3 | annual | <3 µg/m33 | 0 | <3 µg/m3 | 0 |
| NO2 | *400 µg/m3 | 1-hr | 73 µg/m3 | 0 | 31 µg/m3 | 0 |
| | *200 µg/m3 | 24-hrs | 10 µg/m3 | 0 | 11 µg/m3 | 0 |
| | *60 µg/m3 | annual | 2 µg/m3 | 0 | 2 µg/m3 | 0 |
| PM2.5 | 30 µg/m3 | 24-hr | 32 µg/m3 | 1 | 23.5 µg/m3 | 0 |
| PM10 | 50 µg/m3 | 24-hr | 5 µg/m3 | 0 | 15.2 µg/m3 | 0 |
| ground level O3 | *160 µg/m3 | 1-hr | 108 µg/m3 | 0 | 108 µg/m3 | 0 |
| | 130 µg/m3 | 8-hr | 100 µg/m3 | 0 | 104 µg/m3 | 0 |
| H2S | **14 µg/m3 | 1-hr | 5 µg/m3 | 0 | 3 µg/m3 | 0 |
| | **4 µg/m3 | 24-hr | 2 µg/m3 | 0 | 3 µg/m3 | 0 |

*ENR, 2009; ENR, 2010c

$SO_2$ concentrations are very low at Norman Wells (annual average typically less than 3 µg/m$^3$). Since industrial, commercial, and residential processes are a major contributor to $SO_2$, baseline levels throughout the studied site are expected to be slightly higher near Wrigley, decreasing along the Highway corridor to negligible levels in areas to the north near the Blackwater Bridge. As Norman Wells is an agglomeration 6 to 7 times bigger than Wrigley, baseline levels throughout the study site are expected to be very low.

Ambient concentrations of $NO_2$ are well below applicable standards. $NO_2$ concentrations are much higher in the winter months as winter inversions, characterized by very low wind speeds and a stable atmosphere, result in a diminished ability for vertical dispersion of pollutants. Baseline $NO_2$ is expected to be lower in more remote areas of the studied site, due to fewer sources of combustion (automobiles, butane stoves/heaters, industry).

Fine particulate matter ($PM_{2.5}$) is typically higher on average during winter months due to inversion conditions. A short-period peak, which exceeded air quality standards, occurred once in 2009 summer months due to forest fire smoke from Yukon and Alaska. Throughout the studied site, $PM_{2.5}$ would be variable during the summer as a result of forest fires and wind direction.

Coarse particulate matter ($PM_{10}$) concentrations are higher in snow-free months due to road dust and are particularly elevated in April and May due to ‘spring-time dust events’ from residual winter gravel (ENR, 2010c). Monthly average concentrations in Norman Wells are typically in the range of 5 µg/m$^3$ during the winter to 15 µg/m$^3$ during the spring.

Ground level ozone ($O_3$) shows a typical springtime maximum with a monthly average exceeding 60 µg/m$^3$ in April 2009 and May 2010 compared to the annual average of about

40 μg/m$^3$ at Norman Wells. Peak 1-hr and 8-hr average concentrations also occurred in May for 2009 and 2010. Similar levels would be expected throughout the studied site.

$H_2S$ is monitored for oil and gas development in the region. Hourly concentrations indicate essentially non-detectable levels (less than 1 μg/m$^3$). $H_2S$ concentrations are expected to be close to zero in less disturbed areas of the studied site.

The monitoring station at Norman Wells does not monitor CO; however, 2009 data recorded at Yellowknife shows a peak 1-hour maximum concentration of 2.2 mg/m$^3$, well below air quality standards (ENR, 2010c). In small northern communities, the major contributor to CO production is wood burning, so peak values would tend to occur during the winter months and made worse as the temperature goes lower. However, due to the population distribution that characterizes the studied site, CO levels are not expected to pose a concern to air quality.

#### *6.1.1.6 Climate Change*

The influence of climate change is summarized in Table 18 for Wrigley. The ground temperature and the Permafrost Thickness shown in that table are taken from *Climate Change and Transportation in the NWT* (Dillon Consulting Limited, 2007). The values are avergages calculated by combining the summary of modeling results for all surficial geology where permafrost is present in proportion of the percentage of area that is covered by each of them. The proportion of the studied site underlain by permafrost is about 42% as of 2000.

Table 18: Climate Change Scenarios for Wrigley

| | 2000 | 2025 | 2055 | AVERAGE CHANGES (2000-2055) |
|---|---|---|---|---|
| Ground temperature[8] (°C) | -0.047 | -0.036 | 0.380 | +0.427 |
| Permafrost Thickness (m) | 10.97 | 9.82 | 7.54 | -3.43 |

Source: Dillon Consulting Limited, 2007

##### *6.1.1.6.1 Ground temperature and Permafrost Thickness*

Average annual ground temperature over the period of 2000 to 2055 in the Wrigley area is projected to increase by 0.38°C , with the maximum increase (+1.25°C) happening in areas of eolian or lacustrine (fine) surface geology covered with mixed conifer (representing about 3% of the total area where permafrost is present on the studied site).

[8] Temperature at top of permafrost if present, otherwise, temperature at base of seasonal freeze/thaw layer.

Average permafrost thickness is predicted to decrease by 3.43 m over the 55 years period. The maximum change, according to the model results, should happen on glaciofluvial or alluvial (coarse) surficial geology covered by white spruce closed vegetation (-5.04 m). This surface represents about 22% of the total area where permafost is present in the study site.

According to the modeling results, permafrost would have completely disappeared from closed withe spruce forests overlying glaciofluvial or alluvial (coarse), mixed conifer underlain by eolian or lacustrine (fine) and open black spruce-lichen over eolian or lacustrine (fine) by 2055. This would mean that the proportion of the study site underlain by permafrost would become approximately 28% of the total surface, which represents a 14% decrease in 55 years.

##### *6.1.1.6.2 Precipitation*

Climate models have tended to produce mixed results in terms of precipitation projections and have often overpredicted (Nehtruh – EBA Consulting, 2011). Environment Canada's Climate Global Circulation Model (CGCM2) projects an overall decrease in annual precipitation of between 0% and 10% for the Lower Mackenzie Valley by 2050, while a net increase of the same magnitude is projected for Middle and Upper Valley regions to the south (Nehtruh – EBA Consulting, 2011).

With respect to precipitation changes, values during winter range from near 0% to more than 40% in the east, with most scenarios projecting winter precipitation increases of 20 to 30%. During summer, all models project increases between 5 and 20%, with median values of 10%.

Comparison of the available precipitation measurements at Wrigley shows that total precipitation from 1998 to 2007 represented 47% of the total precipitations recorded between 1988 and 1997. Therefore, there was a small increase in precipitation in the ten year period between 1998 and 2007 in comparison to the previous ten year period (1988 to 1997).

### 6.1.2 Geophysical Aspects

#### *6.1.2.1 Physiography*

The proposed route lies within the Northern Canadian Interior Plains physiographic region (Fulton, 1989). It lies on the western border and has been described elsewhere as the Canadian Cordillera borderlands region (Bostock HS, 1967). The region is dominated by low relief, thick morainal plains replete with glacio-fluvial features and deposits on both sides of the Mackenzie River, generally known as the Mackenzie Plains, over generally flat-lying sedimentary rocks. Closer to the river are deep glacio-lacustrine and scattered glacio-fluvial deposits.

The proposed MVH extension lies just east of the pre-historic western-most extension of the Laurentide ice-sheet. Retreat from the ice sheet during the late Wisconsin began approximately 13 kya, reaching the Mackenzie River valley by 12 kya, and then withdrawing substantially east of the valley by 11 kya (Vincent, 1989). Older glaciations are also found in the stratigraphic sequence, but the net result is a landscape dominated by glacial and ice marginal sediments.

The physiography, terrain, geology, and latitude combine to support vegetation and ecosystems of the Low Sub-Arctic Taiga Cordillera EcoRegion and the High Boreal Ecoregion.

#### 6.1.2.2 *Permafrost*

At a regional level, the study area lies within the extensive discontinuous permafrost zone, meaning that 50% - 90% of the ground is expected to contain discontinuous permafrost. This was corroborated by the Biophysical Baseline assessment for the Mackenzie Gas Project (MPEG, 2004) and a technical report by GeoNorth and Golder Associates (2000). Consequently, thermokarst (melt-out) features are expected to be found along the proposed route. Thermokarst (the subsidence of ground due to the melting of ground-ice) is differentiated from karst (the solution of bedrock creating a unique three-dimensional landscape that includes rills, runnels, grikes, subsidence, sinkholes, springs and caves among other features). Both are present in the study area.

For reference, the mapped permafrost and karst information from the MGP (MPEG, 2004) has been transcribed to Figure 11.

#### 6.1.2.3 *Bedrock Geology*

The proposed MVH extension from Wrigley at KM 690 to the Sahtu Settlement-Area Boundary at KM 794 is underlain by sedimentary rocks from the Devonian to Cretaceous Periods (~400 – 66 Mya) that typically include shale, mudstone, sandstone, and conglomerate of the Besa River, Brazeau and Trevor Formations. Bentonite-producing shales are present in the Trevor and Brazeau formations, covering the northern half of the study area.

Resistant dolomite, limestone and sandstone, interbedded with shale form the McConnell Range, part of the Franklin Mountains and are found along the eastern portion of the study area. The carbonate rocks of the McConnell Range are expected to produce karst features.

#### 6.1.2.4 *Terrain Conditions Along Optimized Alignment*

The proposed MVH extension is located within the Mackenzie Plains. The Mackenzie Plain has been subject to multiple glaciations during the Quaternary. However, the most recent glaciation, the Late Wisconsin, has shaped the area into its modern landscape.

Thick ice contact deposits (glacio-lacustrine and glacio-fluvial) as well as ablation till dominate the landscape along the alignment. Tills form poorly-sorted, poorly-consolidated diamictons of clay, silt, sand, gravel, cobbles and boulders. Glacio-lacustrine deposits are better sorted, but still unconsolidated, and range in size from clay to sand. Glacio-fluvial deposits ranged in size from clay to cobbles and larger (MPEG, 2004).

Table 19 below, provides a detailed description of the terrain conditions along the proposed MVH extension, within a 1 km buffer, from Wrigley northward to the Sahtu Settlement

Boundary. This summary is based on interpretations of terrain maps and information acquired from published documents. Further geotechnical investigations will be undertaken along the preferred alignment and in potential material sources to confirm conditions of terrain and quality of material sources for construction. This work will be conducted during winter months when the winter road is available to provide access.

Table 19: Terrain Conditions along Optimized Alignment

| KILOMETER MARKER (KM) | | DESCRIPTION OF TERRAIN CONDITIONS |
|---|---|---|
| General Description | | The proposed route heads north northeast along the east sloping terrace of the Mackenzie River. |
| 697.5<br>Wrigley | 730.0<br>Ochre River | North of Wrigley, the terrain is broad with low-relief, framed to the east by the McConnell Range, and to the west by the Mackenzie River. Clusters of small lakes depressions and wetlands suggest that permafrost is abundant and themokarst driven features and subsidence should be expected to continue to develop.<br>A bedrock ridge rises prominently above the plain at about km 710. This is expected to be limestone or dolomite; a western extension of the McConnell Range. Karst features were identified by the Mackenzie Gas Project EIS (MPEG, 2004) and on the eastern side of the ridge there is a large sinkhole that may be karst related.<br>The route intersects six separate drainages at a 3% gradient before reaching the Ochre River. The Ochre River at the crossing is a sediment rich, incised channel where the sediment is derived by the river cutting down through the deep glacio-lacustrine, morainal and glacial-fluvial deposits, and subsequent valley widening by slumps of the valley sidewalls. The Ochre River is spanned by a bridge with a footing in a prominent mid-stream gravel bar.<br>The route's proximity to the Mackenzie varies from 1 km to 4 km as it navigates around the bedrock ridge. Its elevation is 70 m above the Mackenzie at 150 m a.s.l. and rises to 170 m above the river at 250 m a.s.l. when navigating around the bedrock ridge.<br>Soils are generally mapped as Cryosols. Closer to the river, they are Gleysolic Static Cryosols, becoming Brunisolic Turbic Cryosols on better drained upland sites (MPEG, 2004). |
| 730.0<br>Ochre River | 764.4<br>Dam Creek | North of the Ochre River, the route remains within 1 km of and 50 to 130 m above the Mackenzie River. It crosses 17 creeks and drainages before reaching Dam Creek.<br>Thermokarst features are less evident within the route, and sediments are expected to be dominated by deep glacio-lacustrine clay, silt and sand, and glacio-fluvial sands and gravels.<br>Whitesand Creek is crossed at about km 738; an incised, single thread meandering stream. The retreat of the river valley sidewalls without toe erosion from the river indicates ongoing retrogressive slumps, likely exacerbated by melting permafrost.<br>Several stream crossings pose similar challenges due to slumps in retreating river valley sidewalls, incised deep glacial sediments and broad active alluvial fans caused by the reworking of those sediments (such as at Vermillion Creek for example). |

Table 19 (cont'd): Terrain Conditions along Optimized Alignment

| KILOMETER MARKER (KM) | | DESCRIPTION OF TERRAIN CONDITIONS |
|---|---|---|
| 730.0<br>Ochre River | 764.4<br>Dam Creek | Between Vermillion and Dam Creeks, the terrain becomes more hummocky and the crossings appear more routine. Dam Creek itself is a single span bridge over a relatively narrow, incised meandering stream.<br>Stream crossing reports between Ochre River and Dam Creek describe organic silts, clayey silty sands, clay loams and sand and silty loams. Drainage is typically poor to intermediate (GeoNorth and Golder Associates, 2000).<br>Soil development remains poor along this section, typically forming orthic and cumuli regosols, or regosolic cryosols. Permafrost was identified at about 40 cm the cryosols (GeoNorth and Golder Associates, 2000). |
| 764.4<br>Dam Creek | 784.1<br>Black-water River | North of Dam Creek, the route continues in the broad low relief plain, within 1 km of and less than 50 m above the Mackenzie River. It crosses 7 drainages before meeting Blackwater River.<br>Sands, silts and sandy loams are the common sediments in this section and there is a dearth of thermokarst features indicating better drainage, absent or deeper permafrost.<br>Soils so close to the Mackenzie River floodplain remain poorly developed. Dominant soils grade from poorly drained regosols around Dam Creek, to well drained orthic regosols around Blackwater River.<br>The Blackwater River is crossed by a bridge over gravel bars and the active channel as it connects to the Mackenzie.<br>Evidence of minor sheet erosion exists on the north bank of the Dam Creek crossing and slumping occurs on the south bank of the Blackwater River. |
| 784.1 Black-water River | 794.3<br>Sahtu<br>Settlement Area Boundary | The route continues on broad low relief terrain within 1 km of the Mackenzie River, across kettled and hummocky terrain until km 789.6.<br>The common sediment is sand, silt and sandy loam and soils are predominantly well drained cumuli regosols.<br>From here, the Mackenzie River heads north and away from the Mackenzie River through wetland formations like peat plateaus and/or fens.<br>Once again, thermokarst features are evident on the ground, and soils become poorly drained, organic cryosols. |

Note: Kilometer markers are for the Mackenzie Valley Gas Pipeline.

### 6.1.2.5 *Geohazards and Sensitive Terrain*

Geohazards are geological events that represent or have the potential to damage engineering structures or create uncontrolled risk. Along the proposed route, several potential geohazards are identified at the overview/project description level.

Bentonite clays are likely to be present above the Trevor and Brazeau formations in the area. Bentonite may present challenges depending on the specific engineering properties of the clay.

Melting permafrost is evident throughout much of the study area. Potential hazards related to permafrost include sinkholes, expanding lakes, and retrogressive failures along river crossings.

Wetland features such as peat plateaus and fens have been identified in the northern section of the route, and can pose many challenges for road construction and maintenance.

### 6.1.3 Contaminated Sites

#### *6.1.3.1 Environmental Overview for Contaminated Sites*

Based on a review of various sources of information, including Government of the Northwest Territories, Municipal and Community Affairs Office of the Fire Marshall, INAC, Heritage Archives, and Public Works, very few contamination concerns have been recorded between Wrigley and Blackwater River. A search of the ENR hazardous materials spills database produced a small number of results, which are presented in Table 20 along with records of spills that occurred on the Highway just south of Wrigley. Also shown is one diesel spill, which occurred near the Enbridge pipeline just east of the winter road at Ochre River. At the time of writing, some sources contacted have yet to reply.

Table 20: Reported Spills Between Wrigley and Blackwater River and Near Wrigley to the South

| DESCRIPTION | DATE | LOCATION | COMMODITY | QUANTITY |
|---|---|---|---|---|
| Wrigley to Blackwater | | | | |
| Spill | 24-Feb-75 | Hodgson Creek Bridge Near Wrigley | Diesel Fuel | 590 L |
| Spill | 29-Feb-84 | Norman Wells Winter Road 48.3 km N of Wrigley | Hydrochloric Acid | 0 L |
| Spill | 15-Feb-89 | Norman Wells Pipeline km 285 Ochre River | Diesel Fuel | 454L |
| Spill | 30-Jan-96 | Hodgson Creek KM 690 1 km North of Wrigley | Motor Oil | 2 L |
| Spill | 24-Mar-05 | 120 km North of Wrigley on MacKenzie Hwy | Drill Cutting Waste | 0 L |
| Spill | 25-Nov-08 | Mac Valley Winter Road 14.44 km North of Wrigley | Hydraulic Oil | 7 L |
| Spill | 6-Aug-02 | Ochre River 35 km North of Wrigley | Diesel Fuel | 0 L |

Table 20 (cont'd): Reported Spills Between Wrigley and Blackwater River and Near Wrigley to the South

| DESCRIPTION | DATE | LOCATION | COMMODITY | QUANTITY |
|---|---|---|---|---|
| Near Wrigley to the South | | | | |
| Spill | 12-Apr-81 | South of Wrigley 63:08N 123:17W | JP4 | 615 L |
| Spill | 22-Jan-84 | 32.2 km South of Wrigley on Winter Road | Diesel Fuel | 910 L |
| Spill | 19-Jan-85 | Winter Road South of Wrigley | Diesel Fuel | 150 L |
| Spill | 2-Feb-85 | 0.4 km South of Wrigley | Diesel Fuel | 900 L |
| Spill | 4-Feb-98 | Wrigley Highways Maintenance Yard km 684.5 | Diesel P-40 | 200 L |

The Enbridge pipeline is a concern with respect to soil and groundwater contamination and construction of the new highway. A review of the pipeline route and anticipated highway route indicates that the pipeline will cross the proposed Highway and will be within 500 m of the highway for extended lengths. Pumping stations and flow regulation valves are present throughout the pipeline and the pipeline has had a known incident where a leak was identified at the Norman Wells Site. This information adds further support that the pipeline is an environmental concern to the proposed Highway soils and groundwater. According to Enbridge Fact Sheet, the pipeline was constructed in 1982, the method of construction is not known. There is a potential that laydown and fuelling areas for equipment during construction may have resulted in soil in groundwater contamination. Further research on the pipeline's design, construction, and operation is required to assess in more detail the potential impact the pipeline has on the proposed highway.

Currently, the winter road allows locals to access traditional and recreational resources. A search of land use permits (application, open or active), and surface dispositions (application, open, active, or tilled) indicates that there may have been some activity in the proposed Highway corridor pertaining to mining and related activities (i.e. accessing materials, movement of equipment), which may have contributed to contamination of soils (DLUPC 2006a,b and c). Specifically if borrow pits from mines were used or have been used to maintain the winter road, this could result in soil metal contamination, which would have to be managed along the Highway route. Further research on the road's operation and maintenance will be required as part of future studies in order to assess the potential impact mining-related activities have had and may have on the proposed Highway.

## 6.1.4 Surface Water

### *6.1.4.1 Hydrological Assessment*

The following sections focus on the main tributaries of the Mackenzie River affected by the project. In fact, the Mackenzie Delta and the Mackenzie River are the predominant surface water features that might be affected by the project. Flows and description of basins will be explained in this section. Surface water and sediment quality studies of these rivers will be described as well.

#### *6.1.4.1.1 Data Sources*

Flow

The flow data for the study area is available from two hydraulic stations: 10HC007 and 10HC008, located respectively at latitude 63°14’39”N, longitude 123°28’52”W and latitude 63°29’22”N, longitude 123°36’45”W. Both stations are operated by the regional office of Environment Canada at Yellowknife in the Northwest Territories. Flow records from station 10HC007 cover a period ranging from 2006 to 2008, while the 10HC008 station holds records from 2006 to 2010. The compiled data was used to estimate the flow generated by the drainage area associated with each water course crossing the new MVH extension. The maximum flows were recorded in May 2007 for both stations at 32 $m^3$/s at 10HC007 and 171 $m^3$/s at 10HC008.

Precipitation

The precipitation data covering the area crossed by the existing winter road was recorded at the Fort Simpson A (WMO71946) meteorological station, which is located at 61°45'37 latitude and 121°14'12 longitude. The station is operated by Environment Canada and records data on solid and liquid precipitations since November 1963.

#### *6.1.4.1.2 Description of Basins*

A hydrologic description of the main water basins of the crossed by the winter road can be described as follow:

Ochre River

The Ochre River drainage basin covers an area of approximately 1279 $km^2$. This basin is crossed by the winter road at the following approximate coordinates 63º28’2.3” latitude and 123º41’12.3” longitude and at an elevation of 90 m. The approximate width of the stream at the crossing location is 26 m and the stream follows a south western direction.

The mean flow is calculated using data gathered from the hydro-stations 10HC007 and 10HC008 and is estimated at 1 481 L/s. The maximum and minimum flows are given in Graph 5.

The SCWG[9] classifies the local soils within this basin as Cumilic Regosol, which correspond to drainage conditions that can be qualified as moderate to good (EcoDynamics, 2008). The natural terrain elevation varies from 90 m at the crossing to 1 320 m.

Whitesand Creek

The Whitesand creek is located at latitude 63º32'6.3" and longitude 123º43'44.2". The creek's drainage basin covers an of area approximately 310.3 km². The stream is described as winding as it passes through areas varying in elevation above sea level from 1 020 m to 90 m. At the crossing point with the winter road, the creek is 30 m in width and the elevation reaches 90 m above sea level. According to the SCWG classification, the local soils are of the Cumulic Regosol type, which offer a moderate to poor drainage (EcoDynamics, 2008). The flow calculated using existing flow records from two hydrostations (10HC007 and 10HC008) is estimated to reach 458.9 l/s.

Vermillion Creek

The crossing between winter road and the hydrologic basin is located at latitude 63º41'26" and longitude 123º50'49.7". Vermillion creek's basin is generally composed of Regosolic crysol soils, which offer a moderate drainage capacity (EcoDynamics, 2008). The total area drained by this stream approximately covers 63.3 km².

The mean flow was calculated at 88.9 l/s and the active channel crossing is 20 m in width. Especially during low water flows, the channel is braided while during peak flows banks erosion often occurs. The creek crosses land elevations reaching up to 560 m and lowering, at its crossing with the winter road, to 105 m.

Strawberry Creek

Strawberry creek shows a drainage area covering 46.5 km² and its mean discharge calculated based on the data recorded at the stations (10HC007 and 10HC008) is 66.2 l/s.

The intersection point between the creek and the winter road is located at latitude 63º39'36.5" and longitude 123º49'6.7 that is 150 m upstream from Mackenzie River. At this intersection point, the creek's elevation reaches 90 m above sea level and its width is approximately 9 m. The creek's main channel is quite shallow, irregularly meandering, confined and incised. The local soils are classified as well drained and belong to the Cumilic Regosol type.

Bonnie Creek

Bonnie creek intersects the winter road at latitude 63º33'39.4" and longitude 123º45'5.0" that is 500 m upstream from the Mackenzie River. Elevation above sea level at this point is 90 m. The land drained by the creek's basin represents an area of 11.2 km². The width of the creek's

[9] Soil Classification Working Group, see reference 1 for more detail.

main channel is approximately 5 m when the river is at full capacity. The stream is defined as shallow, winding, incised and confined.

The mean discharge calculated from the same available hydro-stations (10HC007 and 10HC008) is 16.3 l/s. According to the SCWG, the local soils are of the brunisol type which is moderately to well drain (EcoDynamics, 2008).

### Dam Creek

The Dam creek's drainage basin covers and area of 104.6 km². The creek's crossing point with the winter road is located 800 m upstream from the Mackenzie River and corresponds to latitude 63º47'27.5" and longitude 123º57'38.0".

The width of the creek's main channel at the crossing point is 7.5 m at an elevation reaching 90 m. The stream is shallow but evidences of regular flooding deposits over the banks have been confirmed.

The creek's mean flow calculated from the available hydro-stations is 145.1 l/s. The terrain's elevation within the drainage basin varies between 90 m and 720 m above sea level. The local soils are classified as Cumulic regosol, which offer an intermediate to poor drainage (EcoDynamics, 2008).

### Drainage 1

This unnamed creek, crossing the winter road at latitude 63º33'10.4" and longitude 123º44'32.0", has a drainage basin covering an area of 4.8 km². The local soils are classified as Regosolic Crysol under the SCWG classification which is considered as moderately drained (EcoDynamics, 2008). The creek's main channel is shallow, incised with heavy in stream debris and an overhanging cover.

The mean specific flow obtained with the available data from stations10HC007 and 10HC008 is 7.2 L/s, at full capacity the crossing width reaches 1.5 m

### Drainage 2

The drainage basin of this unnamed creek covers an area of approximately 13.0 km². The width of the stream at its crossing point with the winter road is 2 m during peak flow. The general pattern of the creek is winding and incised. The local soils are classified as Cumulic Regosol considered as moderately drained (EcoDynamics, 2008). Erosion is a concern at this crossing, which may lead to the deposit of debris that could create a downstream backwater. The stream's estimated mean flow is 15.3 L/s. Its crossing coordinates with the winter road are 63º35'4.0" latitude and 123º45'40.7" longitude.

Drainage 3

The winter road crossing point of drainage 3 (15.256 $km^2$) is located at latitude 63º36'36.6" and longitude 123º46'33.7". This creek drains a basin of 15.3 $km^2$ and flows between Whitesand creek and Strawberry creek along the winter road. The local soils are of the Eutric Brunisol type which offers rapid drainage (EcoDynamics, 2008). The creek is considered narrow with its width of 2 m (estimated at the winter road crossing point) when at its maximum flowing rate. This stream is winding with an overhanging cover. Some evidence of erosion and debris deposition may be seen downstream of this crossing. The creek's mean flow, obtained with the available data (from stations 10HC007 and 10HC008), is 21.8 L/s.

Drainage 4

The winter road crossing point of drainage 4 is located at latitude 63º52'56.8" and longitude 124º01'43.9". This creek drains a basin of 44.7 $km^2$ and flows between Blackwater River and Three Finger creek. Drainage 4 is a winding, frequently confined watercourse (GeoNorth & Golder Associates Ltd., 2000). The channel width is approximately 4 m and the stream gradient is less than 5%. The bottom substrate is orthic regosal composed entirely of sand, silt and clay layers. The creek's mean flow, obtained with the available data (from stations 10HC007 and 10HC008), is 61.5 L/s.

Blackwater River

Blackwater River's total drainage basin, including the upstream lake's own basin covers an area of 8443 $km^2$. If the lake's basin is removed, the river then drains a basin of 1497 $km^2$. The soil composition is characterized by alternating silt and sand layers which could be considered as moderately to well-drained. The river crosses the winter road at latitude 63º56'42.4" and longitude 124º09'58.8". At this crossing point, the river shows a width of 100 m and its elevation is approximately 95 m from sea level. The river's mean flow is estimated at 11 587 L/s, this consider its passage through Blackwater Lake.

*6.1.4.1.3 Flow Analysis*

Precipitation-flow relationship

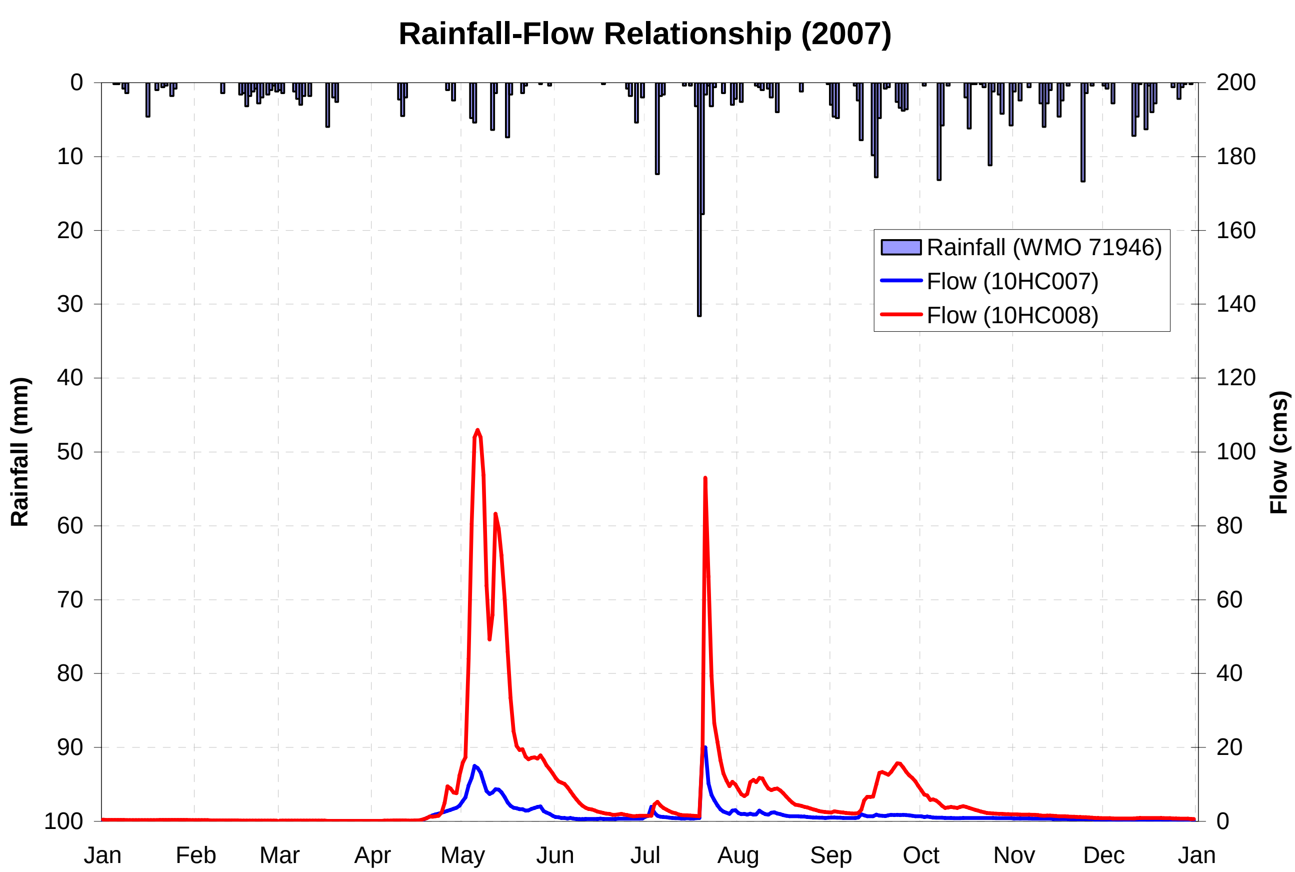
The total precipitation analysis based on the data from the Fort Simpson meteorological station, which is the closest station in relation with the study area, shows that watersheds responses are relatively fast regarding natural inflow.

During the period from April to June, the melting snow represents the principal sources of stream flows. The addition of rainfall during this period could provoke an extreme peak flow. The recorded mean daily flows for this period are 106 $m^3/s$ and 15 $m^3/s$ for Ochre River and Hodgson creek respectively. These peak flows could be explained by runoffs occurring on saturated soil or on partially frozen areas.

Indeed, 2007 records from the 10HC008 station show that a summer storm creates lower peak flows than spring storm peak flows despite that total rainfall was greater in summer in comparison to that of spring. However, station 10HC007 records show a greater peak flow in summer than in spring, hence., for this same year (2007), peak flows were estimated at 93 m³/s for Ochre River and at 20 m³/s for Hodgson Creek (see Graph 6). The difference in hydrologic behaviour between both stations could be explained by the nature of the soils present.

The apparent response of the basin shows that its flow could be more important in spring and summer, which could induce the transportation of greater amount of sediment. This could generate environmental impacts in association with the construction work activities and thus, the fall season would be a better period to conduct such construction works.

Graph 6: Precipitation – Flow Relation (2007)



Drainage flow

Considering the drainage areas, the mean, maximum and minimum flows were estimated at the location of the winter road crossing point (Table 21).

Table 21: Basin Area and Estimated Mean, Maximum and Minimum Flows

| | | CALCULATED FLOWS | | |
|---|---|---|---|---|
| Sub-basin | Area ($km^2$) | Qmean (l/s) | Qmax (l/s) | Qmin(l/s) |
| Drainage 1 | 4.8 | 7.2 | 118.1 | 0.3 |
| Drainage 2 | 13.0 | 15.3 | 254.4 | 0.7 |
| Drainage 3 | 15.3 | 21.8 | 362.7 | 0.9 |
| Drainage 4 | 44.7 | 61.5 | 1036.4 | 2.4 |
| Strawberry Creek | 46.9 | 66.2 | 1106.9 | 2.8 |
| Vermillion Creek | 63.3 | 88.9 | 1487.7 | 3.6 |
| Dam creek River | 104.6 | 145.1 | 2438.3 | 5.8 |
| Ochre River | 1279 | 1481.4 | 26435.6 | 27.3 |
| Bonnie Creek River | 11.2 | 16.3 | 269.8 | 0.7 |
| Blackwater River | 8443 | 11586.9 | 195387.0 | 445.4 |
| Whitesand Creek | 310.3 | 458.9 | 7562.8 | 20.9 |
| | | | | |

### 6.1.4.2 Water and Sediment Quality

In 2002 and 2003, various water quality studies were completed to characterize regional water and sediment quality within rivers located in the study area defined for the MGP EIS. These results were presented in the report produced in 2004 (MPEG, 2004). Some of the rivers considered for these studies cross the Mackenzie winter road including Blackwater River, Ochre River, White Sand Creek and Hodgson Creek. Data were also available for the East channel of the Mackenzie River. The analytical results for these rivers' water and sediments are presented in Appendix 10.

#### 6.1.4.2.1 Water Quality Parameters

Water quality indicators were used to provide chemical, physical and biological information to assess the suitability of surface waters for aquatic life or for use as drinking water. These indicators include: pH, dissolved oxygen, major ions, turbidity and color, acid sensitivity, total suspended solids, total organic carbon, nutrients (such as nitrogen and phosphorus), metals and organic compounds.

#### 6.1.4.2.2 *Sediment Quality Parameters*

Sediments can occur in surface waters as bottom sediments or in the water column as suspended sediments. Four indicators were used to evaluate sediment quality: Particle size, Total organic carbon, Metals and Hydrocarbons.

#### 6.1.4.2.3 *Water and Sediment Quality Guidelines*

Both surface water and sediment quality results obtained for the samples collected during 2002 and 2003 sampling activities were compared to the following guidelines:

- water quality guidelines for protection of aquatic life (CCME, 1999);
- drinking water guidelines (Health Canada, 2001);
- sediment quality guidelines for the protection of aquatic life (CCME, 1999).

#### 6.1.4.2.4 *Summary of Results*

The Rivers crossing the study area show similar proprieties in terms of color and metal concentrations. The results were different for the Mackenzie River since this watercourse collects water from many tributaries. The water quality results highlights include:

- All five rivers presented a color degree higher than the relevant drinking water guideline;
- Ochre River, Hogdson Creek and Whitesand Creek had concentrations of aluminum higher than the relevant chronic aquatic life criteria and the drinking water criteria;
- Sampling from Whitesand Creek also showed concentrations of chromium and iron higher than the relevant chronic aquatic life criteria. Levels of iron were also higher than the drinking water criteria;
- Sampling collected from the Mackenzie River East Channel showed levels of total dissolved solids, metals like aluminum, chromium, copper, iron, lead and zinc higher than the corresponding chronic aquatic life criteria. Manganese, aluminum, iron and lead results were also higher than the drinking water criteria.

The sediment quality results can be summarised as follow:

- Unfortunately, the available results for Blackwater River, White Sand Creek, Ochre River and Hogdson Creek cannot be considered as all parameters with high concentrations might contain error since the spectra used to develop these values were ill-defined;
- For the Mackenzie River East Channel, the results show the presence of arsenic, cadmium, naphthalene and phenanthrene in concentrations greater than the interim sediment quality guideline value (CCME, 1999).

### 6.1.5 Groundwater

The road corridor lies along the edge of the Mackenzie Plain on the western side of the Franklin Mountains from the Blackwater River in the north to Wrigley in the south. The main features that control groundwater flow are bedrock geology and topography, and extensive, intermediate and sporadic discontinuous permafrost. These three types of permafrost are characterized as follows:

- Extensive discontinuous permafrost – permafrost underlying 65% to 90% of the area of exposed land surface. In the northern half of the highway corridor;
- Intermediate discontinuous permafrost - permafrost underlying 35% to 65% of the area of exposed land surface. More likely to occur in the southern part of the highway corridor;
- Sporadic discontinuous permafrost – permafrost underlying < 35% of the area of exposed land. In the southern half of the highway corridor.

In the Franklin Mountains, extensive karst terrain has developed and this has enabled major groundwater flow systems to develop in the mountainous karst terrain. Groundwater flow in the Franklin Mountains has caused extensive spring development throughout the northern half of the Dehcho Region. Groundwater flow on the west flank of the Franklin Mountains affects hydrology in the Mackenzie Plain by maintaining all-year open flow in some streams.

Groundwater inflow to streams, as springs and seeps, provides the baseflow for streams. Baseflow is that part of stream flow that consists of groundwater input. However, groundwater movement is restricted by the presence of permafrost along many parts of the road corridor. In areas of extensive discontinuous permafrost, most streams freeze to the channel bottom in winter and have essentially no baseflow.

Where groundwater occurs above permafrost and seeps from more porous sediments such as gravels, icings or aufeis may occur over winter and during the spring melt period

As permafrost likely underlies 35% to 90% of the land along the road corridor surface, shallow groundwater flow is limited, and so groundwater baseflow to streams is small and many small streams likely dry up during the summer. Groundwater flow beneath the permafrost has little effect on surface flow.

### 6.1.6 Public Water Infrastructure

In the Dehcho region, there are relatively few water related infrastructures. Energy production is essentially ensured by diesel-fuelled generators and most of the hydroelectricity dams in the Northwest Territories are located near Yellowknife or are associated with major industries like mines. The only dams present in the area of the studied road section between Wrigley and the Blackwater River area are Beaver dams. They apparently are a recurrent problem for upstream migration of fish species.

As for man made dams, the closest is located some 240 km up north at Norman Wells. It is a concrete dam, 3 m high, built as a drinking water reservoir for the community. However, the reservoir is no longer in use.

According to 2001 data, water wells are present in Wrigley but their locations are currently unavailable.

### 6.1.7 Ambient Noise

The study sector is located in an unpopulated area. The existing road is currently used only during winter for a 4-month period. Therefore, during the summer season, little or no noise is generated by human activities along this road.

Noise levels in nature can vary. In the present case, the Mackenzie River, which runs along the study zone, can produce noise levels of up to 60 dBA[10] in sectors with rapids. As an indication, noise by-laws have determined that noise levels in a residential zone should be between 40 to 50 dBA, depending on the time of day. Although the noise level existing in nature may occasionally exceed noise standards as applicable in an urban setting, noise of a natural origin is better accepted, because it is considered pleasant. The noise influence of the river will be limited to a narrow strip of land a few hundred metres wide. Further down, the noise will come from the wind in the trees and wildlife (birds or other). The noise level can then be highly variable, with occasional noise peaks as well as periods when the noise level will be very low (30 dBA or less).

When the road is used in winter, traffic noise generates noise levels that are limited to a narrow zone on both sides of the road. Since the volume of vehicular traffic is not higher, the noise level is not constant; rather, it consists of noise peaks. The highest noise peaks are produced by the passage of heavy trucks. They produce noise levels of up to 85 dBA at a distance of 15 m. The farther from the road, the lower the noise peak is. At a 200 m distance, the noise level produced by the passage of this truck will be about 20 dBA lower than the noise level at 15 m. Given that the annual average number of vehicles travelling on the road to Wrigley is 50 to 99 vehicles (DOT, 2007), the $LAeq_{24h}$[11] noise level will be 50 dBA lower when at a distance greater than 25 metres from the centre of the road. According to the World Health Organization

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10 Unit used to express the noise level measured with a filter that accentuates the average frequency components, thus imitating the reaction of the human ear, according to the standards and methods stipulated in publication number 179 of the Central Bureau of the International Electrotechnical Commission (IEC).

11 Parameter allowing consideration of the dynamic fluctuations of the noise level. The Leq equivalent continuous noise level corresponds to the continuous noise level with the same noise energy as discontinuous noise over a given time period. In the present case, the LAeq24h equivalent noise value is evaluated over a 24-hour period.

(WHO), few people are moderately annoyed by LAeq levels that fall below 50 dBA (Berglund et al., 1999).

## 6.2 BIOLOGICAL COMPONENTS

### 6.2.1 Vegetation

The following sections describe the flora and vegetation communities that are present in the Pehdzeh Ki Ndeh - Dehcho Region MVH Project area between Wrigley and the Blackwater River. The selection of Valued Environmental Components (VECs) is described first, followed by descriptions of the broader landscape context and the vegetation communities of the RSA and LSA (defined below). Potential project interactions with VECs are identified, and mitigations are proposed.

#### *6.2.1.1 Study Area*

The Project area includes the segment of the proposed MVH alignment that extends from Wrigley north to the northern boundary of the Pehdzeh Ki Ndeh - Dehcho Region, near the confluence of the Blackwater River with the Mackenzie River (Figure 10).

The local study area (LSA) includes the length of the alignment extending from Wrigley to the Pehdzeh Ki Ndeh - Dehcho Region boundary to the north, and 1 km wide (i.e., 500 m on each side of the centre line) (Figure 10).

The regional study area (RSA) is defined as the extent of the Central Mackenzie Valley HBb Ecoregion (see below). The RSA is considered to represent a biologically defined area for the purposes of describing the characteristics of the region surrounding the LSA (Figure 10).

#### *6.2.1.2 Valued Environmental Component Selection*

The rationale for the selection of VECs was a combination of the potential for Project-related impacts, their presence within the LSA, and the protections afforded to at-risk plant species and wetlands through legislation or policies.

1. Potential Presence: Known or potential occurrence within the RSA or LSA;
2. Potential for Project-related Impacts: Clearing within the project footprint could affect plants, plant communities and wetlands;
3. Legislation: At-risk plant species are identified under Schedule 1 of the federal Species at Risk Act (SARA), the Northwest Territories (NWT) General Status Ranks (GSR) Program, and/or species identified as being of conservation concern by Imperial Oil (2004) in the context of the EIS for the MGP. Wetlands are protected through guidance in the Federal Policy on Wetlands.

Vegetation VECs identified in the context of the Project include the following:

1. Plant communities in general;
2. Wetlands, as defined by the Federal Wetland Policy;
3. At-risk plant species.

#### 6.2.1.3 *Study Limitations*

Baseline descriptions of vegetation VECs are typically derived from combinations of existing vegetation mapping, air photo interpretation, and site visits. Vegetation studies are planned for the next stage. These studies will be undertaken in areas along the alignment and in potential material sources that have not been covered by previous work by the GNWT or MGP. For the purposes of this PDR, a desktop study was conducted based on a literature review.

Existing information regarding vegetation VECs was largely limited to the MGP EIS (MPEG, 2004). The Mackenzie Project Environment Group (2004) developed an Ecological Land Classification system (ELC), which included the demarcation of ecological zones. Each ecological zone was further organized into vegetation types, using vegetation canopy cover and a structural or physiognomic approach (MPEG, 2004). Spatial information within the MGP EIS shows only the boundaries of the ecological zones (MPEG, 2004). The location and extent of the vegetation types, within the ecological zones, is not presented.

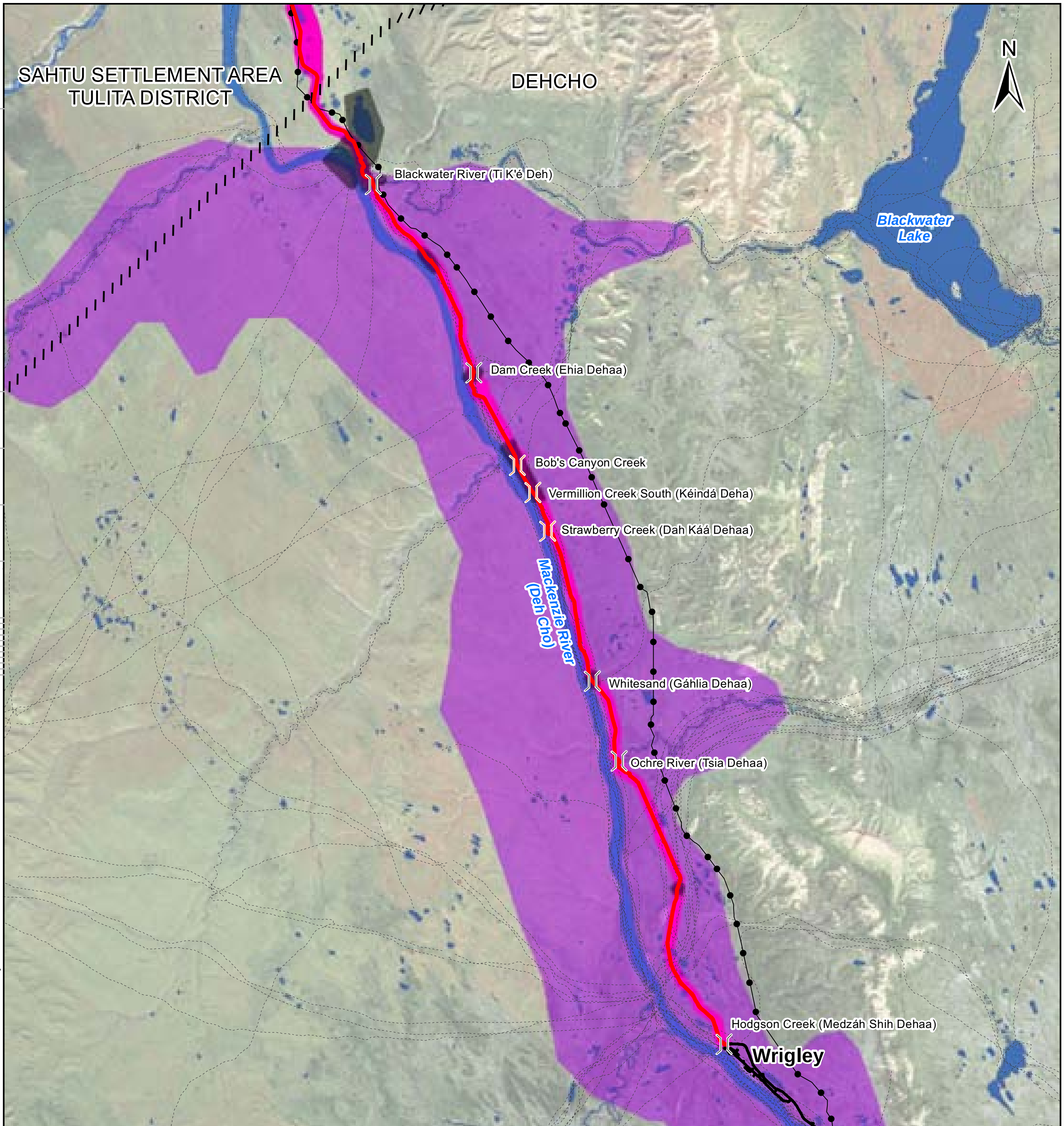
The MVH alignment falls entirely within the South Taiga Ecological Zone as described by MPEG (2004). The South Taiga Ecological Zone extends south from the Great Bear River, near Tulita, beyond the LSA (which ends at Wrigley), and further south into Alberta.

Sixteen vegetation types within the South Taiga Plains are described, as well as an additional common regenerating vegetation type, Si1R. The vegetation communities that occur within the proposed highway alignment could share common features with the communities surveyed for the MGP.

For this reason, the ELC surveys and rare plant reconnaissance surveys conducted in support of the MGP EIS are used to describe the vegetation conditions that could occur within the Project's LSA.

The study limitations associated with the use of the vegetation type descriptions from the MGP EIS, lie in the lack of associated spatial information. Because the South Taiga Plains Ecological Zone is so much larger than the project area between Wrigley and the Blackwater River, it is not possible to confirm the extent or distribution of the vegetation types described below within the project area for this PDR. It is possible that some of the vegetation types described may not exist within the Project LSA.

Although the extent and location of each of the vegetation types in the LSA is not known, the types found in this Ecological Zone are described to guide further decision making and to enable an assessment of the proposed project in the Pehdzeh Ki Ndeh - Dehcho Region.




Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Local Study Area
Regional Study Area (HBb Ecoregion)
PKFN Main Traditional Activity Site

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 10**
**Local and Regional Study Area**
**for Biological Components**

| | | | |
|---|---|---|---|
| Prepared : | G. Pothier | No : | 068-P0037500-202-001-GO-C110-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\v5_cad\GO\01-MXD\068-P037500-0202-001-GO-C110-00_StudyArea_20120227.mxd

#### 6.2.1.4 Landscape Context

The Ecosystem Classification Group (ENR, 2010b) provides a hierarchal system for describing ecosystems in the NWT *via* four levels of ecoregions, with Level I at the broadest scale, and Level IV at the finest scale.

The Project area is situated within the following ecoregions:

- Level I – Northwest Forested Mountains;
- Level II – Boreal Cordillera (BC);
- Level III – Boreal Cordillera – High Boreal (BC HB);
- Level IV – Central Mackenzie Valley (BC HBb).

Generally speaking, vegetation in the BC ecoregion is dominated by tall, dense conifer and mixed-wood forests, tall shrublands, and rich wetlands are characteristic of lower elevation valley bottoms and slopes. High-elevation subalpine forests include alpine fir and several plants that are typical of moist montane ecosystems to the south and west in Alberta, British Columbia and Alaska (ENR, 2010b).

Climate in the BC HB ecoregion is characterized by short, cool summers (early June to August) and long, very cold winters (ENR, 2010b). The mean annual temperature ranges from –4° to -5°C. The mean temperature in January, the coldest month, ranges from –24° to –28 °C and averages 16 to 17 °C in July, the warmest month. Mean annual precipitation ranges from 330 to 390 mm.

#### 6.2.1.5 Vegetation in the RSA

The Project lies entirely within the BC HB HBb ecoregion. The vegetation to the north of Wrigley differs somewhat from vegetation further south; tall, closed-canopy upland forests become less extensive as one travels northward, and become restricted to river banks, alluvial and glaciofluvial terraces and islands, and slopes where drainage and temperature conditions are favourable (ENR, 2010b). Black spruce – shrub – moss woodlands and forests are the dominant vegetation types on level to gently sloping lacustrine and till deposits north of Wrigley; peat plateaus occur on gentle terrain (Ibid.). Massive stand-replacing fires have burned over much of the area near the Dahadinni and Blackwater Rivers (ENR, 2010b). Recently burned areas are dominated by regenerating shrubby and deciduous vegetation, with scattered jack pine stands on coarse-textured till and glaciofluvial deposits (ENR, 2010b).

#### 6.2.1.6 Vegetation in LSA

MPEG (2004) is the sole reference throughout the following section. Therefore, to avoid repeatedly referencing the EIS throughout the section, it is only referenced here.

##### 6.2.1.6.1 *Upland Jack Pine (Sa1)*

Jack pine stands are characteristic of upland areas in the South Taiga Plains Ecological Zone. This vegetation type is also associated with sand dunes and glacial till. Jack pine is dominant in the tree canopy layer. Green alder (*Alnus viridis*), soapberry (*Shepherdia canadensis*), prickly rose (*Rosa acicularis*) and low-bush cranberry (*Viburnum edule*) are common in the shrub layer. The average tree canopy height is 12.3 m. Pine reaches its northern limit near Big Smith Creek, to the north of the LSA and RSA. Mountain cranberry (*Vaccinium vitis-idaea*), common bearberry (*Arctostaphylos uva-ursi*), jack pine and prickly rose are common in the ground cover layer; and fireweed (*Epilobium angustifolium*), bunchberry (*Cornus canadensis*), northern comandra (*Geocaulon lividum*), twinflower (*Linnaea borealis*) and one-sided wintergreen (*Orthilia secunda*) are also present. Feather mosses occurring in this vegetation type are knight’s plume (*Ptilium crista-castrensis*), stair-step moss (*Hylocomium splendens*) and Schreber’s moss (*Pleurozium schreberi*), and reindeer lichens and *Peltigera* are common on the forest floor.

##### 6.2.1.6.2 *Upland Trembling Aspen / Prickly Rose (Sd1)*

The upland trembling aspen / prickly rose (Sd1) vegetation type is located in upland forested areas. Trembling aspen (*Populus tremuloides*) and white spruce are dominant in the tree canopy, and subcanopies are primarily white spruce. The average tree heights range between 15.1 and 17.0 m. Characteristic shrub species include soapberry, green alder, low-bush cranberry, and long-beaked willow (*Salix bebbiana*). Prickly rose is present in both the shrub and ground cover layer. Ground cover plant species are primarily bunchberry, mountain cranberry, fireweed and twinflower; and field horsetail (*Equisetum arvense*), dwarf scouring-rush (*Equisetum scirpoides*), northern comandra, one-sided wintergreen and pink-flowered wintergreen (*Pyrola asarifolia*) occur in lower abundance. Stair-step moss is widespread on the forest floor. *Peltigera* is a common lichen species to most sites, but does not form a large component of ground cover.

##### 6.2.1.6.3 *Upland White Spruce – Trembling Aspen – Jack Pine (Sd2)*

The upland white spruce – trembling aspen – jack pine (Sd2) mixed wood vegetation type is located in upland forested areas. Jack pine, trembling aspen and white spruce are co-dominant in tree canopy layer. Average tree heights range between 12.8 and 14.1 m. White spruce occurs both in the subcanopy and tree canopy. Common shrub species are green alder, prickly rose, soapberry, white spruce, trembling aspen and low-bush cranberry. The plant ground cover layer is composed of mountain cranberry, bunchberry, northern comandra and twinflower. Fireweed, dwarf scouring-rush, one-sided wintergreen, pink-flowered wintergreen and sedges are also present but less abundant. Bryophytes are stair-step moss and Schreber’s moss, and cover most of the forest floor.

#### 6.2.1.6.4 *White Spruce / Stair Step Moss (Sd3)*

Thin bands of the white spruce / stair step moss (Sd3) vegetation type occur along the riparian zones of major rivers, including the Mackenzie. White spruce / stair step moss is also associated with the riparian areas of creeks and occasionally lakeshores. White spruce is dominant in the canopy, and average canopy height is 16.8 m. The shrub layer is green alder, prickly rose, white spruce, soapberry and red-osier dogwood (*Cornus sericea*). Bunchberry, sedges, mountain cranberry, twinflower, pink-flowered wintergreen, dwarf scouringrush and northern comandra make up most of the plant ground cover component. Low-bush cranberry, blue-joint reed-grass (*Calamagrostis canadensis*), northern bedstraw (*Galium boreale*) and one-sided wintergreen also occur, but are less abundant. Stair-step moss is the dominant bryophyte, and knight's plume also occurs in lower abundance. *Peltigera* is a common lichen. Characteristic plant ground cover species for the white spruce / stair step moss (Sd3) vegetation type include greenish-flowered wintergreen, dwarf rattlesnake plantain (*Goodyera repens*) and licorice root (*Glycyrrhiza glabra*). The total surface cover of bryophytes and lichens is high in this vegetation type with a median estimated value of 74.5%.

#### 6.2.1.6.5 *Black Spruce – White Spruce / Stair Step Moss (Sd4)*

The black spruce – white spruce / stair step moss (Sd4) vegetation type is scattered throughout upland terrain, often in association with ridges and knolls, and less frequently in lowland areas. The tree canopy is dominated by white spruce and black spruce. Average tree canopy heights are 9.5 m for black spruce to 13.8 m for white spruce. Green alder, black spruce, prickly rose and Labrador tea are common in the shrub layer. Dwarf shrubs such as bearberry, mountain cranberry and dwarf raspberry (*Rubus pubescens*) are also common. Vascular plants in the ground cover layer include twinflower, dwarf scouring-rush, mitrewort (*Mitella nuda*) and northern comandra. Low-bush cranberry, the sedge *Carex consimilis*, bunchberry, one-sided wintergreen and pink-flowered wintergreen are also present but are less abundant.

#### 6.2.1.6.6 *Alaska Birch - White Spruce (Sd5)*

The Alaska birch – white spruce (Sd5) vegetation type has a scattered distribution on upland terrain, often in association with ridges and knolls, and occurs less frequently in lowland areas. The tree canopy is composed of Alaska birch and white spruce. Average canopy heights are 11.3 m for Alaska birch to 21.1 m for white spruce. Shrub species are prickly rose, green alder, Labrador tea and Alaska birch. Mountain cranberry, northern comandra, bunchberry and twinflower are common in the vascular plant ground cover. Low-bush cranberry, field horsetail, dwarf scouring-rush and one-sided wintergreen are also present but occur in lower abundance. Stair-step moss is the most prominent bryophyte and lichen layer species. Bryophytes and lichens are abundant at an estimated median surface cover of 78.5%.

#### 6.2.1.6.7 *Riparian Willow (Sf4)*

The riparian willow (Sf4) vegetation type occurs in the riparian areas that surround lakes, rivers and creeks. It occurs occasionally throughout the STP ecological zone. Dominant shrub species are green alder and shrubby cinquefoil (*Dasiphora fruticosa*), along with many willow species, including: flat-leaved willow (*Salix planifolia*), shrubby willow (*S. herbacea*), blue-green willow (*S. glauca*), long-beaked willow, myrtle-leaved willow (*S. myrtillifolia*), McCall's willow (*S. maccalliana*) and Richardson's willow (*S. richardsonii*). Labrador tea is present, but less abundant than previously mentioned shrub species. Vascular ground cover plant species are predominantly sedges, including: water sedge (*Carex aquatilus*), mud sedge (*C. limosa*), bog sedge (*C. paupercula*), two-seeded sedge (*C. disperma*) and bristle-stalked sedge (*C. leptalea*). Other important species are blue-joint reed-grass and marsh willowherb (*Epilobium palustre)*. Peat moss (*Sphagnum* spp.) is common in water-logged soils.

#### 6.2.1.6.8 *Riparian Willow – Red Osier Dogwood (Sf5)*

The riparian willow (Sf5) vegetation type occurs on fluvial sediments along the banks of rivers, such as the Mackenzie River. Shrubs are tall willow species including sandbar willow (*Salix interior*), Scouler's willow (*S. scouleriana*), false mountain willow (*S. pseudomonticola*), flat-leaved willow and Alaska willow (*S. alaxensis*). Other species present in the shrub layer are grey alder (*Alnus incana*), young balsam poplar (*Populus balsamifera*)), red-osier dogwood, prickly rose, and green alder. Ground cover species are primarily herbaceous species adapted to frequent flooding and disturbance, including slender wheat grass (*Elymus trachycaulus*), blue-joint reed-grass, licorice root, common yarrow (*Achillea millefolium*), veiny meadow rue (*Thalictrum venulosum*), and common plantain (*Plantago major*). Other herbaceous species present in lower abundance include: Herriot's sagewort (*Artemisia tilesii*), Arctic aster (*Aster sibiricus*), sedges (*Carex* spp.), fireweed, field horsetail, meadow horsetail (*Equisetum pratense*), streamside fleabane (*Erigeron glabellus*), northern bedstraw, moss gentian (*Gentiana fremontii*) and northern grass-of-Parnassus (*Parnassia palustris*). Though diverse, vascular plants are sparse in the ground layer with a median surface cover of 25.0%. Combined, bare ground (18.2 %) and litter (15.0 %) form a more substantial portion of ground surface cover.

#### 6.2.1.6.9 *Riparian Balsam Poplar / Green Alder (Sf6)*

The riparian balsam poplar / green alder (Sf6) vegetation type occurs on fluvial sediment along the banks the Mackenzie River and other large rivers. The tree canopy is balsam poplar with an average height of 10.3 m. Green alder, prickly rose, red osier dogwood and shrubby willow occur in the shrub layer, along with low-bush cranberry and wild red raspberry (*Rubus idaeus*). Ground cover species are twinflower, dwarf raspberry, mitrewort and pink-flowered wintergreen. Wild gooseberry (*Ribes hirtellum*), bunchberry, field horsetail, northern bedstraw, wild red currant (*Ribes triste*) and veiny meadow rue are also present, but less abundant. Most of the surface cover is composed of litter—the median estimate is 96.3%.

#### 6.2.1.6.10 Black Spruce – Tamarack (Sg1)

The black spruce – tamarack (Sg1) vegetation type is associated with both upland and lowland terrain, and frequently occurs along drainages in strips and clusters. The tree canopy layer is open, and dominated by black spruce and tamarack. The average tree height is 8.2 m. The shrub layer is composed of Labrador tea, black spruce, green alder, willow, ground birch, tamarack, prickly rose and shrubby cinquefoil. Vascular plants in the ground cover layer are relatively sparse, with a median total surface cover of 20.4%. Species in this layer include sedges, bearberry, mountain cranberry and dwarf scouring-rush, bunchberry, field horsetail and twinflower. Most of the ground surface cover is bryophytes and lichens (84.0%). Mosses, particularly stair-step moss, provide the majority of the ground surface cover. Common lichen species include reindeer lichens and *Peltigera*.

#### 6.2.1.6.11 Black Spruce / Labrador Tea / Mountain Cranberry

The black spruce / Labrador tea / mountain cranberry (Si1) is the most abundant vegetation type in the STP ecological zone. It is widespread in lowland areas with level topography. Scattered black spruce and tamarack dominate the tree layer with average tree heights between 7.1 to 7.8 m. Black spruce and tamarack are also present in the shrub layer, with Labrador tea, willows, ground birch, bog bilberry (*Vaccinium myrtillus*) and shrubby cinquefoil. Ground cover vascular plant species include myrtle-leaved willow, mountain cranberry, bearberry, dwarf scouring-rush, sedges, three-leaved Solomon's-seal (*Smilacina trifolia*), and twinflower. Field horsetail, northern comandra and mitrewort are also commonly present. Surface cover is primarily bryophytes and lichens, with a median surface cover of 85.0%. Stair-step moss, golden moss (*Sedum acre*), and peat moss are the most common mosses, and common lichens species include reindeer lichens and *Peltigera*.

#### 6.2.1.6.12 Regenerating black spruce / Labrador tea / Mountain Cranberry (Si1R)

The regenerating black spruce / Labrador tea / mountain cranberry (Si1R) vegetation type occurs on burned lowland areas with level topography. Black spruce occurs in the tree layer and the shrub layer. Labrador tea and northern Labrador tea, willow, sweet gale, green alder, bog bilberry, Alaska birch, shrubby cinquefoil and prickly rose also occur in the shrub layer. The ground cover layer of vascular plants includes red bearberry, fireweed, bog rosemary, sedges, dwarf scouring-rush, and mountain cranberry. Common lichens are club lichens, Peltigera, and reindeer lichens. The dominant bryophyte species is *Ceratodon*.

### 6.2.1.6.13 Black Spruce / Cloudberry – Lichen Bog (Si3)

The black spruce / cloudberry – lichen bog (Si3) vegetation type is found on elevated or horizontal peat plateaus and is widespread south of the Mackenzie River in the Alberta Plateau. The scattered to open tree canopy is black spruce, with black spruce also occurring in the shrub layer. The average tree canopy height is 5.9 m. Common shrubs are Labrador tea, northern Labrador tea (*Rhododendron tomentosum*) and leatherleaf (*Chamaedaphne calyculata*). Species occurring in the ground cover layer are mountain cranberry and cloudberry (*Rubus chamaemorus*). Northern comandra and small bog cranberry (*Vaccinium oxycoccos*) also occur in lower abundance. The bryophyte and lichen layer is predominantly composed of reindeer lichens and sphagnum moss, with lesser amounts of club lichens (*Cladonia* spp.). Bryophytes and lichens are the domninant ground cover, with a median surface cover of 85.0%.

### 6.2.1.6.14 Leatherleaf / Bog Rosemary – Peat Moss (Si4)

The leatherleaf / bog rosemary – peat moss (Si4) vegetation type occurs as small circular collapse scars in peat plateaus associated with black spruce / cloudberry – lichen bog (Si3) vegetation types (Section 2.3.13). It is widespread south of the Mackenzie River in the Alberta Plateau. The shrub layer includes leatherleaf and black spruce. Bog rosemary (*Andromeda polifolia*), leatherleaf, cloudberry and sheathed cottongrass (*Eriophorum callitrix*) are common in the ground cover layer. Northern Labrador tea, three-leaved Solomon's seal and small bog cranberry are found in lower abundance. Indicator species for this vegetation type are seaside arrow-grass (*Triglochin maritima*), round-leaved sundew (*Drosera rotundifolia*), mud sedge, bog sedge, one-spike cotton-grass (*Eriophorum scheuchzeri*), and Scheuchzeria (*Scheuchzeria palustris*), which occur at low cover values. Bryophytes and lichens, primarly peat mosses, are the dominant surface cover, with a median surface cover of 97.5%.

### 6.2.1.6.15 Graminoid Fen (Sk3)

The graminoid fen (Sk3) vegetation type occurs in areas of poor drainage, and is frequently associated with patches of open water. Water sedge is the dominant species, and other sedges include small bottle sedge (*Carex utriculata*), mud sedge, and two-stemmed sedge (*C. lachenalii*). Marsh cinquefoil (*Comarum palustre*) is commonly present, and also present but less abundant are bog rosemary, marsh willowherb, three-leaved Solomon's-seal and long-leaved chickweed (*Stellaria longifolia*). Golden moss and peat moss are common. Shrubs, where present on higher drier microsites, are primarily ground birch. Ground cover species have a median surface cover of 38.8%. Open water is 37.5% of surface cover, litter is 27.4%, and bryophytes and lichens are 15.0%.

#### *6.2.1.6.16 Shrub fen (Sk4)*

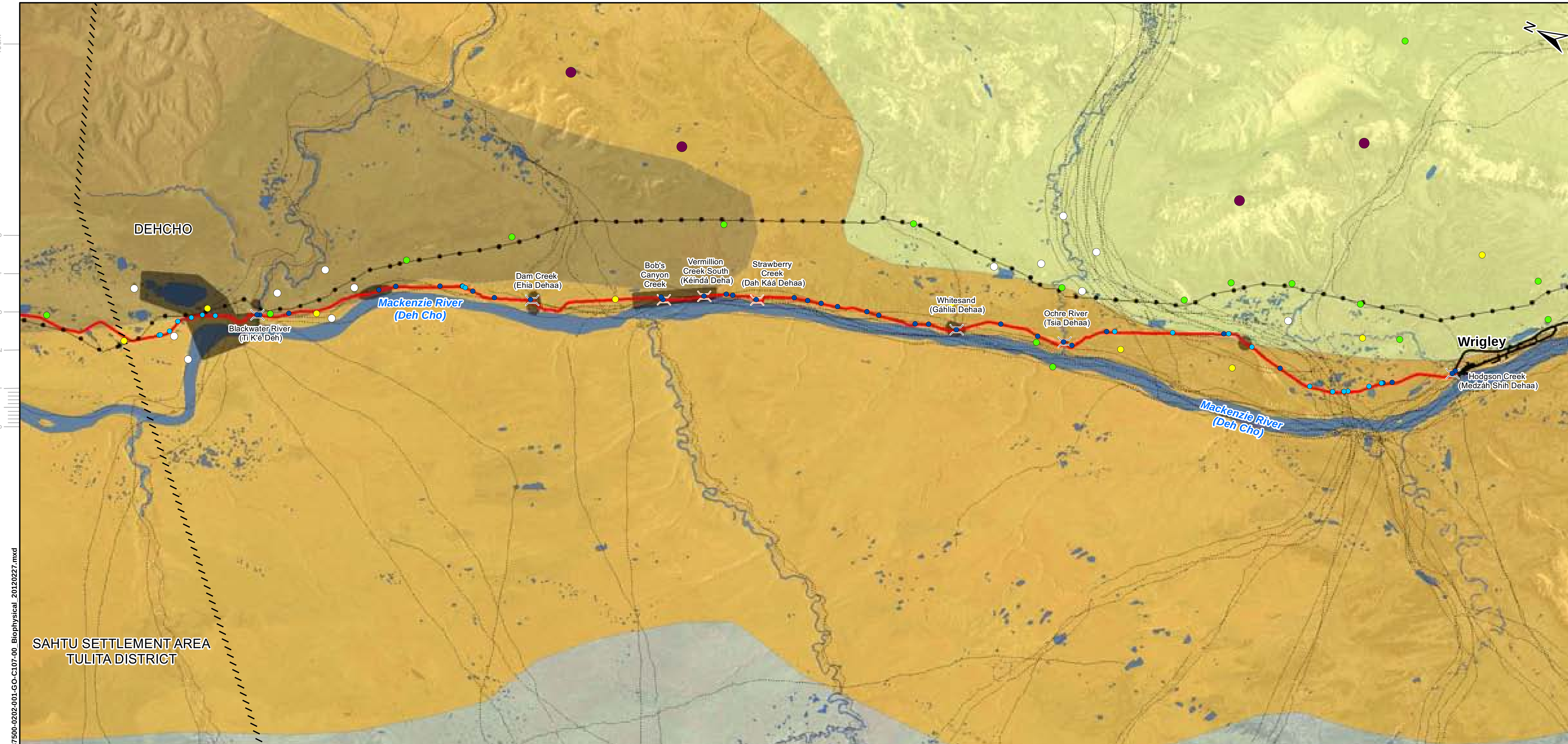
The shrub fen (Sk4) vegetation type occurs in lowland areas with poor drainage, often in association with Sk3 graminoid fens. The shrub layer is dominated by ground birch, sweet gale and willows (flat-leaved willow, blue-green willow, and myrtle-leaved willow). Shrubby cinquefoil, Labrador tea, tamarack and leatherleaf may also be present in the shrub layer. Water sedge is prominent, along with lesser components of other sedge species, marsh cinquefoil, *Rubus arcticus* and water horsetail (*Equisetum fluviatile*). Bryophytes and lichens have the highest surface cover (37.5%), followed by the ground cover layer species (30.0%) and open water and litter, each at 15.0%.

#### *6.2.1.6.17 Treed fen (Sk5)*

The treed fen (Sk5) vegetation type occurs in poorly drained lowlands, usually in association with graminoid (Sk3) (Section 2.3.15) and shrub fens (Sk4) (Section 2.3.16). Open water is commonly associated with this vegetation type. Tamarack and black spruce occur in the tree canopy with low cover values. Average tree canopy height is 7.1 m. The shrub layer includes ground birch, leatherleaf, sweet gale and tamarack, and smaller amounts of Labrador tea. Water sedge, small bog cranberry, star-flowered Solomon's-seal (*Maianthemum stellatum*), and bog rosemary are common in the ground cover layer. Bristle-stalked sedge, mud sedge and tufted bulrush (*Trichophorum cespitosum*) also occur in lower abundance. Common mosses are peat moss, *Tomenthypnum* and *Aulacomnium*. Bryophytes and lichens have a median surface cover of 58.0%. Ground cover layer species are less abundant, with a median total surface cover of 37.8%.

### *6.2.1.7 Wetlands*

Wetlands are common throughout the LSA. Collectively, wetland habitats cover approximately 275 ha of the LSA (approximately 3%). Wetland types occurring in the LSA include those described in the previous sections: Black spruce / cloudberry – lichen bog, leatherleaf / bog rosemary peatmoss, graminoid fen, shrub fen, and treed fen. Appendix 1, sheets 1-T to 20-T) presents the existing wetland crossings associated with the winter road.




- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Wetland Crossing
- Stream / River Crossing
- Rare Plant Location
- Scaup Observation
- Ungulate Observation
- Karst Formation
- Extensive Discontinuous Permafrost
- Intermediate Discontinuous Permafrost
- Sporadic Discontinuous Permafrost
- PKFN Main Traditional Activity Site

Sources :
- © Bing Maps, 2006-2009
- CanVec, Canada Government.
- Northwest Territories, Centre for Geomatics
- PKFN, 2011
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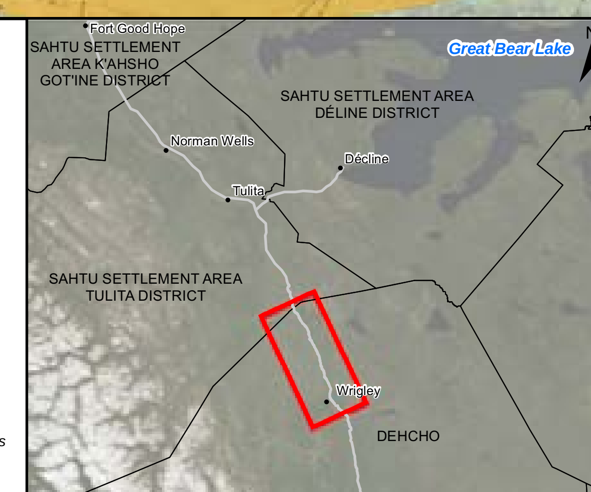
- Dessau, 2011.




Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 11**
**Biophysical Components**

| | | | |
|---|---|---|---|
| Prepared : | G. Pothier | No : | 068-P0037500-202-001-GO-C107-00 |
| Drawn : | G. Lemay | Scale : | 1:275 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 11" x 17"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C107-00_Biophysical_20120227.mxd

### 6.2.1.8 Rare Plants

The rare plants listed in Table 22 were observed by MPEG (2004) during field studies in support of the MGP EIS application (Figure 11). The rare plants detected in the STP ecological zone occurred primarily in association with various types of water bodies, including lakeshores, stream banks, and wetlands.

Some of the species detailed in Table 22 occurred outside the RSA. These species were included in Table 19 because they may have potential to occur in similar habitats within the RSA or LSA. None of the species listed in Table 22 have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and none are protected under the SARA.

Table 22: Rare Plants Detected by Identified by MPEG (2004) in the South Taiga Plains Ecological Zone

| COMMON NAME | LATIN NAME | NWT GSRANK | COSEWIC STATUS | HABITAT ASSOCIATION AND LOCATION | OCCURRENCE IN RSA? (Yes or No) |
|---|---|---|---|---|---|
| Northern water plantain | *Alisma triviale (Alisma plantago-aquatica var. americanum)* | Sensitive | Not Assessed | Mudflat north side of Willowlake River | No |
| Indian hemp | *Apocynum cannabinum (Apocynum sibiricum)* | May Be At Risk | Not Assessed | Graminoid fen near Wrigley, terrace of unnamed river south of Wrigley, on a mud flat by Willowlake River, and on a slope of the Mackenzie River near the proposed pipeline crossing | Yes |
| Poverty wild oat grass | *Danthonia spicata* | Sensitive | Not Assessed | River terrace south of Wrigley, Mackenzie river near Fort Simpson | No |
| White prairie aster | *Aster nahanniensis* | May Be At Risk | Not Assessed | Calcareous spring near Willowlake River | No |
| Canada nodding wild rye | *Elymus canadensis* | Sensitive | Not Assessed | Fluvial sediment on Willowlake River; sandy cobble beach of Mackenzie north of Camsell ferry landing | No |
| Grass-leaved Goldenrod | *Euthamia graminifolia (Solidago graminifolia)* | Sensitive | Not Assessed | Mud flats, cobble / sand beaches, rich fens, drainage channels, point bars, eroded slopes, steep boulder-strewn shores. South end of Sahtu to Fort Simpson | Yes |
| Prairie gentian | *Gentiana affinis* | Sensitive | Not Assessed | Gravel bars and river flats on Blackwater river, cobble beach at confluence of Ochre River and Mackenzie, low terrace of creek just south of Ochre River. | Yes |

Table 22 (cont'd): Rare Plants Detected by Identified by MPEG (2004) in the South Taiga Plains Ecological Zone

| COMMON NAME | LATIN NAME | NWT GSRANK | COSEWIC STATUS | HABITAT ASSOCIATION AND LOCATION | OCCURRENCE IN RSA? (Yes or No) |
|---|---|---|---|---|---|
| Moor rush | *Juncus stygius (Juncus stygius ssp. americanus)* | Sensitive | Not Assessed | Graminoid fens south of Jean Marie River; shrub fen north of Trainor Lake | No |
| Northern bugleweed | *Lycopus uniflorus* | Undetermined | Not Assessed | Wet run beside beaver dam, near drainage of Fish Lake; beaver dam near Fort Simpson | No |
| Slender naiad | *Najas flexilis* | Sensitive | Not Assessed | Wet run beside beaver dam, near drainage of Fish Lake | No |
| Muskeg lousewort | *Pedicularis macrodonta (syn Pedicularis parviflora var. macrodonta (Richards.)* | Sensitive | Not Assessed | Patterned fens near Alberta boundary | No |
| Common reed | *Phragmites australis (Phragmites communis)* | Undetermined | Not Assessed | Shallow water in alkaline lake South of Fort Simpson | No |
| Leafy pondweed | *Potamogeton foliosus* | Sensitive | Not Assessed | Fen habitat near a lake close to the Camsell ferry; flooded riparian near Liard Ferry Crossing | No |
| White beakrush | *Rhynchospora alba* | May Be At Risk | Not Assessed | Patterned fen near Fort Simpson | No |
| Smooth rose | *Rosa blanda* | Undetermined | Not Assessed | Sandy shoreline on a creek south of Tulita | Yes |
| Northern pitcher plant | *Sarracenia purpurea* | Secure | Not Assessed | Graminoid fens, patterned fen, black spruce cloudberry – lichen bog, leatherleaf/bog rosemary –peat moss vegetation type. Fort Simpson to Alberta Boundary | No |
| Alkali cordgrass | *Spartina gracilis* | Sensitive | Not Assessed | Exposed fluvial sediment, fluvial early seral, sandy cobble beaches and mudflats. North of Wrigley to Fort simpson | Yes |
| Rolland's bulrush | *Trichophorum pumilum (Scirpus pumilus, Scirpus rollandii)* | May Be At Risk | Not Assessed | Calcareous spring habitats from Wrigley south to the Willowlake River | No |

### 6.2.2 Wildlife

#### *6.2.2.1 Study Area*

The Project area includes the segment of the proposed MVH alignment that extends from Wrigley north to the northern boundary of the Pehdzeh Ki Ndeh – Dehcho Region, north of the confluence of the Blackwater River with the Mackenzie River (Figure 10).

The wildlife LSA is the area 500 m on both sides of the centre line of the road. This area encompasses the entire Project footprint and adjacent buffers, and is considered to be adequately sized to describe baseline wildlife values and provide for an effective assessment of direct and indirect Project impacts. The LSA is large enough to understand variability, particularly the presence of unique and potentially important wildlife habitats, but not so large that Project-related impacts cannot be assessed in detail.

The nature and spatial extent of potential project impacts to wildlife VECs were considered in determining the LSA. This area is large enough to assess both direct impacts (e.g., Project-related habitat loss), and indirect impacts (e.g., noise impacts on breeding birds). The LSA is approximately 9 400 ha. The road right-of-way is approximately 60 m wide by 102 km long or approximately 565 ha. Assuming that the existing winter road is followed as the preferred route (with no re-alignments) and the average width of the right-of-way to be cleared to accommodate the all-weather road is 10 m wide, the new disturbed area (excluding borrow pits and related access roads) would be approximately 95 ha.

The wildlife RSA is defined as the extent of the Central Mackenzie Valley HBb Ecoregion (as discussed in the section describing vegetation for the project). The RSA is considered to represent a biologically meaningful area that provides a regional context for the habitats in the LSA (Figure 10).

#### *6.2.2.2 Valued Environmental Component Selection*

The rationale for the selection of a species or species group as a potential VEC considered the presence, sensitivity and behaviour, project-related impacts, regulatory triggers and identification by local and / or scientific communities.

1. Potential Presence: The likely presence of a species within the Project alignment was determined through a desktop information review, including a review of other relevant environmental assessment applications.
2. Potential for Project-related Impacts: Potential Project-related impacts on wildlife VECs are anticipated to include habitat loss, habitat avoidance related to sensory disturbance, and direct mortality.
3. Scientific, Social, and Economic Importance: VECs include species of economic and social importance identified in other environmental assessment documents.

4. Legislation: Nesting songbirds, waterbirds, and waterfowl are protected under the regulations of the federal Migratory Birds Convention Act. Wildlife species listed under Schedule 1 of SARA are protected on federal land, and areas designated as “critical habitat” are also protected under SARA.

The species and/or species groups that were identified as wildlife VECs in the context of the environmental assessment of the Project are: woodland caribou (*Rangifer tarandus caribou)*, moose (*Alces alces*), grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*), marten (*Martes pennanti*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethica*), breeding songbirds, breeding waterfowl, and breeding raptors. Songbirds, waterfowl, and raptor species at risk are considered, as well as amphibians.

#### 6.2.2.3 *Study Limitations*

Due to the fact that detailed vegetation mapping has not yet been conducted for the LSA, baseline descriptions of wildlife occurrence and habitat suitability for this section of this PDR is based on a literature review Vegetation and wildlife studies are planned for the next stage. These studies will be undertaken in areas along the alignment and in potential material sources that have not been covered by previous work by the GNWT or MGP. Further studies should be indertaken in further steps for wildlife and vegetation..

The literature review included the use of coarse-scale wildlife habitat maps to describe potential wildlife occurrence in the LSA. The data sources and quality of the occurrence information used to create these mapping is not known. Due to the fact that high-level information was used to inform the wildlife study, it is not possible to reliably discriminate the relative values of habitat within the LSA or the Project footprint.

Furthermore, the locations of specific habitat features noted to be valuable to Project VECs within the LSA are also unknown. It is a study limitation that vegetation communities and habitat features required by wildlife VECs cannot be determined due to a lack of detailed information.

Habitat suitability mapping was conducted by MPEG (2004) in RSA for the MGP that occurred within South Taiga Plains (STP) Ecological zone (see Section 6.2.1.3). The MGP RSA included a 40 km buffer around the pipeline alignment. Similar to the study limitations of the vegetation section, no spatial information as to the location of the rated habitats was provided in the MGP EIS. Rather, the MGP EIS reported percentages based on the extent of rated habitats within the RSA. Where applicable, these percentages are reported in the following sections to provide a coarse measure of potential values within the MVH study areas.

### 6.2.2.4 Mammals

Seven mammal species were selected as VECs (Table 23). Their federal and territorial conservation status , basic habitat use, population size (if available), and their likely use of the LSA is described in the following subsections.

Table 23: Conservation Status of Mammals Selected as VECs in the Project Area

| COMMON NAME | SCIENTIFIC NAME | CONSERVATION STATUS | | | |
|---|---|---|---|---|---|
| | | NWT GSRANK | COSEWIC | SARA Schedule | SARA Status |
| Woodland caribou (boreal population) | *Rangifer tarandus caribou* | Sensitive | Threatened | Schedule 1 | Threatened |
| Moose | *Alces alces* | Secure | Not Assessed | No Schedule | No Status |
| Grizzly bear | *Ursus arctos* | Sensitive | Special Concern | No Schedule | No Status |
| Wolverine | *Gulo gulo* | Sensitive | Special Concern | No Schedule | No Status |
| American marten | *Martes pennanti* | Secure | Not Assessed | No Schedule | No Status |
| Beaver | *Castor canadensis* | Secure | Not Assessed | No Schedule | No Status |
| Muskrat | *Ondatra zibethicus* | Secure | Not Assessed | No Schedule | No Status |

#### 6.2.2.4.1 Woodland Caribou

The boreal population of woodland caribou, (herein referred to as boreal caribou) are listed under Schedule 1 of the SARA as Threatened. In the NWT, boreal caribou are ranked as Sensitive under the general status program (Table 23).

The boreal caribou ecotype occupies the eastern edge of the Boreal Cordillera, including the Nahanni and Liard Ranges, and the Franklin Mountains east of the Mackenzie River (ENR, 2010b). Boreal caribou in the NWT are grouped into two populations, based on range, under the Federal Recovery Strategy: NWT North and the NWT South. The population trend of these two populations are respectively classified under the Draft Recovery Strategy as “likely self-sustaining”, and “as likely as not self-sustaining” (Environment Canada, 2011).

The boreal caribou population in the NWT is estimated to include 6 000 to 7 000 animals by ENR (2010a). The federal Recovery Strategy population estimate is lower at 5 800 animals (Environment Canada, 2011).

Boreal caribou are generally nomadic and spend most of the year in open bog and closed-canopied black spruce habitats, although there may be some seasonal migration to preferred calving and wintering areas (ENR, 2010a).

Winter habitats are an important life requisite for boreal caribou. Boreal caribou winter range is ideally composed of abundant terrestrial and arboreal lichen resources, with few predators.

These characteristics are often associated with low-elevation peatlands intermixed with upland / hilly areas in mature or old-growth coniferous forests (ENR, 2010a; Environment Canada, 2008). Winter diets are primarily terrestrial and boreal lichens, with less important components including evergreen shrubs, grasses, sedges, and other vascular plants (ENR, 2010a). Open coniferous forests with abundant lichen are prime winter habitats, and mixed forests and riparian areas are also used to a lesser degree (Nagy et al., 2005).

Calving females tend to distribute themselves broadly on the landscape occurring either singly or occasionally in pairs (Environment Canada, 2008). During calving security from predators is paramount, and cows seek out treed islands surrounded by open water in peatlands, lakes, and ponds to minimize predation risks (Environment Canada, 2008).

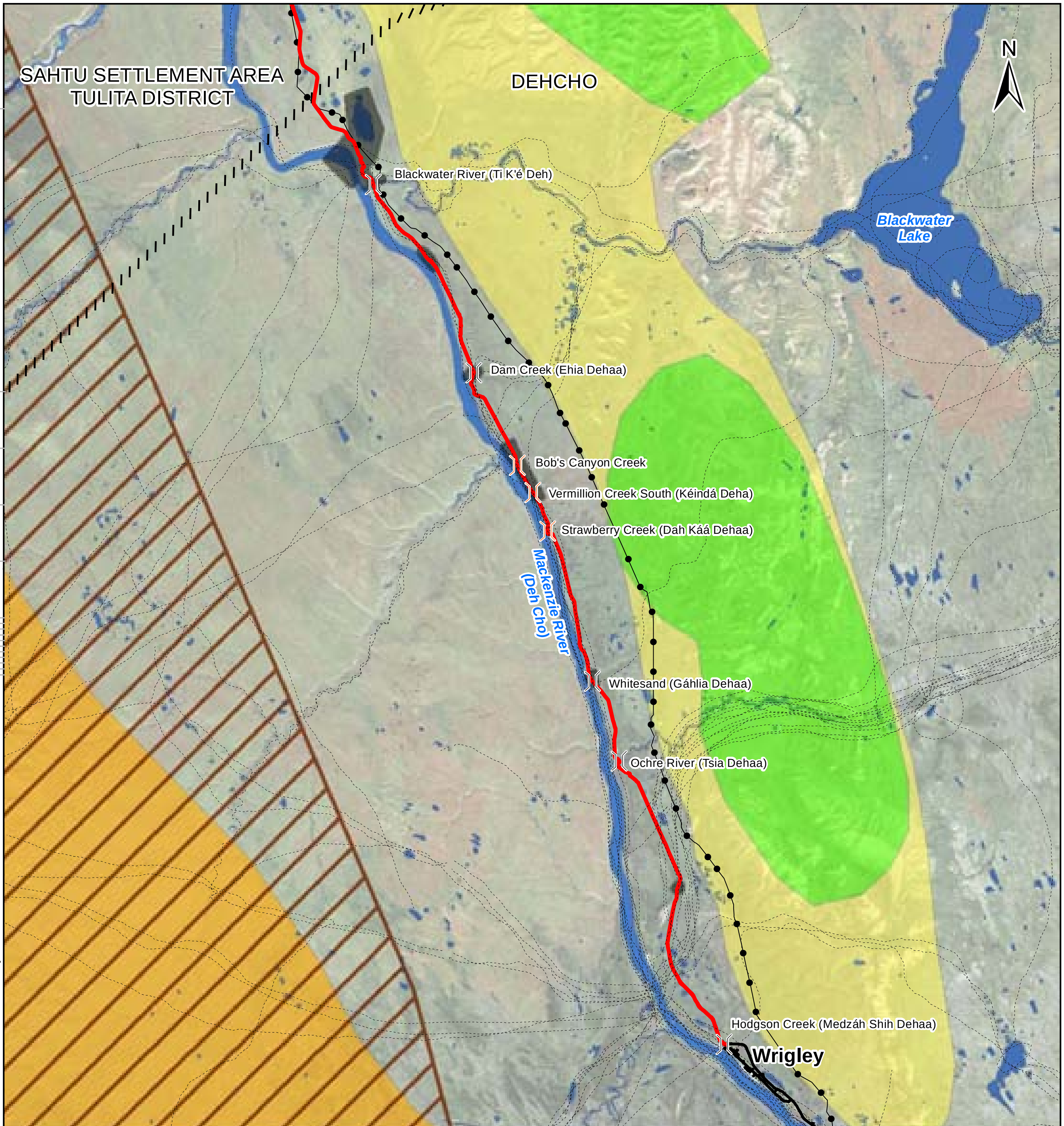
In summer, caribou foraging habits shift to herbaceous flowering plants, sedges, grasses and horsetail. Lichen is a component of the summer diet, but it is not as prominent as in the winter diet. Summer foraging areas are primarily open coniferous forests with an abundance of lichens, low shrub, riparian, sparsely vegetated, and recently burned habitats (Nagy et al., 2005).

Boreal caribou are likely to use all available habitat types within the LSA and RSA at some time during the year. Habitat modelling indicates that habitats from Wrigley north to the Pehdzeh Ki Ndeh - Dehcho Region Boundary on the east side of the Mackenzie are high value boreal caribou habitats during calving and summer (DLUPC, 2003 and references therein).

The location of Boreal caribou winter range is shown in Figure 12. The source of data used to create this map by the Dehcho Nation is not known at the time of writing. A boreal caribou monitoring project is ongoing in the Dehcho Region. This project has tracked caribou movements *via* collar location data since 2004 (Larter and Allaire, 2010). Lambda estimates averaged over 5 years suggest that boreal caribou in the Dehcho South ($\lambda = 0.92$) and Dehcho North ($\lambda = 0.97$) study areas are in decline (Larter and Allaire, 2010). Lambda represents the finite rate of population change or the net reproductive rate over some time interval, in this case 5 years. Lambda estimates less than 1, indicate a declining population.

Boreal caribou use the LSA and RSA throughout the year, and there is evidence that Bluenose East barren-ground herd occurs in the LSA during the winter in some years. However, MPEG (2004) indicated, *via* a personal communication of a caribou expert, that the Bluenose East herd rarely occurs in the pipeline study area.

Aerial surveys conducted in support of the MGP EIS, detected numerous ungulate observations in the highway LSA (MPEG, 2004). Mapping associated with these surveys did not differentiate between moose and caribou observations, but include observations of both species (Figure 12).




Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Grizzly Range

**Caribou Range**

Calving Areas
Summering Areas
Wintering Areas

PKFN Main Traditional Activity Site

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Figure 12**
**Regional Grizzly and Caribou Range**

| | | | |
|---|---|---|---|
| Prepared : | G. Pothier | No : | 068-P0037500-202-001-GO-C109-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C109-00_GrizzlyCaribou_20120227.mxd

#### 6.2.2.4.2 *Moose*

Moose populations are considered secure in the NWT, and have not been assessed federally by COSEWIC because populations of this ungulate are generally stable throughout Canada (Table 20). Moose in the Boreal Cordillera Ecoregion are primarily sedentary, with seasonal migrations occurring over short distances and along elevation gradients (ENR, 2010b). Moose have been included as a VEC because of their social, cultural and economic importance.

Recent surveys indicate moose density in the Mackenzie Valley region, between the Blackwater River in the north and the Jean Marie River in the south (including the communities of Wrigley, Fort Simpson, and Jean Marie River), were 4.4 moose/100 km$^2$, with 32.1 calves: 100 adult females (Larter, 2009).

High quality moose habitat includes semi-open, sub-climax forests dominated by deciduous trees and shrubs. Heavily used areas include river floodplains, riparian areas along creeks, wetlands, and regenerating burns (Maier *et al,* 2005). Such areas occur throughout the LSA.

In winter, forage is a critical life requisite for moose. Willow species, and red-osier dogwood are preferred winter forage species. Conifer stands play a role in providing snow interception and thermal cover during winter. Deep snow can limit moose movements (Dussault *et al.,* 2005): snow depths >60 cm begin to restrict movements, whereas snow depths >90 cm are severely restricting, particularly in the late winter (Bertram and Vivion, 2002; Dussault *et al*., 2005).

Security cover in early spring during calving season, in the form of dense tall shrub stands, shorelines and islands, is considered to be a key life requisite. Mineral licks are also a life requisite for moose.

Important winter habitat areas include the islands and floodplains of the Mackenzie River, riparian habitats associated tributary streams, and regenerating burns. These habitat types provide moose life requisites throughout the year.

Habitat suitability modeling of the Mackenzie Pipeline RSA indicates abundant effective moose habitat in 52% of the South Taiga Plains Ecological Zone (MPEG, 2004). It is likely that moose use the Highway LSA throughout the year.  Figure 11 shows ungulates observations which relates essentially to moose.

#### 6.2.2.4.3 *Grizzly Bear*

Grizzly bear is considered to be a species of “Special Concern” by COSEWIC, but has no status or schedule under the SARA (Table 20). A Special Concern designation indicates that this species might become threatened or endangered because of a combination of biological characteristics and identified threats (COSEWIC, 2004).

Grizzly bear populations in NWT are considered stable, although this species is listed as sensitive (Table 23), which indicates that it might require special attention or protection to prevent it from becoming at risk in the future (GNWT, 2004).

There are an estimated 4 000 to 5 000 grizzly bears in the NWT. Approximately 1,000 resident grizzly bears occur in the Inuvialuit Settlement Region (Nagy and Branigan, 1998); and 420 grizzly bears occur in the Gwich'in Settlement Area (GRRB, 2000).There is no quantitative information available on grizzly bear population size in the Dehcho Region or Sahtu Settlement Area.

Grizzly bears are omnivorous, feeding on a variety of plants and animals, including carrion, roots, emerging vegetation and winter-weakened ungulates in spring; insects and herbaceous vegetation summer; and roots and berries in the fall. Grizzly bears are typically solitary animals with home ranges of up to 220 $km^2$. The size and quality of the home range is of critical importance to grizzly bears.

High quality grizzly bear habitats in the Dehcho Region occur outside of the RSA, in mountainous terrain to the west of the Mackenzie River (DLUPC, 2003, MPEG, 2004) (See range distribution in Figure 12).

Habitat suitability mapping conducted for the Pipeline RSA indicates the following distribution of effective grizzly bear habitats in South Taiga Plains Ecological Zone provides 52% fall foraging habitat, 22% denning habitat, and 87% spring foraging habitat (MPEG, 2004).

Grizzly bears may occasionally occur within the Highway LSA, but it is unlikely to provide habitat sufficient to support resident populations.

##### *6.2.2.4.4 Wolverines*

Wolverines are considered to be a sensitive species in NWT, and COSEWIC considers the western population of wolverines to be a species of special concern (Table 20). SARA does not confer protection to wolverines.

Wolverine population numbers in the NWT are unknown, but are thought to be stable (ENR, 2010a). Wolverines live at low densities (Banci, 1994). They are well-adapted to deep snow packs, and appear to require large sparsely inhabited wilderness areas to meet their life requisites (Banci, 1994). They are scavenging predators with foraging habits that vary between seasons. In winter, they are primarily scavengers relying on carrion (Petersen, 1997); and during the growing season they prey on small mammals including snowshoe hare, grouse, ptarmigan, ground squirrels, tree squirrels, mice and voles. Wolverines may also opportunistically take moose and caribou calves.

Wolverines travel extensively in pursuit of foraging opportunities, and preferred habitat types are not apparent. It is likely that wolverines occur throughout the LSA and RSA in low abundance in all seasons.

*6.2.2.4.5 American Marten*

Marten populations are considered secure in the NWT (Table 23). Marten have not been assessed federally by COSEWIC, and have no status under SARA. Marten population density is unknown across the NWT, but in the southwest, martens occur at 0.5 animals/km$^2$. Densities are lower further north (ENR, 2011).

Marten prefer mature spruce forests, particularly those with a complex understory structure and sufficient crown closure. Marten also use moist areas with shrubby understorey and coarse woody debris for feeding and security cover. In winter, the use of non-forested habitats including wetlands, dry open areas, and areas of disturbance which lack overhead canopy cover and structural complexity is limited (Buskirk and Powell 1994).

Marten are opportunistic predators and foragers, and will feed on a variety of small mammals and forest birds (Takats *et al*., 1996). Marten winter diets in northern BC include the following prey species in order of importance: red-backed vole (*Myodes gapperi*), deer mouse (*Peromyscus maniculatus*), red squirrel (*Tamiasciurus hudsonicus*), snowshoe hare (*Lepus americanus*), various bird species, grouse, various shrew species, and porcupine (*Erethizon dorsatum*) (Quick, 1955). Squirrels and hares become more important forage items in late winter and early spring (Buskirk and Ruggiero, 1994; Buskirk and MacDonald, 1984).

In winter, marten require "entry" points for subnivean (below snow) hunting (Buskirk *et al*.,1989; Takats *et al*., 1996) of active rodent prey (Lofroth and Steventon, 1990; Sherburne and Bissonette, 1994). Steventon and Major, (1982) found over 90% of marten winter feeding sites to be located at openings created by coarse woody debris at low snow depths and by lower branches of live trees in deeper snow. Excessive snow depths (>30 cm) limit access to subnivean prey and, therefore, overhead cover is also required to prevent excessively deep snow accumulation (Koehler and Hornocker, 1977; Boyd, 1977).

Marten are present throughout the LSA and RSA in suitable closed canopy forests in all seasons.

*6.2.2.4.6 Beaver and Muskrat*

Beaver and muskrat are considered secure in the NWT, and have not been assessed by COSEWIC (Table 23). Beavers and muskrats are likely common throughout the highway alignment in association with aquatic habitats. Both species use lakes, ponds, wetlands, and slow-moving watercourses. Density varies with habitat quality.

The average density of active beaver lodges in a survey area located in western NWT was 26 lodges/100 km$^2$ (Poole and Croft, 1990). This survey included several blocks in the Sahtu Settlement Area and Dehcho Region that are proximate to the MVH alignment (Poole and

Croft, 1990). The reported beaver colony densities were considered moderate to high in comparison to densities in other northern boreal habitats (Poole and Croft, 1990). It is likely that beaver and muskrat are present in suitable habitats within the LSA.

#### 6.2.2.5 Birds

The Mackenzie Valley forms one of North America's most travelled migratory corridors for waterfowl (ducks, geese, and swans) breeding along the arctic coast. The Central Mackenzie Valley HB ecoregion and the Central Mackenzie Valley Low Subarctic (LS) ecoregion are both part of the important Mackenzie River waterfowl migration corridor (ENR, 2010b).

##### 6.2.2.5.1 Breeding Birds

A total of 115 breeding bird species potentially occur in the LSA. This includes migratory and resident species, songbirds, upland game birds, and woodpeckers. Of these species, five are of conservation concern at the territorial level (i.e., GSR of “At Risk”, or May Be At Risk”) or federal level (COSEWIC rank of “Special Concern”, “Threatened”, or “Endangered”) (Table 24).

Table 24: Bird species of Conservation Concern with Potential to Occur in the Highway Alignment

| COMMON NAME | SCIENTIFIC NAME | CONSERVATION STATUS | | | |
|---|---|---|---|---|---|
| | | NWT GSRANK | COSEWIC | SARA Schedule | SARA Status |
| Common nighthawk | *Chordeiles minor* | At Risk | Threatened | Schedule 1 | Threatened |
| Horned grebe | *Podiceps auritus* | Secure | Special Concern | No Schedule | No Status |
| Olive-sided flycatcher | *Contopus cooperi* | At Risk | Threatened | Schedule 1 | Threatened |
| Peregrine falcon (*anatum* subspecies) | *Falco peregrinus anatum* | Sensitive | Non-active | Schedule 1 | Threatened |
| Peregrine falcon (*tundrius* subspecies) | *Falco peregrinus tundrius* | Sensitive | Non-active | Schedule 3 | Special Concern |
| Rusty blackbird | *Euphagus carolinus* | May Be at Risk | Special Concern | Schedule 1 | Special Concern |
| Short-eared owl | *Asio flammeus* | Sensitive | Special Concern | Schedule 3 | Special Concern |

Common Nighthawk

Common nighthawk is a species of conservation concern at both territorial and federal levels. COSEWIC ranks common nighthawk as a Threatened species, and the SARA legally protects this species under Schedule 1 of the Act (Table 24). Common nighthawk is considered At Risk under the NWT GSR program.

Common nighthawks may nest in suitable habitats within the highway study area. Nests are located on the ground in open forests, forest clearings (including recently logged or burned areas), rocky outcrops, peatbogs, marshes, lakeshores, river banks, gravel areas (roads, quarries and flat gravel-covered roofs), and airports (ENR, 2011). Common nighthawks arrive to breed in mid- May to early June, and depart by mid-August to mid-September (ENR, 2011).

### Olive-sided Flycatcher

Olive-sided flycatchers are ranked as Threatened by COSEWIC, and are protected under Schedule 1 of the SARA. They are considered a species At Risk under the NWT GSR program.

Olive-sided flycatchers are likely to breed in areas of the highway alignment where suitable habitat exists.Olive-sided flycatchers breed along forest edges and openings, including burns; natural edges of bogs, marshes, and open water; semi-open forest; and harvested forest with some structure retained (Altman and Sallabanks, 2000). Tall, prominent trees and snags, which serve as singing and foraging perches, and unobstructed air space for foraging, are common features of all nesting habitats (Altman and Sallabanks, 2000).

Olive-sided flycatchers arrive in the NWT in late May and early June, and depart in late July to early August (ENR, 2011).

### Rusty Blackbird

Rusty blackbird is a species of conservation concern at both the territorial and federal levels. COSEWIC ranks rusty blackbird as a species of Special Concern, and the SARA affords this species legal protection under Schedule 1 (Table 24).

Rusty Blackbirds can occur throughout the LSA during the breeding season, wherever suitable habitats are present. Generally speaking, suitable breeding habitats include wet coniferous and mixed forests, fens, bogs, muskegs, beaver ponds, and other openings in the forest such as swampy shores along lakes and streams (Avery, 1995). Nests are located in areas of dense vegetated treed and/or shrubby areas close to the water (Avery, 1995). Rusty Blackbirds arrive near Yellowknife in April or May, and begin their southerly migration by mid-October (Bird Studies Canada et al., 2010). Highway study area arrival and departure dates are unknown, but are probably similar to those near Yellowknife.

#### *6.2.2.5.2 Breeding Waterfowl and Waterbirds*

A total of 68 waterfowl and waterbird species potentially use the RSA during the breeding season (Table 24). This list of species includes primarily migratory species of the following categories: waterfowl (ducks, swans, geese, grebes, and rails); waterbirds (shorebirds, herons, rails, gulls, terns, and jaegers). These species are migratory, and are likely to use the area for breeding and staging habitats. The horned grebe (*Podiceps auritus*) is a species of conservation concern (Table 24), which is likely to occur in the RSA.

Waterfowl are generally associated with lake edges, ponds, marshes, sedge meadows, and bogs. Emergent vegetation associated with these waterbodies provides important foraging and security habitats.

The waterbirds category includes a diverse group of species, which use a wide range of habitats for nesting and feeding. Aquatic habitats are required to meet life requisites, including shorelines of wetlands, ponds, and lakes. Terrestrial habitats including dry uplands, sandy ridges, and disturbed areas may also be important habitats depending upon the species

MPEG (2004) conducted aerial surveys for waterfowl, specifically lesser and greater scaup, in the Project vicinity. Scaup locations and numbers in the LSA are presented in Figure 11. While greater and lesser scaup occurrence is not necessarily indicative of the habitat selection all waterbirds, it provides a measure of waterbird habitat use in the LSA.

Horned Grebe

The horned grebe is a species of Special Concern federally by COSEWIC, but has no status or schedule under the SARA (Table 24). It is a secure species in the NWT, where its population size is unknown.

Open water is a life requisite for horned grebes, and they are commonly associated with small ponds, wetlands, and shallow lakeshores (COSEWIC, 2009). These water bodies are found in both open and forested areas. Breeding ponds contain areas of open water and abundant emergent vegetation. Nests are located within emergent vegetation as it provides nest material, concealment and anchorage, and protection for the young (COSEWIC, 2009). Horned grebes arrive on their breeding grounds in May and depart by September (Stedman 2000).

##### *6.2.2.5.3 Breeding Raptors*

Twenty-three raptor species potentially occur in the LSA. These species include migratory and resident species. Of the species listed in Table 24, two species met the VEC criteria as species of conservation concern: peregrine falcon (*Falco peregrinus*) and short-eared owl (*Asio flammeus*). These species are described below.

Peregrine falcon

Two subspecies of peregrine falcon could nest in proximity to the highway alignment; each is treated differently by COSEWIC, the SARA, and ENR. COSEWIC and ENR assigns a conservation status rank to a subspecies complex (*anatum* and *tundrius* combined), whereas SARA legally protects only the *anatum* subspecies (Table 24).

The *anatum*/*tundrius* subspecies complex is ranked as being of Special Concern by COSEWIC, and as Sensitive under the NWT GSR program (Table 24). The subspecies complex has no status or schedule under the SARA.

Under the SARA, *Falco peregrinus anatum* has a status rank of Threatened, and is a Schedule 1 species; *F. p. tundrius* has a status rank of Special Concern and is a Schedule 3 species, which confers no legal protections.

Peregrine nesting sites are well studied in the NWT, and records of active nests have been recorded for decades. Nests are usually associated with cliff habitats. There are approximately 110 known peregrine nest locations along the Mackenzie Valley, from north of Wrigley to Inuvik (ENR, 2006). These nests include a large portion of the core northern population of *anatum* falcons residing within the NWT (Ibid). It is unknown how many currently active nests there within the LSA or RSA. However, MPEG (2004) reported seven peregrine nests in the South Taiga Plains Ecological Zone, all of which were near the northern boundary of the Ecological Zone.

Short-eared owl

The short-eared owl has been assessed as a species of Special Concern by COSEWIC, and is also listed by the SARA as a Special Concern species under Schedule 3 (Table 24), which confers no legal protections. It is ranked as a Sensitive species in the NWT.

Short-eared owls are not year-round residents in the highway study area. They arrive in the NWT and commence breeding by April or May and depart by late October. Short-eared owls are associated with open areas, often low wet areas where small mammalian prey species are abundant. Nests are located on the ground on upland sites with sufficient vegetation for security cover. Population size in the NWT is unknown, but likely fluctuates between 1 000 and 10 000.

#### *6.2.2.6 Amphibians*

Amphibian distribution in the NWT is limited by cold climate and short growing seasons. At-risk amphibian species are restricted to the Dehcho and South Slave region of the NWT, and are not anticipated to be abundant in the LSA or RSA. Common amphibian species including the wood frog (*Rana sylvatica*) and the boreal chorus frog (*Pseudacris maculata*) may occur in the LSA and RSA, but few records exist within these areas, as this area is likely at or near the northern extent of the species' ranges. Because the presence of amphibians in the LSA is uncertain, amphibians will not be brought forward into an impacts assessment as a VEC. Further studies will be conducted in summer 2012 to determine the occurrence of amphibians in the LSA.

### 6.2.3 Fish and Fish Habitat

#### *6.2.3.1 General*

The proposed highway alignment traverses several rivers, streams and ephemeral drainages as it passes through the Pehdzeh Ki Ndeh - Dehcho Region. Due to its proximity to these watercourses, the Project has the potential to affect fisheries resource values. This section describes the fish and fish habitat that have been identified through previous studies conducted in the Pehdzeh Ki Ndeh - Dehcho region. Table 25 presents a listing of historical reports that have been consulted during this overview. Once key features have been described, measures to avoid or mitigate adverse impacts on fish and fish habitat can be identified and considered for protection of fisheries resources as the proposed Project proceeds through construction and subsequent use.

Table 25: Historical Fisheries and Aquatics Reports Reviewed

| AUTHOR | YEAR | TITLE |
|---|---|---|
| AMEC & Golder Associates Ltd. | 2004 | Environmental Impact Statement for the Mackenzie Gas Project, Volume 5: Biophysical Impact Assessment Part C, Aquatic Resources: Fish and Fish Habitat |
| GeoNorth & Golder Associates Ltd. | 2000 | Technical Report: An Environmental Information Update For Selected Stream Crossings Along the Mackenzie Valley Winter Road |
| Stewart & Low | 2000 | A Review of Information on Fish Stocks and Harvests in the Dehcho Area, Northwest Territories |

Note: Further are studies are proposed by DOT for 2012, including bridge site surveys at locations where new bridges have been identified in the PDR and fisheries studies at locations where new bridges and culverts have been identified in the PDR.

The watercourses that will be intersected by the proposed highway alignment are tributaries to the Mackenzie River, which travels through the Mackenzie Delta and empties into the Beaufort Sea. The largest tributary crossed by the proposed alignment is the Blackwater River. Major watercourses, such as the Blackwater River, can provide year round fish habitat, as water continually flows during the winter months. Smaller streams that freeze to the stream bed may not provide overwintering habitat, but still have the potential to provide spawning, rearing, and migratory habitat throughout the remainder of the year. Even ephemeral melt-water drainages can provide seasonal habitat, and provide water, nutrients and oxygen to downstream environments.

Over thirty different fish species have been recorded in the river drainages of the Dehcho Region (Stewart & Low, 2000). Many of these species have social and economic importance to local residents. Species such as Arctic Grayling (*Thymallus arcticus)*, Inconnu (*Stenodus leucichthys)*, Northern Pike (*Esox lucius)*, Walleye (*Sander vitreus)*, and Lake Whitefish (*Coregonus clupeaformis*) are integral to the local subsistence and sport harvests (Stewart & Low, 2000). A listing of fish species previously recorded in some of the major watercourses crossed by the proposed highway alignment is presented in Table 26. There are currently no fish species listed under the *Species at Risk Act* as endangered, threatened or special concern that have the potential to occur in the study area.

Table 26: Fish Species Historically Captured in the Study Area (GeoNorth & Golder 2000; Stewart & Low 2000)

| FISH SPECIES COMMON NAME | FAMILY | SCIENTIFIC NAME |
|---|---|---|
| Arctic Cisco | Salmonidae | Coregonus autumnalis |
| Arctic Grayling | Salmonidae | Thymallus arcticus |
| Broad Whitefish | Salmonidae | Coregonus nasus |
| Burbot | Lotidae | Lota lota |
| Emerald Shiner | Cyprinidae | Notropis atherinoides |
| Flathead Chub | Cyprinidae | Platygobio gracilis |
| Inconnu | Salmonidae | Stenodus leucichthys |
| Lake Chub | Cyprinidae | Couesius plumbeus |
| Lake Whitefish | Salmonidae | Coregonus clupeaformis |
| Longnose Sucker | Catostomidae | Catostomus catostomus |
| Mountain Whitefish | Salmonidae | Prosopium williamsoni |
| Ninespine Stickleback | Gasterosteidae | Pungitius pungitius |
| Northern Pike | Esocidae | Esox lucius |
| Round Whitefish | Salmonidae | Prosopium cylindraceum |
| Slimy Sculpin | Cottidae | Cottus cognatus |
| Spottail Shiner | Cyprinidae | Notropis hudsonius |
| Trout-Perch | Percopsidae | Percopsis omiscomaycus |
| Walleye | Percidae | Sander vitreus |

#### *6.2.3.2 Stream Crossings*

Based on review of available historical reports and examination of aerial photographs taken by Dessau in 2011, 34 potential watercourses have been identified to date as potentially intersecting the proposed highway alignment in the Pehdzeh Ki Ndeh - Dehcho region. A listing of these 34 watercourses is provided in Table 27, as well as approximate UTM coordinates for each potential crossing location. For the purposes of this document, watercourses have been named based on the distance, in kilometres, from kilometre marking (KM) 692.03 near Wrigley, Northwest Territories (UTM 475970, 7011620), to the location where the watercourse intersects with the proposed highway alignment.

Table 27: Preliminary Watercourse Crossing Locations Identified to Date

| WATERCOURSE ID (FOR THE PURPOSES OF THIS PDR) | HISTORICAL WATERCOURSE NAME(S) | APPROXIMATE CROSSING LOCATION | | HISTORICAL ASSESSMENT LOCATION | |
|---|---|---|---|---|---|
| | | Easting | Northing | Easting | Northing |
| KM 692.30 | Hodgson Creek | 475736 | 7011728 | - | - |
| KM 696.82 | None | 473317 | 7015384 | - | - |
| KM705.42 | None | 470824 | 7023125 | - | - |
| KM 710.35 | None | 471369 | 7027862 | - | - |
| KM 718.79 | None | 467938 | 7035574 | - | - |
| KM 721.61 | None | 465978 | 7037414 | - | - |
| KM 722.45 | Ochre River | 465952 | 7038075 | 465762 | 7037632 |
| KM 724.49 | None | 465535 | 7039921 | - | - |
| KM 727.36 | None | 465206 | 7042721 | - | - |
| KM 730.66 | Whitesand Creek | 463489 | 7045444 | 463746 | 7045218 |
| KM 732.74 | Drainage 1 | 463001 | 7047419 | 463110 | 7047212 |
| KM 733.71 | Bonnie Creek | 462617 | 7048303 | 462673 | 7048309 |
| KM 736.48 | Drainage 2 | 462074 | 7050956 | 462221 | 7050738 |
| KM 737.36 | None | 461944 | 7051827 | - | - |
| KM 739.55 | Drainage 3 | 461379 | 7053905 | 461519 | 7063611 |
| KM 740.75 | None | 461097 | 7055069 | - | - |
| KM 741.74 | None | 460866 | 7056033 | - | - |
| KM 742.74 | None | 460633 | 7057006 | - | - |
| KM 745.72 | Strawberry Creek | 459359 | 7059422 | 459471 | 7059215 |
| KM 747.56 | None | 458926 | 7061092 | - | - |
| KM 748.02 | None | 458796 | 7061536 | - | - |
| KM 749.65 | Vermillion Creek South | 458005 | 7062948 | 458116 | 7062601 |
| KM 752.61 | Bobs Canyon Creek | 456532 | 7065508 | 456630 | 7065773 |
| KM 752.81 | Drainage 13 | 456629 | 7065715 | 456640.00 | 7065501 |
| KM 762.91 | Dam Creek | 452480 | 7074159 | 452653 | 7073890 |
| KM 765.51 | None | 451505 | 7076573 | - | - |
| KM 767.16 | None | 451279 | 7078183 | - | - |
| KM 769.66 | None | 450608 | 7080490 | - | - |
| KM 772.83 | None | 449252 | 7083358 | - | - |
| KM 774.09 | Drainage 4 | 448502 | 7084357 | 448605 | 7084494 |
| KM 780.88 | REV3-AK | 444236 | 7089533 | 444426 | 7089450 |
| KM 783.26 | Blackwater River | 442742 | 7091387 | 442829 | 7091192 |
| KM 785.29 | Drainage 5 | - | - | 442320 | 7093137 |
| KM 787.31 | Drainage 6 | - | - | 437629 | 7099230 |

Bridges are currently installed as part of the existing winter road infrastructure at six of the major watercourses that intersect the highway alignment. Historical habitat information is available for these six watercourses, which is summarized in Section 6.2.3.3 (GeoNorth & Golder Associates Ltd., 2000; Stewart & Low, 2000).

There are approximately 28 additional watercourses in the study alignment area that may potentially require infrastructure to traverse (e.g. bridge or culvert). Stream assessments for select watercourses were conducted in 1999 for a proposed upgrade to the Mackenzie Valley winter road being considered at that time by the DOT (GeoNorth & Golder Associates Ltd, 2000). Information collected for the assessments included channel measurements, stream flow, substrate characteristics, water quality, erosion potential, habitat features, and fish presence. Eight of the crossing locations assessed correspond with crossing locations being considered for this Project. There is one additional watercourse crossing location (KM 780.88 or REV3-AK) that was assessed as part of the MGP EIS (MPEG,2004). Basic habitat characteristics for these nine watercourses are provided in Section 6.2.3.4 and summarized in Table 28 . Habitat parameters obtained from historic reports are used in this PDR document, where possible, to inform highway routing, identify engineering constraints, evaluate information gaps, determine potential impacts of the proposed highway, and to establish preliminary avoidance and mitigation measures. The information reviewed was collected in 1999 (GeoNorth & Golder Associates Ltd., 2000) and prior to 2004 (MPEG, 2004) and, therefore, changes to habitat characteristics and quality may have occurred over time. Habitat information reported in this document will be confirmed by a qualified professional on the ground in spring/early summer 2012, prior to commencement of any construction works.

Table 29 provides a breakdown of the watercourse crossing information that is available and has informed this report. The six watercourses with existing bridges and the remaining watercourses are described to the extent that information is available. Any information gaps will be filled by the studies proposed for 2012.

Table 28: Summary of Available Habitat Information for Select Watercourse Crossings

| NAME OF WATERCOURSE | WETTED CHANNEL WIDTH (m) | CHANNEL WIDTH (m) | SUBSTRATE | % MAKE-UP | DOMINANT RIPARIAN VEGETATION | AVAILABLE INSTREAM COVER | FISH HABITAT POTENTIAL |
|---|---|---|---|---|---|---|---|
| REV3-AK | - | - | - | - | - | - | No suitable habitat present.<br>Ephemeral stream. Flow primarily during spring run-off. Dry during late summer and winter. No discernable banks or evidence of annual sediment transport (AMEC & Golder Associates Ltd. 2004). |
| Drainage 4 | - | - | - | - | - | - | Low.<br>Lack of defined substrate. Beaver dam present. Too shallow for overwintering.<br>Potential rearing and feeding habitat approximately 50 m downstream of the crossing location. |
| Drainage 13 | - | - | Fines<br>Gravel<br>Cobble<br>Boulder | - | - | - | No suitable habitat present.<br>Dry, vegetated gully. Intermittent meltwater drainage. |
| Drainage 12 (Bob's Canyon) | 4.8 | 5.8 | Fines<br>Gravel<br>Cobble<br>Boulder | 0<br>20<br>40<br>40 | | 70 | Moderate - rearing.<br>Low - overwintering.<br>Low - spawning. |
| Strawberry Creek | 8 | 8 | Fines<br>Gravel<br>Cobble<br>Boulder | 10<br>10<br>10<br>70 | Willow<br>Grasses | 80 | Moderate - rearing / spawning.<br>Low - overwintering. |

Table 28 (cont'd): Summary of Available Habitat Information for Select Watercourse Crossings

| NAME OF WATERCOURSE | WETTED CHANNEL WIDTH (m) | CHANNEL WIDTH (m) | SUBSTRATE | % MAKE-UP | DOMINANT RIPARIAN VEGETATION | AVAILABLE INSTREAM COVER | FISH HABITAT POTENTIAL |
|---|---|---|---|---|---|---|---|
| Drainage 3 | 1.3 | 1.3 | Fines<br>Gravel<br>Cobble<br>Boulder | 45<br>50<br>5<br>0 | Alder | 65 | Moderate to low - rearing / spawning.<br>Low - overwintering. |
| Drainage 2 | 0.77 | 0.79 | Fines<br>Gravel<br>Cobble<br>Boulder | 100<br>0<br>0<br>0 | Alder | 80 | Low.<br>Poor substrate, shallow. |
| Bonnie Creek | 2.4 | 2.9 | Fines<br>Gravel<br>Cobble<br>Boulder | 15<br>10<br>15<br>60 | Alder | 65 | Moderate - rearing. Low - overwintering.<br>Low - spawning.<br>Presence of Arctic grayling is suspected. |
| Drainage 1 | 0.66 | 0.74 | Fines<br>Gravel<br>Cobble<br>Boulder | 80<br>10<br>10<br>0 | Spruce | 90 | Low.<br>Debris jams impede migration. Low flow, poor substrate. |
| Drainage 5 | - | - | - | - | - | - | No suitable habitat present.<br>No defined channel, substrate or surface flow. Potential barrier to fish movement (2 m drop-off) present near crossing location. |
| Drainage 6 | - | - | - | - | - | - | No suitable habitat present.<br>Dry, vegetated gully. |

Source: (GeoNorth & Golder Associates Ltd., 2000; AMEC & Golder Associates Ltd., 2004)

Table 29: Summary of Available Information

| EXISTING CROSSING INFRASTRUCTURE | AVAILABLE INFORMATION | NUMBER OF WATERCOURSES |
|---|---|---|
| Bridge | Historical reports including description of habitat parameters and / or fish-bearing status. | 6 |
| None | Historical reports including description of habitat parameters and / or fish-bearing status. | 11 |
| | Aerial photography only. | 17 |
| | TOTAL | 34 |

#### 6.2.3.3 *Watercourses with Existing Bridges*

Presently there are bridges at six watercourse crossing locations that are part of the existing winter road infrastructure. The bridges are located on the Blackwater River, Dam Creek, Hodgson Creek, Ochre River, Vermillion Creek South, and Whitesand Creek. Additional work may be required on two of the six existing bridges: Preliminary engineering design describes a foundation upgrade on the Dam Creek Bridge and possible replacement of the Hodgson Creek Bridge with a new bridge at a different crossing location. These upgrades are outside the scope of this PDR and may be subject to approval under the *Fisheries Act*. Appropriate approvals for these upgrades will be acquired or applied for as necessary. There are no current plans to upgrade the other four bridges. General specifications for the existing bridge structures are summarized in Table 30. Historical habitat and fish-bearing status information for these watercourses is presented below.

Table 30: Summary of Existing Bridges

| WATERCOURSE | LENGTH (m) | DECK WIDTH / OPENING (m) | SUPERSTRUCTURE / STRUCTURE | FOUNDATION | YEAR CONSTRUCTED |
|---|---|---|---|---|---|
| KM 692.30 - Hodgson Creek | 24 | 4.3 | WG-Steel Girders / Timber Deck | Binwall abutments / Timber Bearing Pads | 1988 |
| KM 722.45 - Ochre River | 102 | 4.0 | WG-Steel Girders / Timber Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 |
| KM 730.66 - Whitesand Creek | 89 | 4.0 | WG-Steel Girders / Concrete Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 |
| KM 749.65 - Vermillion Creek South | 116 | 4.0 | WG-Steel Girders / Concrete Deck | Reinforced Concrete Ballast Wall / Abutments-Piers-Steel Piles | 2001 |
| KM 762.91 - Dam Creek | 18 | 4.0 | Painted Steel Girders / Timber Deck | Binwall Abutments -3 Steel H-Piles | 1996 |
| KM 783.26 - Blackwater River | 297 | 6.0 | 4 spans, WG-Steel Girders / Concrete Deck / plus 10m jump spans at each end | Steel pipe piles /Steel pipe piers / Concrete Abutments | 2010 |

#### 6.2.3.3.1 KM 692.30 – Hodgson Creek

Hodgson Creek was not assessed as part of the watercourse crossing assessment conducted by GeoNorth and Golder Associates Ltd. (2000). Thus, no habitat parameters are available for this crossing location. Hodgson Creek is known to be fish-bearing. Previous studies (e.g., Stewart & Low, 2000) have identified that the headwaters of Hodgson Creek provide overwintering habitat for Arctic Grayling, Slimy Sculpin, Lake Chub, Longnose Sucker, Burbot, and Northern Pike. The creek also provides spawning and nursery habitat for Arctic Grayling, Lake Chub, Longnose Sucker, Round Whitefish, and Slimy Sculpin (Stewart & Low, 2000). A bridge exists at this crossing location as part of the existing winter road infrastructure. However, a replacement bridge is being considered for this crossing. Upgrade works on the Hodgson Creek Bridge are outside the scope of this PDR and may be subject to authorization under the *Fisheries Act*. All necessary authorizations and approvals must be acquired prior to proceeding with the upgrade work.

Photo 9: Hodgson Creek Bridge

#### 6.2.3.3.2 KM 722.45 – Ochre River

At the proposed highway crossing location, the Ochre River is a winding, frequently confined, open channel, approximately 85 m wide, with a gradient of 7 to 10% (GeoNorth & Golder Associates 2000). The channel becomes increasingly braided towards the confluence with the Mackenzie River. The substrate is comprised primarily of cobble with gravel and sand. Bank stability was assessed as moderate to solid and the dominant riparian vegetation was comprised of alder and birch. Arctic Grayling, Round Whitefish, Inconnu, Burbot, Longnose

Sucker, Trout-Perch, Flathead and Lake Chub, Northern Pike, Spottail and Emerald Shiner, and Slimy Sculpin have all been recorded in the Ochre River (Hatlfield et al., 1972; EPB, 1973; Slaney, 1974a, McCart, 1982; DOT, 1997; all cited in GoeNorth & Golder Associates Ltd., 2000). Northern Pike appear to use the mouth of the river as a spawning and nursery area while Arctic Grayling, Longnose Sucker and Lake Chub use spawning and nursery habitat further upstream (Stewart & Low, 2000). The quality of fish habitat potential for the Ochre River at the crossing location was assessed as high for rearing and moderate for spawning but poor for overwintering due to reduced flows. However, Arctic Grayling, Longnose Sucker and Slimy Sculpin have been observed using the river as overwintering habitat (Stewart & Low, 2000). There is a bridge that spans the Ochre River at the proposed highway crossing location, which is currently part of the existing winter road infrastructure. It is assumed that all necessary permits and approvals were obtained for this work.

Photo 10: Ochre River Bridge

##### 6.2.3.3.3 *KM 730.66 – Whitesand Creek*

Whitesand Creek is approximately 30 m wide with stream gradient of approximately 7 to 10% (GeoNorth & Golder Associates, 2000). The creek has a winding, fairly open channel with no natural drop offs. Channel substrate is predominately comprised of boulders with some gravels and cobble. Bank stability on the left downstream bank was assessed as poor while stability of the right downstream bank was assessed as solid. The riparian vegetation is dominated by willow. The quality of fish habitat was considered moderate to high for rearing but poor for overwintering. Round Whitefish, Arctic Grayling, Lake Chub, Longnose Sucker, and Slimy

Sculpin have been, historically, captured in Whitesand Creek (Stewart & Low, 2000). A bridge currently spans this proposed highway crossing location. It is assumed that all necessary permits and approvals were obtained for this work.

Photo 11: Whitesand Creek Bridge

#### 6.2.3.3.4 KM 749.65 – Vermillion Creek South

The stream morphology of Vermillion Creek South is open, frequently confined, and braided in the vicinity of the proposed crossing location (GeoNorth & Golder Associates, 2000). Channel width at the crossing location is approximately 20 m with a stream gradient of 15%. Boulders are the dominant substrate with cobble as sub-dominant. Bank stability was assessed as poor while habitat quality was assessed as moderate value for rearing, low value for spawning, and low value for overwintering. Emerald Shiner, Slimy Sculpin, and Arctic Grayling have been captured in Vermillion Creek South (DFO unpublished data 1997 cited in GeoNorth & Golder Associates Ltd., 2000) as well as Northern Pike, Longnose Sucker, Ninespine Stickleback, broad, lake and Mountain Whitefish, Arctic Cisco, and Walleye (EPB 1974; Slaney 1973; Slaney 1974; all cited in GeoNorth & Golder Associates Ltd., 2000). A bridge structure currently spans this crossing location as part of the winter road infrastructure. It is assumed that all necessary permits and approvals were been obtained for this work.

Photo 12: Vermillion Creek South Bridge

#### 6.2.3.3.5 *KM 762.91 – Dam Creek*

Dam Creek is an approximately 8 m wide watercourse that winds through a rolling spruce forest (GeoNorth & Golder Associates, 2000). Channel substrate is predominately comprised of cobble. The riparian vegetation is primarily comprised of a mix of willow, alder, and grasses. Bank stability in the vicinity of the stream crossing was assessed as generally very solid. The gradient of the stream bed ranges from 5 to 10%. Arctic Grayling, Lake Chub, Longnose Sucker, and Slimy Sculpin have been recorded in Dam Creek from early June to early October (Slaney 1974b cited in GeoNorth & Golder Associates, 2000; Stewart & Low, 2000). Habitat quality is considered high for rearing but moderate for spawning due to high velocity flows and the limited amount of gravel substrate (GeoNorth & Golder Associates, 2000). Quality overwintering habitat potential was assessed as low. There is currently a small bridge spanning Dam Creek along the winter road alignment. An upgrade to the bridge foundation structure is being considered. Upgrade works on the Dam Creek Bridge are outside the scope of this PDR and may be subject to authorization under the *Fisheries Act*. All necessary authorizations and approvals must be acquired prior to proceeding with the upgrade work.

Photo 13: Dam Creek Bridge

#### 6.2.3.3.6 KM 783.26 - Blackwater River

The Blackwater River is a winding, broad, generally confined river that drains Blackwater Lake (GeoNorth & Golder Associates Ltd., 2000). The river channel is approximately 90 m wide and has a stream bed gradient of approximately 7%. The bed substrate is comprised of a mix of gravels, cobbles and boulders while riparian vegetation is comprised primarily of willows and grasses. It is a fish-bearing watercourse, with records of Arctic Grayling, Longnose Sucker, Slimy Sculpin, and Round Whitefish inhabiting the river (Hatfield et al. 1972; EPB 1974 as in GeoNorth & Golder Associates Ltd., 2000). The River has been identified as providing spawning habitat for both Arctic Grayling and Longnose Sucker (Stewart & Low, 2000). Specifically, the crossing location has been described as having moderate to high potential for rearing and spawning habitat quality, particularly for species such as Arctic Grayling (Fernet 1986 cited in GeoNorth & Golder Associates Ltd., 2000). The quality of overwintering habitat has been identified as low at the crossing location but is considered moderate to high quality upstream of the assessment locations where pool areas were observed.  Currently, a bridge structure exists at this crossing location.  It is assumed that all necessary approvals were originally obtained for this work.

Photo 14: Blackwater River Bridge

### 6.2.3.4 Previously Assessed Watercourses with no Existing Crossing Infrastructure

There are nine watercourses that have been previously assessed, but currently do not contain any installed crossing structure. A description of the biophysical parameters for each site is summarized below based on available literature and documentation. Information on habitat parameters and fish-bearing status from field surveys to be conducted in spring/early summer 2012 will be used to inform decisions regarding the type of crossing infrastructure that may be required for a given watercourse.

#### 6.2.3.4.1 KM 732.74 (Drainage 1)

Drainage 1 is a narrow watercourse with a mean channel width of approximately 1 m (GeoNorth & Golder Associates Ltd., 2000). Stream gradient is approximately 5% and the bed material is predominately comprised of fines. Debris jams are frequent and potentially impede fish migration. Bank stability is moderate with the dominant riparian vegetation being spruce. Low flow, inappropriate substrate composition, the presence of debris jams, and silty stream flow conditions resulted in the watercourse being designated as having, overall, low quality fish habitat (GeoNorth & Golder Associates Ltd., 2000).

Photo 15: KM 732.74 (Drainage 1) Potential Crossing Location

*6.2.3.4.2 KM 733.71 – Bonnie Creek*

This creek is characterized by an approximately 3 m wide stream channel, 5 to 7% stream gradient, and channel substrate predominately comprised of boulders (GeoNorth & Golder Associates Ltd., 2000). At the time of the assessment, there was a log jam downstream of the crossing location that may have been a barrier to fish migration. Bank stability was considered moderate with evidence of severe undercutting of the left downstream bank. The dominant riparian vegetation was identified as being alder. Fish habitat potential was considered moderate quality for rearing but poor quality for spawning and overwintering due to silty water conditions, poor spawning substrate composition, and high velocity flows (GeoNorth & Golder Associates Ltd., 2000).

Photo 16: KM 733.71 - Bonnie Creek Potential Crossing Location

*6.2.3.4.3 KM 736.48 (Drainage 2)*

Drainage 2 is 1 m wide unnamed drainage (GeoNorth & Golder Associates Ltd., 2000). The stream bed gradient is approximately 5% and the bed material is overwhelmingly comprised of clay, silt and sand. Debris jams are present in the stream channel. Bank stability of the drainage channel was assessed as high with the dominant riparian vegetation being alder. Fish habitat potential in this watercourse was considered poor due to shallow depths and poor substrate composition (GeoNorth & Golder Associates Ltd., 2000).

Photo 17: KM 736.48 (Drainage 2) Potential Crossing Location

#### *6.2.3.4.4 KM 739.55 (Drainage 3)*

This unnamed drainage is approximately 2 m wide with a 5% stream bed gradient (GeoNorth & Golder Associates Ltd., 2000). The channel substrate is comprised primarily of a mix of gravels and fines. Bank stability at the crossing location was assessed as moderate with the dominant riparian vegetation being alder. Quality of spawning and rearing habitat was considered moderate to poor. Overwintering habitat quality was considered poor due to shallow stream depth and the presence of debris jams (GeoNorth & Golder Associates Ltd., 2000).

Photo 18: KM 739.55 (Drainage 3) Potential Crossing Location

### *6.2.3.4.5 KM 745.72 – Strawberry Creek*

Strawberry Creek is an irregularly meandering watercourse that is confined and has an approximate channel width of 8 m in the vicinity of the crossing location (GeoNorth & Golder Associates Ltd., 2000). The stream bed gradient is 7 to 10% and the channel substrate is comprised predominately of boulders. Bank stability was assessed as moderate with the dominant riparian vegetation being willow and grasses. No records of fish presence were identified but habitat potential was assessed as moderate for rearing and spawning. Overwintering habitat potential was considered poor due to shallow stream depths (GeoNorth & Golder Associates Ltd., 2000). Preliminary engineering design of the crossing structure at this location includes two open bottom arch culverts. Based on available information, it appears that no further habitat assessment work has been undertaken. Verification of the fish habitat at this crossing location should be carried out by a qualified professional prior to proceeding with the installation of any crossing structure.

Photo 19: KM 745.72 - Strawberry Creek Potential Crossing Location

### *6.2.3.4.6 KM 752.81 (Drainage 13)*

Drainage 13 was identified as having no suitable fish habitat (GeoNorth & Golder Associates Ltd., 2000). The drainage was described as a dry, vegetated gully with an undefined channel and poor substrate.

Photo 20: KM 752.81 (Drainage 13) Potential Crossing Location

#### *6.2.3.4.7 KM 752.61 – Bob's Canyon Creek (Drainage 12)*

Bob's Canyon Creek (or Drainage 12), is an approximately 6 m wide stream channel, confined in an incised valley (GeoNorth & Golder Associates Ltd., 2000). The stream bed gradient is 5 to 10% and, at the time of the assessment, the stream contained 0.5 m chutes created by log jams. The substrate is comprised of mostly cobbles and boulders. Bank stability was assessed as low adjacent to the crossing location. At the time of the assessment, fish presence was considered unlikely at the crossing location due to the presence of log jams and chutes. However, moderate rearing habitat potential was identified. Spawning and overwintering habitat potential was considered poor (GeoNorth & Golder Associates Ltd., 2000). Slope stability issues have been identified at this crossing location (GeoNorth & Golder Associates Ltd., 2000); preliminary engineering design has considered an open bottom arch culvert crossing structure at this location. Based on available information, it appears that no further habitat assessment work has been undertaken. Verification of the fish habitat at this crossing location should be undertaken by a qualified professional prior to commencing with the installation of any crossing structure at this location.

Photo 21: KM 752.61 - Bob's Canyon Creek (Drainage 12) Potential Crossing Location

#### 6.2.3.4.8 KM 774.09 (Drainage 4)

Drainage 4 is a winding, frequently confined watercourse (GeoNorth & Golder Associates Ltd., 2000). The channel width is approximately 4 m and the stream gradient is less than 5%. The bottom substrate is comprised entirely of sand, silt and clay. Bank stability was assessed as moderate and the dominant riparian vegetation is comprised of alder. The fish habitat potential was considered moderate for rearing minnow species at the crossing location but was considered unlikely to provide feeding habitat for larger fish. The habitat potential was considered poor for spawning and overwintering due to the presence of a beaver dam downstream of the crossing location, poor quality substrate (i.e. lack of boulders), and shallow stream depth. However, habitat approximately 50 m downstream of the crossing location appeared to be suitable for most life stages (GeoNorth & Golder Associates Ltd, 2000).

Photo 22: KM 774.09 (Drainage 4) Potential Crossing Location

#### *6.2.3.4.9 KM 780.88 (REV3-AK)*

This vegetated melt water drainage flows primarily during spring runoff. It is likely dry during late summer and winter (MPEG, 2004). There are no discernable banks or evidence of annual sediment transport (MPEG, 2004). This watercourse is believed to not provide suitable fish habitat. No data was available regarding fish species captured or reported in this watercourse.

Photo 23: KM 780.88 (REV3-AK) Potential Crossing Location

#### 6.2.3.4.10 KM 785.29 (Drainage 5)

Drainage 5 is described as a “narrow, dry gully draining a steep valley on a curve of the winter road” (GeoNorth & Golder Associates Ltd., 2000). The gully measured approximately 4 m wide and 0.5 to 1.1 m in depth. No defined channel or substrate was identified. Drainage 5 is not anticipated to provide suitable fish habitat (GeoNorth & Golder Associates Ltd., 2000). A 2 m drop-off downstream of the crossing would likely create a chute or waterfall during peak flows and would likely become a barrier to fish passage (GeoNorth & Golder Associates Ltd., 2000).

#### 6.2.3.4.11 KM 787.31 (Drainage 6)

Drainage 6 is approximately 7 m wide with no defined stream channel or substrate (GeoNorth & Golder Associates Ltd., 2000). This dry, vegetated gully is unlikely to provide suitable fish habitat (GeoNorth & Golder Associates Ltd., 2000).

### 6.2.3.5 Watercourses with no Crossing Infrastructure & no Biophysical Data

Aerial photographs of the proposed highway alignment were taken in 2010 . Based on examination of existing maps (1:25,000) (CanVec, Government of Canada (2000 to 2009); LiDAR EBA 2010; Dessau 2011) as well as the available aerial photographs (1:1000) (LiDAR EBA 2010), approximately 17 additional watercourses have been identified. No known historical fish and fish habitat information/records are available for these watercourses. In general, a change in vegetation was noted adjacent to suspected watercourses and a channel was often visible traversing the existing winter road alignment perpendicularly. Rough preliminary measurements taken using the aerial photographs suggest that these watercourses have channel widths of roughly 2 m or less. As indicated above, at this time, fish presence and habitat quality at these locations is unknown, Field surveys will be conducted in spring/early summer 2012 to confirm their status.

#### 6.2.3.6 *Suspected Wetland Areas and Other Unclassified Water Bodies*

Review of existing maps and aerial photographs indicates the presence of suspected wetland areas and other unclassified water bodies (i.e. ponds, lakes) in the vicinity of the proposed highway alignment that may provide aquatic habitat. Suspected wetland areas and other unclassified water bodies within 100 m of the proposed alignment have been identified for the purposes of informing detailed engineering design and avoiding/minimizing potential impacts to fish and fish habitat (Table 31 below). As with watercourses, the suspected wetland areas and unclassified watercourses have been given an identifier based on their distance, in km, along the proposed highway alignment from a zero marker in Wrigley (UTM 475970, 7011620).

It is noted that the alignment route as presented in this PDR document is subject to change during detailed engineering design. Should the alignment shift outside this buffer area, consideration of additional suspected wetland areas or water bodies may become necessary. Further discussion of potential impacts to fish and fish habitat as a result of encroachment into riparian areas surrounding these features is presented in Section 7.

Assessment of suspected wetland areas and unclassified water bodies will be conducted by a qualified professional in the field in the spring/early summer 2012, in order to characterize the quality and function of potential aquatic habitat and to determine connectivity to fish-bearing watercourses. This assessment will be used to inform highway routing and to determine appropriate riparian setbacks. Refer to Appendix 1 for areas of the alignment that have been identified as passing within 100 m of a suspected wetland area or unclassified water body.

Table 31: Suspected Wetland Areas or Unclassified Water Bodies within 100 m of the Proposed Alignment

| SUSPECTED WETLAND AREA OR UNCLASSIFIED WATER BODY (within 500 m of the proposed alignment) | FEATURE ID (For the purposes of this PDR document) | LOCATION ALONG ALIGNMENT WITHIN 100 M OF A SUSPECTED WETLAND AREA OR UNCLASSIFIED WATER BODY | |
|---|---|---|---|
| | | Easting | Northing |
| Suspected Wetland Area | KM 697.61 | 472943 | 7016077 |
| Unclassified Water Body | KM 698.53 | 472346 | 7016776 |
| Unclassified Water Body | KM 700.1 | 471392 | 7017994 |
| Suspected Wetland Area | KM 700.39 | 471251 | 7018254 |
| Unclassified Water Body | KM 701.21 | 470887 | 7018982 |
| Unclassified Water Body | KM 702.91 | 470545 | 7020652 |
| Suspected Wetland Area | KM 707.98 | 471356 | 7025622 |

Table 31 (cont'd): Suspected Wetland Areas or Unclassified Water Bodies within 100 m of the Proposed Alignment

| SUSPECTED WETLAND AREA OR UNCLASSIFIED WATER BODY (within 500 m of the proposed alignment) | FEATURE ID (For the purposes of this PDR document) | LOCATION ALONG ALIGNMENT WITHIN 100 M OF A SUSPECTED WETLAND AREA OR UNCLASSIFIED WATER BODY | |
|---|---|---|---|
| | | Easting | Northing |
| Suspected Wetland Area | KM 709.99 | 471514 | 7027541 |
| Unclassified Water Body | KM 714.04 | 469863 | 7031234 |
| Unclassified Water Body | KM 718.2 | 468175 | 7035037 |
| Suspected Wetland Area | KM 767.56 | 451285 | 7078778 |
| Unclassified Water Body | KM 767.77 | 451290 | 7078990 |
| Suspected Wetland Area | KM 786.36 | 441845 | 7094255 |
| Suspected Wetland Area | KM 787.3 | 441494 | 7095119 |
| Suspected Wetland Area | KM 788.12 | 440992 | 7095753 |
| Suspected Wetland Area | KM 789.18 | 440333 | 7096519 |
| Suspected Wetland Area | KM 790.11 | 439441 | 7096781 |
| Suspected Wetland Area | KM 790.84 | 438914 | 7097264 |
| Suspected Wetland Area | KM 790.94 | 438855 | 7097343 |

## 6.3 SOCIOECONOMIC COMPONENTS

The following section provides a brief description of the Wrigley community and socioeconomic resources found along and near a 102 km section of the proposed MVH extension from Wrigley to the south boundary of the Sahtu Settlement Area, within the Pehdzeh Ki Ndeh - Dehcho Region of the Northwest Territories. The administrative structure, demographic and socioeconomic profiles, community wellness, as well as insfrastructures and utilities are described. The socioeconomic components assessment focuses on the PKFN community of Wrigley (a member community of the Dehcho First Nation), as this is the only community in the immediate vicinity of the Project, and the most likely to experience the impacts of the proposed MVH.

Information provided in this section was gathered from numerous sources including Statistics Canada, the GNWT Bureau of Statistics, Legislative Assembly of Northwest Territories and information made available through consultation with the community of Wrigley.

### 6.3.1 Administrative Structure

The Dehcho Region (DCR) is one of five administrative regions in the Northwest Territories. The region consists of six communities with the administrative centre situated in Fort Simpson. Along with the community of Wrigley, the DCR also includes several smaller communities, such as, Fort Providence, Fort Liard, Nahanni Butte, Trout Lake, Jean Marie River, Kakisa, Hay

River Reserve and West Point First Nation. All of these Dehcho communities are composed of mostly Aboriginal populations.

The Fort Simpson regional office of the Department of Municipal and Community Affairs (MACA) is responsible for the delivery of many of the Department's programs and services to community governments. Regional staff assists community governments with budgeting, debt recovery, financial reporting and other activities to support the use of sound financial management practices. They also assist communities with capital planning and the operation and maintenance of community infrastructure and equipment.

In addition, regional community development and recreation staff assists with local recreation, sport and youth programs. They also provide leadership for community capacity-building initiatives. Regional staff assists community governments with community planning activities and administer leases for Commissioner's Lands.

Within the DCR, the community of Wrigley is acknowledged as a designated authority (DA) under the MACA's structure of community governments. As a DA the PKFN is contracted with MACA to provide municipal services (MACA, 2011). Wrigley community lies at the south end of this section of the MVH extension, as shown in Figures 1 and 3. Located on the east bank of the Mackenzie River below its junction with the Wrigley River at 63'14'N latitude and 123'28'W longitude (Figure 1), Wrigley is the northernmost point of the existing Mackenzie Highway (Hwy 1), an approximate 225 km drive north of Fort Simpson.

### 6.3.2 Demographic Profile

#### *6.3.2.1 Territory and Population Density*

The Dehcho region is in the southwest corner of the Northwest Territories and covers roughly 216 000 $km^2$. There are ten communities involved in the Dehcho region of which eight communities have largely Aboriginal populations and two have a mix of Aboriginal and non-Aboriginal residents. The Dehcho region is home to the largest Dene population of any region in the NWT. The Dehcho First Nation membership includes ten First Nations and three Métis locals.

Compared to other areas of Canada, the territorial population of the DCR is small and geographically scattered. The population in 2001 was 6,718. This equates to a population density for the Dehcho region of slightly more than 3 people per 100 sq. km.

As noted in the regulatory section of this document, the territory within the Dehcho region is subject to ongoing negotiations to settle land claims. The PKFN occupy part of the lands currently subject to negotiation.

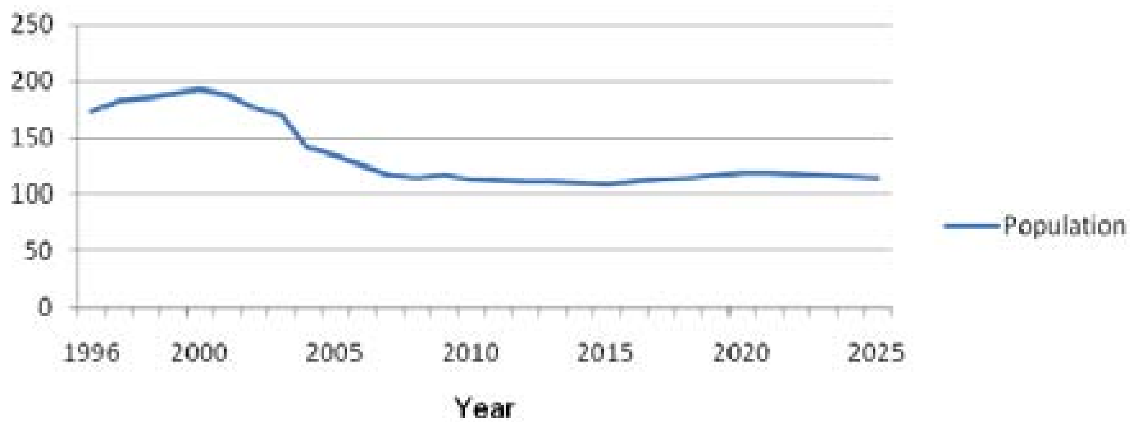
From the Blackwater Bridge (DOT KM 784.1) northward, the proposed road alignment will traverse a parcel of Sahtu Settlement Lands (Surface Rights Only) that is located within the

Dehcho region. This situation for the purpose of future land tenure for the MVH will require observance of provisions within the Sahtu Dene and Metis Comprehensive Land Claim Agreement and the Dehcho First Nations Interim Measures Agreement.

#### *6.3.2.2 Population*

As seen in Graph 7, Wrigley's population has decreased from 173 to 113 between 1996 and 2010, representing a growth rate of -35.0% (Bureau of Statistics, 2010). By 2025, it is anticipated the population will grow minimally to 115 persons (Bureau of Statistics, 2010).

Graph 7: Wrigley Historic and Projected Population, 1996 - 2025

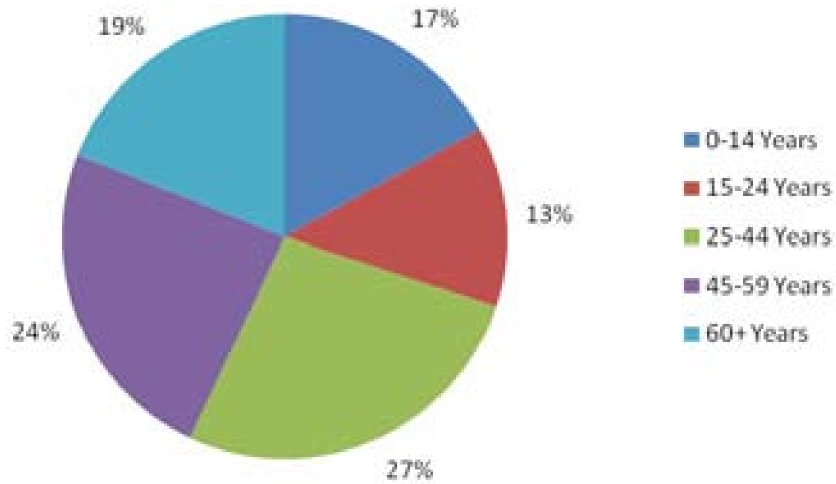



Source: Bureau of Statistics, 2010.

Between 1998 and 2007, Wrigley averaged 2.4 births per year, while deaths occurred at an average of 1 per year. Although this contributes to the anticipated population growth in Wrigley over the next decade, it also suggests that the past population decrease is a result of people migrating away from the community.

The population by age group for Wrigley in 2009 is presented in Graph 8. The population is relatively young, with 57% of the population aged 44 or younger. There are more males (56% of population) than females (44%) in the community (Bureau of Statistics, 2010).

Graph 8: Wrigley Population by Age Group, 2009




Source: Bureau of Statistics, (2010)

#### 6.3.2.3 Language, History and Cultural Identitiy

Known in the Dehcho South Slavey language as Pehdzeh Ki or “clay place", Wrigley is the third settlement of the Slavey Dene since the mid to late nineteenth century. Initially the Slavey Dene settled at Old Fort Island, which was located 32 km north of the present site of Wrigley, where a Hudson’s Bay Company trading post was established in 1870. In the late 1950s, a power plant and school teachers' residence were built and the population grew to 128 by 1960 (Legislative Assembly of the NWT, 2011).

In 1965, the settlement was moved to the present site of Wrigley where there was a well-maintained wartime airstrip constructed by the U.S. military. Many of the buildings were barged to the new site and fifteen new houses were built.

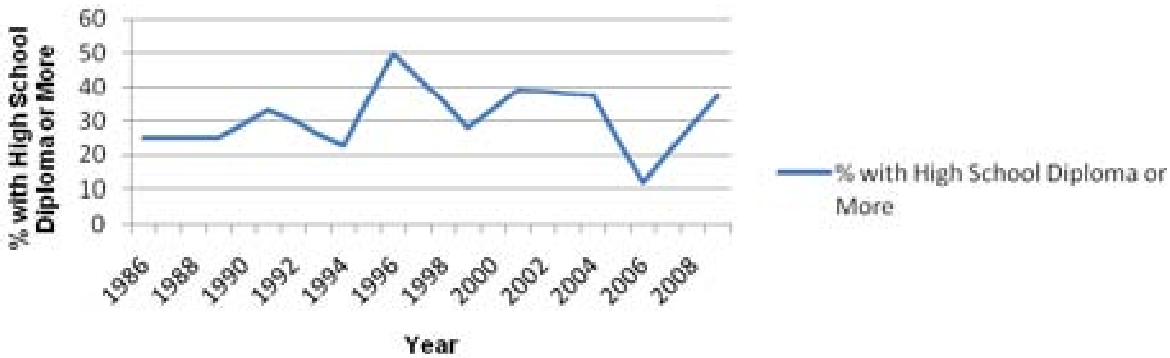
Today, approximately 96% of Wrigley’s population is Aboriginal, and the community continues to maintain a traditional lifestyle of trapping, hunting, and fishing, while local businesses provide for the needs of local residents. Although Wrigley is an English-speaking community, 80.7% or residents speak an Aboriginal language. In the DCR, the predominant traditional language is a dialect of the Dene language, known as South Slavey (sometimes called Dené Dháh or Dene Zhatıé).

### 6.3.3 Socioeconomic Profile

#### *6.3.3.1 Education*

Although the percent of Wrigley residents who achieved a high school diploma or a higher qualification has fluctuated since 1986, there has been a minimal increase overall in the percentage of high school graduates over the same period. Starting at 25% in 1986, the percentage of residents achieving at least a high school diploma peaked in 1996 at 50% before dropping to a low of 11.8% in 2006 (Graph 9).

Graph 9: Wrigley Educational Levels, 1986-2006




Source: Bureau of Statistics, (2010)

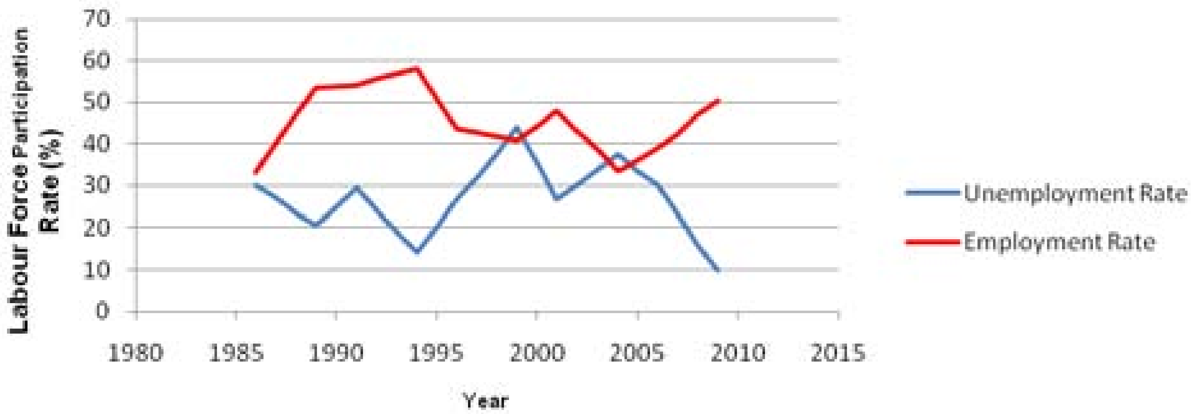
In 2009, of those residents employed, 73.5% had achieved a high school diploma or higher qualification, whereas 35.7% had achieved and education level of less than a high school diploma (Bureau of Statistics, 2010).

#### *6.3.3.2 Labour Force*

In 2009, 91 residents of Wrigley were aged 15 years and older and technically considered the potential labour force. Employment data indicates that Wrigley had a labour force participation rate (the percentage of persons 15 years of age and over who are actually involved in the labour force) of 56% and an unemployment rate of 9.8% (Bureau of Statistics, 2010).

As shown in Graph 10, since 1986 the general trend for Wrigley indicates a decline in unemployment over time, with a corresponding trend of employment rates increasing over time (Bureau of Statistics, 2010).

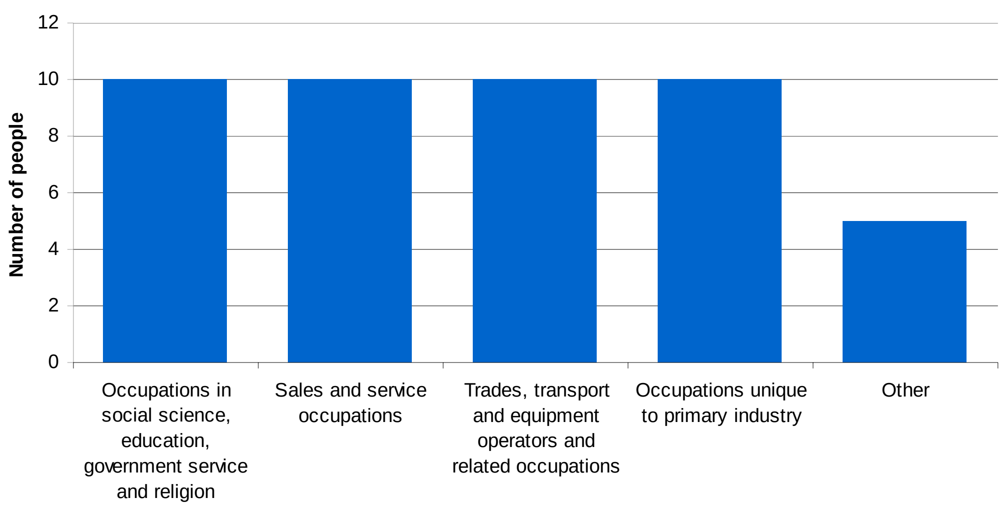
Graph 10: Wrigley Employment and Unemployment Rates




Source: Bureau of Statistics, (2010)

A reflection of Wrigley's workforce is also revealed in labour force by industry statistics presented by the 2006 Census. Of the 45 persons identified as part of Wrigley's experienced labour force[12], 10 worked in the social science, education, government service and religion category, 10 residents worked in sales and service, 10 held trades, transport and equipment operators and related occupations and 10 were employed in occupations in the primary industries, and 5 in other occupational fields (Graph 11).

Graph 11: Wrigley Labour Force by Occupational Category




Source: Statistics Canada, (2007).

[12] Refers to persons 15 years and over, excluding institutional residents who, during the week (Sunday to Saturday) prior to Census Day (May 16, 2006), were employed. Residents considered unemployed were those who had last worked for pay or in self-employment in either 2005 or 2006.

#### 6.3.3.3 Local Economy

As previously stated, the residents of Wrigley continue to carry on their traditional livelihoods. In 2008, 42.9% of the community participated in traditional activities such as hunting and fishing, 21% trapped, 22% produced arts and crafts and 74% of households consumed country foods (Bureau of Statistics, 2010).

Within the community, the formal economy is limited to businesses that provide for the essential needs of the community. This includes the Petanea Co-op store, which also runs the Petanea Hotel and is designed to meet the community’s common economic, social and cultural needs. Through the co-op, other products such as local arts and crafts and outfitting and guiding services can also be accessed.

The fur trade has long been a part of the traditional economy of Wrigley. Fur and hides, including beadwork, are also often used in the creation of traditional Dene craft. In 1998, D'Arcy Moses, a local fashion designer, created Nats'enelu, a local business which incorporates indigenous Dene culture and traditional design details into the mainstream fashion marketplace.

Recently, PKFN established PKCL, which looks to provide economic and employment opportunities by capturing business opportunities within the Pehdzeh Ki traditional territory. PKCL provides general contracting services, including equipment rentals and performs all-weather highway maintenance, winter road maintenance, and airport maintenance.

### 6.3.4 Individual, Family and Community Wellness

This section describes community wellness in the study area, which refers to the physical, emotional, and social well-being of all components of a community, including individuals and families.

Aboriginal people have long recognized the interaction and interdependence of physical, emotional, mental and social well-being and view the spirit as centrally important to achieving this balance. The influence of these interrelated concerns is seen in this section on individual, family and community wellness, which deals with wellness facilities and services, and the conditions and activities of people to which these services must respond.

#### 6.3.4.1 Health Conditions

As of 2009, 61.5% of the population of Wrigley smoked, which is a percentage of smokers considerably higher than experienced by the Northwest Territories as a whole (35.2%). This is an indicator of possible health and wellness issues in the community. It is not known at this time whether such issues have increased since the all-weather road reached Wrigley in 1994.

### 6.3.4.2 Family Concerns and Community Conditions

In 2009, approximately 11.9% of Wrigley households had 6 or more persons, nearly twice the rate experienced throughout the NWT (6.7%). Also, 64.3% of households in 2009 were found to be in core need[13]. In addition, 33.3% of families in Wrigley were lone-parent families.

The cost of living in Wrigley in 2009 was 52.5% higher than experienced in Edmonton, Alberta[14]., while prices were about 54.7% above those found in Yellowknife[15].

As previously mentioned (Section 5.5.3) a survey was presented to members of the Wrigley community to gain people's perception of the Project as well as the principal potential positive or negative impacts of the all-weather highway on the community and their traditional activities. Of the responses, a common concern of the community was the potential adverse impact on local health conditions from a perceived increase in access to restricted and illegal substances (drugs and alcohol), due to the all-weather highway, leading to possible substance abuse issues.

According to the Northwest Territiories Addiction Survey produced by the GNWT Department of Health and Social Services (2006), the rate of heavy drinking and binge drinking among NWT communities was more than double the Canadian average. Additionally, another Health and Social Services report in 2005 noted that drug-use patterns for marijuana, cocaine and crystal methamphetamine were changing due to improved economics in the NWT and the greater availability of drugs. The report also suggested a link between drug-use, heavy drinking and poverty, noting that the highest rates of substance abuse were found among those living in low income households.

In 2009, the community of Wrigley reported 16 cases of property crime or a rate of 141.6 reports per 1,000 persons. This was lower than the average of 197.2 experienced by the Northwest Territories as a whole. Conversely, Wrigley reported a violent crime rate of 150.4 per 1 000 persons (17 cases reported in 2009), which was considerably higher than the average rate of 85.9 experienced across the NWT.

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13 If a household has any one housing problem (suitability, adequacy, or affordability) or a combination of housing problems, and the total household income is below the Community Core Need Income Threshold, the household is considered to be in core need. The core need income threshold is an income limit for each community that represents the amount of income a household must have to be able to afford the cost of owning and operating a home or renting in the private market without government assistance.

14 Cost of living differentials are used to calculate the Government of Canada federal isolated post allowances and use Edmonton as a base, e.g., Edmonton = 100

15 Food price indexes are calculated using Yellowknife as a base, e.g., Yellowknife = 100

#### 6.3.4.3 Housing

As of the 2006 census, there are a total of 40 private dwellings occupied by the residents of Wrigley. Most of these dwellings (35) were privately owned. All of the houses in Wrigley are single-detached houses, with 50% in need of major repair, representing nearly three times the average experienced throughout the NWT (17.6%) (Statistics Canada, 2007).

#### 6.3.4.4 Community/Social Services

##### 6.3.4.4.1 Health

Wrigley has a Health Center, which is primarily run by a Community Health Worker (CHW) and Community Health Representative (CHR) along with a Home Support Worker (HSW). The CHW and CHR provide health care in the absence of trained medical and/or nursing personnel under the long-distance direction and guidance of the medical/nursing staff of the Fort Simpson Health and Social Services Center. When providing basic and emergency care or assessment, the CHW and CHR will be required to independently perform a basic assessment (vital statistics) and provide the results to medical/nursing personnel in Fort Simpson for diagnosis and treatment. The CHW and CHR ensure that individuals within the community have access to care and treatment, and that the Nurse Administrator is aware of the constant and emergency medical needs of the community.

The Fort Simpson Health and Social Services team (Physicians, Community Health Nurses, Community Social Services Workers, Mental Health and Addictions Counselors and Community Wellness Workers) have regular scheduled visits to Wrigley. The team provides medical support, child and family support, counseling services and educational sessions. These visits are provided once a month when a Physician and Health Nurse visit Wrigley.

##### 6.3.4.4.2 Emergency and Protection

Wrigley maintains its own fire fighting capability through the local volunteer fire department and an emergency plan, but receives police services through the Fort Simpson detachment of the RCMP.

##### 6.3.4.4.3 Education

Education services are provided in Wrigley from kindergarten through grade 9. For the final three years of schooling (grades 10-12), students live and study in Fort Simpson where residences and house parents are provided. Students return to Wrigley during school breaks and holidays.

##### 6.3.4.4.4 Recreation

The community of Wrigley has a large community complex, which is used for recreational activities and large community meetings, gatherings and events. The community complex is organized and operated by the community recreation coordinator.

## 6.3.5 Community Infrastructure and Utilities

This section describes the physical infrastructure and services that affect the quality of life of people, families and the communities in which they live.

### *6.3.5.1 Transportation Infrastructure*

Currently, Wrigley is the northernmost point of the existing Mackenzie Highway (Hwy 1), an approximate 225 km drive north of Fort Simpson, which is the main transportation hub for the region. Although recognized as an all-weather road, the route involves the N'dulee ferry, and ice crossing and access between Wrigley from Fort Simpson is often seasonally restricted, with winter travel often not recommended by the DOT.

During the winter months, Wrigley also becomes the southern tip of the Mackenzie Valley ice road, providing access to the Sahtu region. During this time, communities to the north on Wrigley including, Tulita, Deline, Norman Wells, Fort Good Hope and Colville Lake are accessible by road.

Scheduled air service is available from Fort Simpson. A barge service from Hay River operates in the summer months, providing goods and materials to Wrigley and other communities located along the Mackenzie River (Legislative assembly of the NWT, 2011).

### *6.3.5.2 Utilities*

Water is delivered to households in Wrigley by truck and liquid and solid waste disposal services are provided. Solid waste is disposed of at a site 5 km north-east of the community. Diesel-fuelled generators supply power with 200 kW of spare power capacity available and heat is provided by P-50 fuel oil.

### *6.3.5.3 Communications*

Communication infrastructure in Wrigley consists of satellite phone, television and internet service. Local community radio  is produced by the Native Communications Society of the Northwest Territories and  newspaper services are provided by the Deh Cho Drum which serves the Deh Cho communities of Fort Liard, Fort Providence, Fort Simpson, Jean Marie River, Trout Lake, Nahanni Butte, Kakisa and Wrigley.

# 7 ANTICIPATED ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION MEASURES

This section initially considers the sensitive environmental components identified at the optimisation of alignment phase and presents the strategies that were implemented to minimise the effects of the optimized alignment. The anticipated environmental impacts and proposed mitigation measures for the construction and operation phases of the project are then described based on the project's characteristics and the environmental portrait established for the territory traversed.

## 7.1 OPTIMIZATION OF ALIGNMENT PHASE

The Decho region segment of the MVH is particular since a road alignment already exist that is the current winter road. For this reason, the preliminary design consisting in the analysis of potential alignments and the selection of a preferred route is not required for this segment. However, the current winter road alignment was reviewed to evaluate the optimisation possibilities.

Optimisation, from an environmental perspective, implied the identification of sensitive components (physical, biological and human). Four main components were identified as sensitive, they are:

- The presence of water and wetlands;
- The presence of moose and moose pasture areas;
- The presence of traditional human activities along side the current alignement (cultural, spiritual and burial sites, hunting areas, etc.);
- The presence of permafrost.

These sensitive components were discussed in Section 3.5.3. The main mitigation applied for the optimisation of the current alignment was proposing deviations to further off the alignment from the sensitive components, with the exception of permafrost. This resulted in the current optimized alignment described in Section 3.6.4. As for permafrost, specific geotechnical data is not available at this time, but such data will be available in the later stages of the project once the geothecnical studies have been completed. The results of the geotechnical studies will determine whether the proposed alignement requires further optimisation or rather the use of mitigation technics in problematic areas. These mitigation technics, including special embankment design, thermosyphon, air convection embankment and heat drain, are described in Section 3.8.

## 7.2 CONSTRUCTION AND OPERATION PHASES

This section combines the elements of the previous sections in order to determine if the proposed construction and operation phases of the project will have an impact (either positive or negative) on the existing environment. Potential impacts on traditional and other land uses, the physical environment the biological environment and the socioeconomic environment) will be examined separately. All potential impacts that have been identified as part of the research for this report have been included.

### 7.2.1 Traditional and Other Land Uses

#### *7.2.1.1 Potential Impacts on Traditional Land Use*

The assessment of impacts on traditional land use in the area of the MVH extension is related to the potential for the Project to affect traditional activities occurring along and near the route. Due to the construction of the MVH extension, it is possible that access to certain areas along the route will be restricted for current land users, limiting future access to resources and culturally significant areas. In other areas, access to traditional land use areas may be improved through the development of the all-weather highway. In depth-studies should be undertaken regarding traditional land use as it was identified as a sensitive component by the PKFN during public consultations.

##### *7.2.1.1.1 Traditional Resource Harvesting*

In considering the socio-cultural history and traditional land uses that exist in the area of the Mackenzie Valley, north of the community of Wrigley, it is evident that the proposed MVH extension route will interact with a number of areas traditionally usedfor the harvesting of wildlife and vegetation resources. This will include areas important for the harvesting of caribou, moose, small game and vegetation, as well as additional non-traditional hunting and economic land uses that may be permitted in the vicinity of the Project area.

Cabin sites, which are the focal point for trapping and hunting activities, may also be affected at Dam and Whitesand Creeks, as well as areas south of Blackwater River. Impacts to cabin sites may result in their disuse and a reduced ability for cabin owners to pursue the collection of traditional resources in the area.

Although the seasonal winter road may be currently used to access these areas, the all-weather access created by the MVH extension road may have the impact of increasing access to the Mackenzie River area for individuals and groups not currently utilizing its resources, and potentially not associated with the Pehdzeh Ki First Nation. While the increase in year-round access may benefit the Pehdzeh Ki First Nation by increasing access to resources, this also has the potential to result in a reduction of available traditional resources in the area. However this may also result in an increased ability to pursue traditional practices in areas adjacent to the Mackenzie Valley.

#### 7.2.1.1.2 *Spiritual and Other Traditional Activities*

Given the importance of traditional practices for the PKFN in the areas surrounding the Project, impacts may also occur to the cultural value of these areas, resulting in a diminished historical and social identity for the PKFN community, who maintain right and title within their asserted traditional territory.

Areas most likely to experience this potential impact include those that contain culturally significant sites, such as burial, spiritual and ceremonial areas, the harvest of medicinal plants, as well as areas of concentrations of archaeological heritage sites. Portions of the MVH extension located near the Blackwater and Ochre Rivers, and Whitesand Creek are especially susceptible to this impact, as they are focal points for current and historical traditional uses of the landscape.

#### 7.2.1.1.3 *Potential Impacts on Archaeological and Heritage Resources*

The areas north of Wrigley along the Mackenzie River and its tributaries are known to contain a number of protected archaeological and heritage sites. These sites are important aspects of PKFN cultural heritage in the region. Any impact to cultural heritage in the form of disturbance or removal of known, and undiscovered buried archaeological sites located along the route, will result in a reduced cultural, scientific and public value to the Mackenzie Valley area.

Based on consultation with the PKFN, and a review of available resources, including community mapping and a database of known heritage sites held by GNWT, 35 archaeological sites appear to be located within approximately 1.5 km of the current winter road alignment, and 21 sites are within 500 m of the alignment.

The following locations along the proposed alignment (as currently planned to follow the winter road) may have conflicts with recorded archaeological sites:

- Blackwater River;
- 2.2 km north of Blackwater River;
- Ochre River;
- Unnamed drainage 2 km north of Whitesand Creek.

In addition, 2.2 km north of Blackwater River there are recorded sites that must be considered in the analysis of options for the crossing of the Blackwater River and the approaches to the bridge. The highway itself will not impact these sites, but the crossing infrastructure and related works may result in impacts to these sites.

There may be a grave or graves near the Blackwater River. These must be located to ensure that the road or any construction-related activities remain as far away as possible.

Although most of the drainage crossings were assessed by an archaeologist in 1999, field assessment of the current plans is recommended for the following reasons:

1. There are significant uncertainties regarding recorded site locations;
2. Any small changes in the approaches to crossings may impact new, undisturbed areas;
3. Increased width of the disturbed area along the highway right-of-way may impact new, undisturbed areas;
4. Erosion or downcutting by water may reveal buried sites that were previously not visible.

In the present study, terrain potential assessments for archaeological resources was completed to a general level. In some instances, inconsistencies between archaeological site coordinates and location descriptions on site forms prohibited reliable assessment of their proximities to the proposed road. Ground reconnaissance for archaeological and heritage resources in the next study phase, prior to any final design, would help to address these deficiencies. All recorded archaeological sites will need to be located in order to determine the site's position relative to proposed project activities, ground disturbance and the footprint, and to ascertain the site's condition, that is, whether it is still intact, and then, to complete assessment of impact potential.

It is clear from the high numbers of recorded archaeological sites at virtually every larger water course that alignment revisions or proposed disturbance of any intact ground at creek or river crossings or along water bodies and terraces will require intensive archaeological ground assessments. The typically dense vegetation cover and the subtle nature of some types of archaeological remains will necessitate particularly intensive investigation strategies, involving closely spaced pedestrian transects to ensure thorough inspection coverage. Due to the buried or obscured nature of some types of archaeological resources expected in this area, intensive systematic subsurface testing will be required in most areas judged to be suggestive of good archaeological potential. In order to adequately complete intensive archaeological inventory survey, the highway alignment to be assessed should be finalized within a 100 m wide corridor prior to further field reconnaissance of archaeological and heritage resources.

Boundaries of associated components such as borrow sources, work staging areas, and construction camps must be identified prior to field work. It is crucial that proposed borrow sources, in particular, be included in the next phase of study, prior to any final design. In this region, knolls or ridges are considered high potential for archaeological resources and these are typically the landforms that offer gravel or sand borrow.

Archaeological sites are typically of limited spatial extent. This is advantageous, on the one hand, in that a small realignment or repositioning of a project component can readily avoid impacting an archaeological resource. Conversely, a small realignment can also mean that a site that was previously avoided could be impacted, or if a realignment to an unsurveyed area occurs, that an unrecorded archaeological resource may be affected. Therefore, locations of archaeological sites must be carefully considered on an ongoing basis during all phases of study planning, and an archaeologist should be consulted to advise when further assessment is required.

Mitigation measures will need to be designed as appropriate for each individual site as the details of the site and the nature of the impact are confirmed. These may include avoidance (the preferred mitigation), temporary site protection, or systematic data recovery. It is expected that most archaeological sites found could be readily avoided with a minor project realignment or footprint adjustment.  In the event that project relocation is not feasible and a site will be impacted, recommended site mitigation will likely comprise detailed mapping, recording and excavation of a sufficient number of units to obtain a representative sample of the site contents. This ensures that knowledge of that site is available for future generations. All site mitigation must be finalized in consultation with the Territorial Archaeologist of the Government of the Northwest Territories at the Prince of Wales Northern Heritage Centre.  In the event of an unanticipated cultural find during any project related activity, all activities in that vicinity must cease and the Territorial Archaeologist of the Government of the Northwest Territories must be contacted.

#### *7.2.1.2 Mitigation of Potential Impacts on Traditional Land Use*

Mitigation measures to be applied to limit the intensity and extent of potential impacts on traditional land use primarily focus on protection of vegetation and wildlife and restricting the footprint of the project. However, in certain cases, compensation for loss of resources or impacts to important ceremonial or heritage sites may require compensation. Compensation does not necessarily mean financial compensation, but should be directed at addressing specific community needs for the local people. The analyze or the carry-out of in-depth investigative studies to identify all sites is the first mitigation measures to be implemented as this component has been identified as a major concern by the PKFN members during public consultation (see section on Community Involvement).

##### *7.2.1.2.1 Mitigation of Potential Impacts to Traditional Resource Harvesting*

In order to minimize the potential impact of the construction of an all-weather highway on traditional resource harvesting, non-tradition hunting, gathering and fishing activities should be regulated and monitored. As tourism expands in the area, a key area of touristic interest may be hunting and fishing, and therefore this may impact the resources available to the PKFN and other residents of the Dehcho and surrounding regions by impacting the wildlife and fish populations. The vegetation areas may also be impacted through recreational touristic activities such as hiking, hunting and camping. It will be important to provide visitors with information about the protection of vegetation and wildlife, pollution and relevant regulations.

Mitigation measures that are recommended to minimize impacts on the biological and physical environments (see below) will address potential impacts to traditionally used resources, including impacts to wildlife and vegetation resources.

Prior to undertaking final design and construction activities, further discussion with the PKFN and other users of the Dehcho territory must take place in order to determine more specifically the boundaries of important hunting, fishing and vegetation areas in the region. Consultation activities may include a door-to-door survey, flyovers of the proposed Project footprint with members of the Wrigley community and interviews with elders and other community members. This work is expected to continue from work conducted under a Memorandum of Understanding between GNWT-DOT and PKFN in 2010. The sensitive areas identified must be avoided to the extent possible in the design of the highway alignment as well as during construction.

In order to mitigate the loss of access and subsequent use that may occur for cabin sites located near the all-weather road, cabins may be moved to locations selected by the PKFN government. Where cabins cannot be relocated, compensation may be required.

###### *7.2.1.2.2 Mitigation of Potential Impacts to Spiritual and Other Traditional Activities*

During the design and construction phases, known cultural, historical and spiritual areas must be avoided. Project engineers and construction workers should respect a buffer area around all identified sites.

Further discussion with locals will be required during the detailed design phase to better define the boundaries and exact locations of important cultural sites as well as to locate any important sites that have not yet been identified. In addition, access routes to reach important sites must be considered. Members of PKFN should be provided with detailed drawings of the alignment and temporary sites to be used during construction throughout the design phases in order to members to ensure that the route avoids all critical areas.

Although the all-weather road may impact some important cultural or traditional sites, it may also increase access to other sites in different areas by improving the transportation network in the area. In order to optimize the alignment, during the design phase accessibility to locations of interest to the population should be examined to identify potential barriers to reaching important sites and potential opportunities. Some sites along the highway may be of interest for tourism and these should be considered in the design as well.

###### *7.2.1.2.3 Mitigation of Potential Impacts on Archaeological and Heritage Resources*

In order to ensure the most reliable archaeological overview assessment, visual examination of the terrain is recommended including an extensive and focused documentary research, incorporating traditional knowledge that may be available. Detailed archaeological studies should be conducted by a qualified archaeologist in possession of a Class 2 permit, as per the *Northwest Territories Archaeological Site Regulations (2001)*.

In order for archaeological field investigations to be most beneficial, it is recommended that all alignment revisions, borrow sources and associated infrastructure be delineated to as specific locations and size of area as possible. Additionally, revisits to all nearby previously recorded archaeological/heritage resources sites are recommended in order to determine proximity of the proposed highway alignment potential for both direct and indirect impacts and avoidance possibilities by minor revisions to the highway alignment during the detailed design stage. Final design and location should recognize that decisions related to the crossing of the Blackwater River and highway approaches to the bridge may result in impacts to sites on each side of the crossing, unless duly considered.

Although considerable ground disturbance has already occurred along the winter road, it is anticipated that some alignment/approach revisions, widening, expanded work areas or construction camps will affect undisturbed ground. Pedestrian surveys by the qualified permitted archaeologist should be conducted of sections of the proposed highway alignment that are on undisturbed terrain rated as good potential.

Avoidance is the preferred method for mitigation of archaeological sites, but in the event that project relocation is not feasible and a site will be impacted, recommended site mitigation will likely comprise detailed mapping, recording, and excavation of a sufficient number of units to obtain a representative sample of the site contents. Mitigation must be designed for each individual site based on the site content and significance, and the nature of the impact. Mitigation recommendations must be approved by the permitting agency of the GNWT prior to implementation. It is recommended that previously recorded archaeological sites be avoided by a minimum of 100m and that recorded graves be avoided by at least 500 m.

Potential damage to archaeological sites will be mitigated by a thorough archaeological excavation of the sites, or by compensation, to be negotiated with the PKFN and the Dehcho leadership.

It is recommended that all locations of archaeological sites must be carefully monitored on an ongoing basis during all phases of study planning, and an archaeologist should be consulted to advise when further assessment is required.

In the event of an unanticipated cultural find during any project-related activity, all activities in that vicinity must cease and the Territorial Archaeologist of the Government of the Northwest Territories must be contacted.

### 7.2.1.3 Potential Impacts on Other Land Uses and Future Development

#### 7.2.1.3.1 Potential Impacts on the Proposed Mackenzie Gas Project

One potential impact of the MVH extension is the benefit of an all-weather road for the construction of the planned MGP. It has been acknowledged that even if the MVH is built before the MGP, it is not expected to significantly reduce initial cost of MGP construction (DOT, 2009). For the proposed construction for the MGP, it is expected that in the absence of all weather road access, the majority of the pipe, heavy building equipment and materials for the proposed MGP will be brought in by barge to existing or new barge landing and staging areas. However, while the MVH extension may not change the initial construction costs of the MGP, it will likely save the oil and gas industry 15 percent a year on all future field drilling and development. The savings result principally from reduced logistics costs.

#### 7.2.1.3.2 Potential Impacts on Natural Resource Exploration and Development

An independent assessment of the economic impacts associated with an all weather road in the region was provided by Meyers Norris Penny LLP in October 2007 for the Mackenzie Aboriginal Corporation and titled “Mackenzie Valley All-Weather Road Opportunity Assessment” (MNP, 2007). The report studied and quantified the impact of the Highway on future oil and gas exploration and development, assuming that the MGP would be built. In doing so the report acknowledged that, with respect to natural resource exploration and development in the NWT, the inherent economic cost in time and money for development and exploration activities is a central issue.

The report further stated that the presence of an MVH extension in the Mackenzie Valley region would serve to materially reduce these costs, thereby stimulating investment in the region and generating significant positive financial and other benefits for the region. Introduction of an all-weather road or highway access to natural resource exploration would provide advantages in extending the length of the drilling season and reducing costs.

The October 2007 report summarizes the advantages of extending the drilling season as follows:

- The Highway would extend the drilling season from 90 to 129 days. This enables a fundamental and permanent increase in the rate at which the natural resource base may be developed, relative to the current state, thereby allowing for the full economic benefit associated with the development of the resource base over a shorter period of time;
- The estimated rate of increase in the release of the economic benefit is approximately 43%. With the Highway present, the economic benefit associated with the drilling and subsequent production from 500 wells expected over a 25 year period would accrue in approximately 17.5 years;

- The impact of this permanent increase in the rate of release of economic benefit due to the presence of the Highway in the region yields a potential additional gain of $3.4 billion to the government at the end of 25 years. This net gain has the present value equivalent of approximately $1 billion at 5% annual growth.

The October 2007 study summarizes the reduction in the cost of drilling exploration and production wells as:

- An estimated reduction of 15% in the per unit cost of exploration and production well drilling, resulting in an average $2.25 million reduction in costs per well drilled. The total estimated cost savings to industry are $1.25 billion, predicated on the drilling of 500 new wells; and,
- The permanent extension of the exploration season will allow an additional $70 million in wages to be released into the regional economy, driven by the ability of industry to drill these 500 wells in the time it previously took to drill 350 and the consequential need for incremental labour hours to do so.

The October 2007 report concluded that the presence of the MVH extension in the Mackenzie Valley region would serve to materially reduce the cost of exploration and development, thereby stimulating investment in the region and generating substantial positive financial and other benefits for the region.

The authors note that the oil and gas potential in the area north of Dehcho and SE of Norman Wells may afford Dehcho opportunities to more directly serve this industry beyond exploration phase, especially if an all-weather road is available.

#### *7.2.1.4 Mitigation of Potential Impacts on Other Land Uses and Future Development*

##### *7.2.1.4.1 Mitigation of Potential Impacts on the Proposed Mackenzie Gas Project*

In order to maximize the benefits of the MVH extension for the development of the MGP, the highway should be completed prior to beginning construction of the gas pipeline. In addition, the detailed drawings for the highway should be provided to the MGP developers for use during the MGP detailed design phase. Finally, consideration should be given to the location of staging areas and construction camps during the development of the MVH for the MGP as well, as use of the same sites for both projects may limit the potential impacts to the natural and human environments.

##### *7.2.1.4.2 Mitigation of Potential Impacts on Natural Resource Exploration and Development*

The development of the all-weather highway will have a positive impact on natural resource exploration and development. The MVH should be completed in a timely fashion in order to increase access to potential exploration sites. Also, as part of the MVH, training should be offered to locals in construction methods, health and safety protocols, engineering and skilled trades, as well as other pertinent vocations, in order to ensure that local residents develop skills that can be used in future projects, such as exploration and development projects. Capacity development in local communities will assist residents to obtain more employment opportunities and increase their contribution to the development of their region.

## 7.2.2 Physical Components

### *7.2.2.1 Air Quality*

#### *7.2.2.1.1 Potential Impacts on Air Quality*

Dust, air emissions associated with the construction of the Highway, the borrow sources and their access routes are expected to have limited, localized and generally temporary impacts on air quality and the sound environment in the vicinity of the Highway.

Dust particles of various sizes are expected. Larger particles (> 44 microns diameter) are typically associated with nuisance issues, while smaller particles (< 10 microns diameter) can potentially create human health issues at elevated levels in populated areas. Emissions from diesel engine combustion exhaust during construction and operation are also expected to be generated.

During the construction of the Highway, typical dust sources will include: heavy equipment movements, loading and unloading of materials, crushing, screening, blasting, erosion from material stockpiles, etc. Emissions from diesel engine combustion exhaust are considered to be relatively minor. Construction-related emissions are expected to be localized, short term and intermittent.

During operation, light and heavy vehicle circulation on the unpaved road will generate dust particles, mainly during summer dry periods. This regular and constant generation of dust will deposit layers of particles on the local vegetation foliage thus potentially reducing photosynthesis. The generation of dust may also have an impact on bird reproduction success for those nesting close to the highway. Dust deposition may also affect wetland ecosystems as well as fish habitat. These vehicles will also generate air contaminant through their exhaust system, but it is not considered to be a significant impact because of the low circulation density.

#### *7.2.2.1.2 Mitigation of Potential Impacts on Air Quality*

The application of water from nearby, suitable lakes, as per the GNWT Guideline for Dust Suppression (ENR, 1999), will be effective during summer construction periods in controlling dust created by loading and unloading materials, stockpiling and wind erosion. Any water extracted for dust control or other purposes will be undertaken in accordance with Northwest Territories Water Licence requirements and Department of Fisheries and Oceans (DFO) water withdrawal criteria.

All construction vehicles and machinery should be inspected to ensure that they are in good working conditions to reduce air emissions.

Similar water application may be required during the operation stage in the most critical areas to reduce the impacts of dust deposits on trees, wetlands and aquatic environments.

#### *7.2.2.2 Surface Soils*

##### *7.2.2.2.1 Potential Impacts on Surface Soils*

Enlargement and localized adjustment to the alignment of the existing road and the opening of borrow sites and their access roads could generate the following direct impacts on surface soils:

- Modification of existing stratigraphy;
- Destabilisation of surface soils presenting a low cohesion coefficient;
- Exposition of soil strata sensitive to harsh weather conditions (heavy rains, freezing/thawing cycles, etc.);
- Contamination of surface soils through leaks or spillage of contaminants from the construction vehicles and machinery.

##### *7.2.2.2.2 Mitigation of Potential Impacts on Surface Soils*

Mitigation of impacts on surface soils can be achieved through:

- Completion of baseline information through further studies
- Minimizing the enlargement of the MVH's right of way;
- Using the existing alignment as much as possible;
- Using existing borrow sites and minimizing haul distances;
- Creation of site specific remediation plans;
- Following Best Management Practices (BMPs) for sediment and erosion control.

#### *7.2.2.3 Geohazards*

##### *7.2.2.3.1 Potential Impacts of Geohazards*

The geohazards associated with bentonite clays, melting permafrost and wetland features as described in Section 6 could lead to damage to the road structure and possible ensuing impacts on sedimentation, erosion, fish and fish habitat. As with groundwater issues, the key mitigation measure is to anticipate and design for groundwater conditions. Once a fill, cut or culvert is in place, remedial actions are difficult and expensive.

Potential Impacts of geohazards Include:

- Road structure destabilization due to:
  - Plastic behaviour of soils (bentonite clays)
  - Permafrost melt;
- Alignment constraints due to influence of wetland features;
- Increased erosion and degradation of channel slopes at stream crossings including landslides and thermokarst activity;
- Increased sedimentation of streams.

###### *7.2.2.3.2 Mitigation of Potential Impacts of Geohazards*

The mitigation of geohazards is primarily achieved through good design and route location and siting. To support this process, mapping of seepage areas, permafrost zones and sediments sensitive to erosion will facilitate the development of the most appropriate design and display where route re-alignments to avoid or minimize the impacts of geohazards may be required.

Mitigation methods to reduce the potential impacts of geohazards include:

- Completion of baseline through further studies;
- Minimizing the exposure of permafrost;
- Ensuring sufficient cross drainage to prevent pooling which can cause permafrost degradation;
- Limiting the loading of materials on top of clays;
- Limiting the exposure of clays to vibrations;
- Minimizing surface erosion;
- Stabilizing slopes through both engineering techniques and revegetation wherever possible;
- Following Best Management Practices (BMPs) for sediment and erosion control.

##### *7.2.2.4 Contaminated Sites*

###### *7.2.2.4.1 Potential Impacts of Contamination on Soil and Water*

The primary impact of the road in soil and water contamination will likely be due to spills caused by accidents or malfunctions, either during construction or during road operation and maintenance.

Construction Phase

- Fuel spills due to accidents or malfunctions of construction equipment;
- and/or vehicles transporting people and/or materials.

Operations Phase

- Fuel spills during road accidents or at re-fuelling points;
- Accidents involving vehicles transporting materials that could contaminate soils, groundwater and/or surface waters. The nature of this contamination will depend on the goods and materials transported on the highway. In the event of mining and oil and gas development, the range of contaminants would be greater than that to which the winter road is exposed at present.

It is noted that due to frozen ground conditions for much of the year and permafrost, spills should be expected to remain close to the ground surface and be available for transport/movement downslope and downstream.

The geographic extent of the impacts of a spill will vary with the material, site conditions, time of year and proximity to a drainage course, especially the Mackenzie River. There is a potential for a large spill to affect a large area if the spill material is liquid and enters the Mackenzie River.

*7.2.2.4.2 Mitigation for Potential Impacts of Contamination on Soil and Water*

Mitigation is discussed in the context of the two key phases of the project; construction and operation.

Construction Phase

- Designate safe re-fuelling and vehicle maintenance sites;
- An environmental management plan (EMP) that includes employee/contractor training, equipment maintenance, fuel and hazardous waste management practices, contingency plans, and spill response will reduce the potential of groundwater contamination. The following standards ought to be adhered to: Worker's Compensation Board standards, and CCME's Code of Practice for fuel and hydrocarbon storage tanks. All fuel ought to be stored in double-walled tanks at least 100 m away from any water body. Spills ought to be reported immediately to the 24-hour Spill Report Line. Vehicle refueling should occur at least 100 m away from any water bodies as well;
- The EMP should include environmental protection plans to address the practices and standards mentioned above.

Operation Phase

- Ensure that vehicles used to haul hazardous materials on the road comply with existing standards to meet the road and environmental conditions on the highway;
- For road sections close to the Mackenzie River and at regular intervals along the road, consideration should be given to providing for storage of equipment and materials to support spill cleanup with particular reference to fuel spills;

- Consideration should be given to training (selected) personnel in local communities to support spill cleanup and to respond to emergencies, including knowledge of proper health and safety practices related to the materials likely to be transported on the highway.

### 7.2.2.5 Surface Water

Impacts and mitigation measures related to surface water are presented in Section 7.2.3.3 on Fish and Fish habitat (also called aquatic environment).

### 7.2.2.6 Groundwater

#### 7.2.2.6.1 Potential Impacts on Groundwater

Groundwater impacts tend to be subject to very local conditions and road construction activities. Key variables include surface sediments, ground slopes, permafrost conditions, existing surface groundwater seepage, surface drainage patterns and flow conditions, as well as road fills and road cuts.

The highway and the exploitation of borrow sites may affect groundwater quantity and quality in the following principle ways:

- Creation of groundwater fed wetlands (bogs and marshes) in some areas, especially permafrost areas, due to interception of near surface groundwater flows;
- Loss of wetlands due to draining of existing wetlands through road ditches and associated crossings;
- Formation of icings and aufies due to exposure/interception of groundwater flows at road cuts;
- In unconsolidated sediments slope stability can be reduced due to interception of groundwater flows;
- Formation of new groundwater seepage areas, or changes in seepage rates, due to road cuts and blockage of drainage courses;
- Creation of wetlands and saturated soils due to blockage of drainage courses, affecting groundwater discharge and recharge rates;
- Groundwater quality will mostly be affected by changes in surface water quality and/or the spill of contaminated materials where leaching could carry contaminants into the groundwater;
- Groundwater quality can also be affected by poorly managed sewage from construction camps;
- Interception of groundwater at borrow sites, which may affect local groundwater flows and icing conditions;

- Bridge crossings are not expected to affect groundwater conditions in the channel. The approach fills may affect local groundwater flows and re-direct these flows;
- Culvert sites and the associated fills will likely affect local groundwater flows, causing one or more of the impacts described above, most especially creating wetlands due to blockage of small near surface and surface flows, changing rates of groundwater flow, especially downstream from the crossing.

Most groundwater impacts are expected to be local in extent. The duration of a groundwater impact could be long term and through time affect ecological resources both locally and proximal to the immediate area of impact on groundwater due to changes in surface water conditions.

#### *7.2.2.6.2 Mitigation for Potential Impacts on Groundwater*

The key mitigation measure is to anticipate and design for groundwater conditions. Once a fill, cut or culvert is in place, remedial actions are difficult and expensive. Mapping of seepage areas, permafrost zones and sediments sensitive to erosion will facilitate selection of the most appropriate design or the need for any route re-alignments.

Management of sewage generated during construction activities to protect groundwater should occur. An example of an acceptable management practice would be to transport the waste off-site.

### *7.2.2.7 Ambient Noise*

#### *7.2.2.7.1 Potential Impacts on Ambient Noise*

Ambient noise levels may be affected by various activities at the construction stage such as cutting of vegetation, movement and operation of heavy machinery, blasting activities (if required) and the manipulation of granular material. At the operation stage, the main source of noise will be related to the increase circulation of light to heavy transport vehicles. Given that no permanent residence is located near the road, no significant noise impact is anticipated. However, some hunting and fishing cabins are present and the described noise sources may create reduce success of hunting and fishing by keeping the animals away from their normal territory. The noise sources described may equally generate vibrations that could have the same type of impact.

Furthermore, these impacts may have some impacts on the local fauna’s behaviour, reducing their reproduction success rate as well as creating stress and disorientation.

Let it be noted that the number of vehicles travelling on a road must be doubled to obtain a noise increase of 3 dBA (Barber, 1992). Although the noise level has indeed doubled, a 3-dBA increase is barely detectable by the human ear.

*7.2.2.7.2 Mitigation for Potential Impacts on Ambient Noise*

Since the main impact of noise increase would be related to the construction phase, the construction activities that are the noisiest should be avoided during hunting and fishing seasons as well as during the reproduction seasons for the valued wildlife species and during the birds' short nesting season.

## 7.2.3 Biological Components

### *7.2.3.1 Vegetation*

#### *7.2.3.1.1 Potential Impacts on Vegetation*

Construction Phase

Potential adverse impacts of the Project on vegetation VECs are associated with the construction activities such as clearing and stripping of vegetation, filling, levelling and grading, blasting (if required), culvert and bridge installation, and the possible introduction of invasive plant species. Environmental impacts include both temporary disturbance impacts and permanent loss of vegetation communities, wetlands, and potentially rare plants. Changes to abiotic conditions (e.g., soil substrates) that are required for the development of both common and rare plant communities may result from indirect changes to hydrological conditions (drainage patterns). Wetland structure and function loss is also anticipated as a result of project construction activities.

Operation Phase

Vehicle traffic and road maintenance during the operation phase of the Project have the potential to adversely affect vegetation VECs.

Vehicle traffic can result in the deposition of dust on roadside vegetation. The magnitude of the impact of dust deposition on vegetation in the LSA will be related to traffic volumes. Dust deposition will increase during grading events.

Normal highway activities have the potential to directly affect wetland habitats through the introduction of sediment and chemical contaminants via road runoff, and changes to water conditions including: temperature, pH, Total Suspended Solids, and Dissolved Oxygen. Other potential impacts to wetlands include: changes to the local hydrology which could result in the drying of wetland or conversely higher flooding rates.

Road maintenance activities such as snow removal can result increased snow accumulations on roadsides which may result in changes to local hydrology during spring melt due to increased snow volumes and causing perturbation to local wetland ecology.

Further, snow accumulations may take longer to melt than snow in the surrounding areas, resulting in reductions to baseline vegetation growing season length.

Road runoff and the use of de-icing and dust suppressant compounds, as part of road maintenance, can adversely affect vegetation, wetlands, and aquatic ecosystems including fish-bearing habitats. Chemical contaminants associated with road runoff include: metals, hydrocarbons (e.g. rubber residues and petroleum products) and de-icing agents (Norrstrom and Jacks, 1998). A major component of road runoff is salt; salts are commonly used in road maintenance for winter de-icing and summer dust suppression (Environment Canada, 2001). The most commonly used salts include sodium chloride (NaCl), calcium chloride ($CaCl_2$), and magnesium chloride ($MgCl_2$), with NaCl accounting for 98% of all usage (Transportation Research Board, 1991; Environment Canada, 2001).

Other potential impacts associated with use of the MVH may be associated with vehicle emissions: oxides of nitrogen may be harmful to vegetation (or may act as a fertilizer), resulting in changes in plant community composition; heavy metals such as lead may cause phytotoxicity; secondary pollutants such as ozone may injure plants and affect plant species composition; and wind gusts from traffic may affect plant growth (Angold,1997).

Indirect impacts may come as a result of increased human access to vegetation communities. Increased road access may allow ATVs, dirt bikes, and off-road vehicles better access to previously undisturbed areas. This may increase trampling of at-risk plant species and plant communities, and introduce invasive plant species.

#### 7.2.3.1.2 *Mitigation of Potential Impacts on Vegetation VECs*

The first step in mitigating the impacts on vegetation VECs will be to complete baseline studies through field surveys in early and late summer 2012. Based on these studies, further mitigations will include those mentioned below.

<u>Minimize Project Footprint</u>

The following mitigation techniques can be utilized to restrict the project footprint thereby avoiding unnecessary disturbance of vegetation:

- Minimize the extent of grubbing, stripping and the removal of shrubs or trees in all areas planned for Project development;
- In areas of disturbance related to non-permanent infrastructure, remove only the above-ground vegetation, thereby avoiding ground disturbance. High blade during winter months to avoid damage to the duff layer and leave root structures intact;
- Cleared areas not required for the operation phase must be revegetated with indigenous species;
- Avoid locating lay-down areas on wetland edges or riparian areas;
- Minimize the footprint of borrow sites by using existing quarries where possible;
- Reclaim any new quarries through re-vegetation and re-contouring.

Conduct Rare Plant Survey Work

Once the initial baseline is complete, further studies may be warranted to protect rare plants. Such as:

- Surveys to delineate the extent of rare plant occurrences in the Project footprint should be conducted prior to final design, by qualified personnel during the appropriate period (May to June);
- The extent of the occurrences should be delineated in the field, and temporary disturbances within these boundaries should be avoided;
- The habitat and soil conditions should be documented in the vicinity of the individuals to be displaced by the Project footprint.

Attempt Translocation and Monitor

A preferred mitigative approach to environmental impacts to rare plants is to avoid and reduce disturbance. Where this is not possible, other mitigation techniques should be employed. These are described below:

- Attempt a translocation of displaced individuals of rare plant species if determined feasible by species experts, and relocate individuals preferably in a suitable protected area or other suitable locations;
- It is recommended that translocated individuals be monitored over an appropriate time-frame to determine survivorship thresholds;
- Collect and contribute voucher specimens to Natural History museums or university herbariums.

Where mitigation is not practical, compensation will be required to offset the impact on the rare plant species.

Sediment and Erosion Control

Follow BMPs for sediment and erosion control. Develop a Construction Environmental Management Plan (CEMP) to reduce impacts in wetlands and stream crossings. Mitigation techniques to achieve this include:

- Minimizing soil exposure;
- High blade during winter months to avoid damage to the duff layer and leave root structures intact
- Re-vegetating areas of disturbance as soon as possible;
- Utilization of sediment control techniques such as silt curtains where sediment entrainment does occur.

Maintain natural hydrology of wetlands and streams

Construct and design roads using standard operating procedures and road building techniques in order to maintain natural drainage regimes. Mitigation techniques to achieve this include:

- Maintaining current drainage patterns and rate through the installation of appropriately sized culverts;
- Management of culverts to avoid blockages and ponding;
- Utilization of textile underlays and appropriate fill depths over the road bed to avoid permafrost melt.

Limit Opportunities for Colonization by Invasive Species

Measures to limit invasive species include the following: minimize areas of soil disturbance during construction and maintenance. Where ground disturbance from project activities occur on soils prone to soil erosion (e.g., steep slopes, areas prone to high winds or drainage channels), re-establish vegetation as soon as possible or provide alternative protection to soil (e.g., geotextiles) until vegetation cover is re-established. Areas where the risk of soil erosion is minimal should be left for natural re-establishment of native vegetation and monitored for progress. Where possible, emphasis should be placed on the use of native species for seeding and reclamation of disturbed areas.

#### *7.2.3.2 Wildlife*

##### *7.2.3.2.1 Potential Impacts on Wildlife*

Construction and operation impacts are defined as permanent and temporary habitat loss, habitat avoidance due to sensory disturbance, habitat fragmentation and direct mortality. These impacts may differ by wildlife species.

Habitat Loss

Direct footprint impacts such as destruction or alteration of habitat can permanently or temporarily remove habitat.

Habitat Avoidance

Avoidance or abandonment (collectively referred to as “avoidance”) of habitat occurs when wildlife are subjected to visual or auditory stimuli that elicit a response. Reactions to stimuli vary in magnitude, ranging from low-grade stress responses (increased heart rate; stress hormone corticoid releases), to changes in daily activity budgets (more time spent vigilant, less time feeding), to flight responses, and at the highest magnitude, the abandonment of habitat – possibly in favour of less optimal habitat. This potential impact can extend the boundaries of habitat loss impacts rendering otherwise available habitats in proximity to Project components unusable.

Habitat Fragmentation

Habitat fragmentation is an extension of habitat loss and habitat avoidance impacts. Linear developments divide large habitat patches into smaller patches and/or restrict movement between these patches. This potential impact can be important for wide-ranging animals, and the magnitude of the impact is dependent on the degree to which the linear development acts as a physical or psychological barrier to movement. For some VECs, reduced patch size can potentially reduce the overall value of the habitat, and ultimately result in increased home range size required to meet life requisites.

Direct Mortality

Project-related activities potentially result in human-caused direct mortality of VECs; this includes the potential for vehicle collisions with wildlife, and the possible need for control of habituated problem wildlife.

###### 7.2.3.2.2 *Mitigation of Potential Impacts on Wildlife*

The first step in mitigating the impacts on wildlife will be to complete baseline studies through field surveys in late summer or early fall 2012. Further mitigation measures will be based on these studies and will include those mentioned below.

Minimize Project Footprint

The following mitigation techniques can be utilized to restrict the project footprint thereby avoiding unnecessary disturbance of wildlife:

- Minimize the extent of grubbing, stripping and the removal of shrubs or trees in all areas planned for Project development;
- In areas of disturbance related to non-permanent infrastructure, remove only the above-ground vegetation, thereby avoiding ground disturbance. High blade during winter months to avoid damage to the duff layer and leave root structures intact;
- Avoid locating lay-down areas on wetland edges or riparian areas and in proximity to important habitats or habitat features;
- Minimize the footprint of borrow sites by using existing quarries where possible;
- Reclaim quarries where possible through re-vegetation and re-contouring.

Conduct Pre-construction Surveys

Pre-construction surveys should be conducted by qualified environmental professionals immediately prior to vegetation clearing and/or construction activities to confirm the presence of important habitat features for terrestrial wildlife and birds. These important features may include dens and potential den sites (e.g., wildlife trees for fisher), stick nests, wetland features, high quality foraging areas, mineral licks, escape terrain, high quality winter range, winter cover, and calving range.

See Table 32 for specific monitoring and pre-construction survey recommendations

Establish Buffers

Where practicable, important habitat features, including wetlands, riparian areas, den sites, mineral licks, natural meadows, high quality foraging habitats identified in pre-construction surveys will be buffered. Appropriate buffer distances will be assessed by a qualified professional.

- Implement a no-shooting zone within 500 m of the highway;
- Implement a 1-week voluntary hunting closrure along the highway (including 8 km on either side) to permit lead animals (e.g., boreal caribou) to pass;
- Prohibit the use of non-construction off-road vehicle use year round except for snowmobiles once the ground freezes, and once the road is covered by snow (this should include 8 km on either side of the highway);
- Implement minimum buffer distances around lake shorelines, which may be important habitat for staging birds; and
- Implement minimum buffers around active nests and den sites.

See Table 32 for suggested buffer distances.

Timing Considerations

Avoid clearing and construction activities during bird nesting and fledging season (May 1 to July 31) in all habitat types as per the Migratory Birds Convention Act and the NWT Wildlife Act. Avoid clearing and construction activities in proximity to important terrestrial wildlife habitats in important seasons. For example avoid construction activities in proximity to caribou winter range in late winter.

Nest-clearing Surveys

If tree-clearing activities are scheduled during the breeding bird nesting period (May 1 to July 31), nest clearing surveys using a standardized protocol such as the Active Migratory Bird Nest Survey (EC, undated) will be implemented immediately prior to clearing activities.

Minimize Wildlife Interactions

Provide training for construction workers in techniques for avoiding interactions (particularly safe disposal of food and garbage waste), and for proper conduct during an unavoidable interaction. Proper conduct includes not interfering with wildlife natural processes such as feeding on a natural food source, hunting and traveling.

### Monitor Wildlife Vehicle Collisions

As the alignment will likely not be able to avoid important wildlife habitat, especially for moose, the incidence of wildlife collisions should be monitored for a number of years post construction. If the number of collisions warrants action, steps may be require to reduce collisions, especially in winter periods.

### Identify Important Habitats Adjacent to the Alignment

The available information documenting important wildlife habitats requires field confirmation of habitat locations in relation to the alignment to support mitigation for interactions between the vehicles and wildlife, and final location of the alignment.

Table 32 provides a summary of the potential impacts on wildlife by species associated mitigation measures that have been recommended above.

Table 32: Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Woodland caribou (boreal population) | Habitat loss or alteration<br>Habitat fragmentation | ▸ Remain as far as possible from lakes to minimize disturbance to animals and/or create visual barriers to reduce hunter visibility from the highway<br>▸ Avoid open, mature spruce habitat, peatland complexes, lakes and ponds with abundant ground and tree lichen.<br>▸ Highblade to protect duff layer during freezing conditions | ▸ Monitor the presence of caribou where clearing and construction cannot be avoided. Ensure real-time locations are reported to construction crews and other appropriate authorities/Project staff.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop | ▸ SARA Schedule 1<br>▸ NWT Department of Natural Resources. 2010. Action Plan: Boreal Woodland Caribou in the Northwest Territories (2010-2015).<br>▸ Environment Canada. 2011. Recovery Strategy for Woodland Caribou (Rangifer tarandus caribou), | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Where possible, avoid clearing and construction when caribou are present (November to May).<br>▸ Cease construction and clearing activities when caribou are present, when Project activities cannot be re-scheduled.<br>▸ Increase staff awareness through education on ways to minimize interaction with and habituation of wildlife.<br>▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| | Direct mortality (wildlife collision)<br>Indirect mortality (increased hunting and poaching kills) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway.<br>▸ Implement a 1 week voluntary hunting closure along the highway (including 8 km on either side) to permit lead animals to pass. | appropriate wildlife habitat avoidance mitigation. | Boreal Population in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 55 pp. | |
| Moose | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Avoid locating lay-down areas on and creating winter access to wetland edges or riparian areas and in proximity to important habitats or habitat features.<br>▸ Implement a pre-determined minimum buffer distance around lake shorelines.<br>▸ Minimize the number of riparian crossings. | ▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable.<br>▸ Increase staff awareness through education on ways to minimize interaction with and habituation of wildlife. | | | |
| | Direct mortality (wildlife collision)<br>Indirect mortality (increased hunting and poaching kills) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway.<br>▸ Implement a 1 week voluntary hunting closure along the highway (including 8 km on either side) to permit lead animals to pass. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Grizzly bear | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Minimize disturbance to material sources.<br>▸ Implement a minimum 800 m horizontal setback from seasonally important habitat at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around identified seasonally important habitat from September 1 to May 1 (carnivore denning season). | ▸ Report all wildlife collision mortalities.<br>▸ Conduct seasonally important grizzly bear habitat surveys (to determine if active) in the fall preceding construction or site preparation disturbance.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Implement a minimum 800 m horizontal setback from seasonally important habitat at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around identified seasonally important habitat from September 1 to May 1 (carnivore denning season).<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife.<br>▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable. | | | |
| | Direct mortality (wildlife collision)<br>Indirect mortality (increased hunting, poaching and problem kills) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway.<br>▸ Implement a 1 week voluntary hunting closure along the highway (including 8 km on either side) to permit lead animals to pass.<br>▸ Maintain a clean work site by providing proper disposal receptacles for food and waste. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Wolverine | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Minimize disturbance to material sources.<br>▸ Implement a minimum 800 m horizontal setback from den at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around an active den site from September 1 to May 1 (carnivore denning season). | ▸ Report all wildlife collision mortalities.<br>▸ Conduct den surveys (to determine if active) in the fall preceding construction or site preparation disturbance.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Implement a minimum 800 m horizontal setback from den at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around an active den site from September 1 to May 1 (carnivore denning season).<br>▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable.<br>▸ Maintain a clean work site by providing proper disposal receptacles for food and waste.<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |
| | Direct mortality (wildlife collision)<br>Indirect mortality (clearing and site preparation) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| American marten | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Minimize disturbance to material sources.<br>▸ Implement a minimum 800 m horizontal setback from den at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around an active residence site from September 1 to May 1 (carnivore denning season). | ▸ Conduct residence surveys (to determine if active) in the fall preceding construction or site preparation disturbance.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Implement a minimum 800 m horizontal setback from den at all times of the year.<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around an active residence site from September 1 to May 1 (carnivore denning season).<br>▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable.<br>▸ Maintain a clean work site by providing proper disposal receptacles for food and waste.<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |
| | Direct mortality (wildlife collision)<br>Indirect mortality (clearing and site preparation) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Beaver | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Avoid altering natural drainage conditions (water quality and quantity) | ▸ Conduct lodge surveys (to determine if active) in the fall preceding construction or site preparation disturbance.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable. | | | |
| | Indirect mortality (clearing and site preparation) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway. | | | |
| Muskrat | Habitat loss or alteration.<br>Habitat fragmentation. | ▸ Avoid altering natural drainage conditions (water quality and quantity) | ▸ Conduct residence surveys (to determine if active) in the fall preceding construction or site preparation disturbance.<br>▸ Identify important habitat adjacent to the alignment through field confirmation to further develop appropriate wildlife habitat avoidance mitigation. | ▸ None | Year-round, especially winter (November to May) |
| | Sensory disturbance (auditory, visual or olfactory) | ▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable. | | | |
| | Indirect mortality (clearing and site preparation) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Endorse a no-shooting zone within 500 m of the highway. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Common nighthawk | Habitat loss or alteration. | ▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Maintain a clean work site by providing proper disposal receptacles for food and waste. | ▶ Conduct breeding bird and nest surveys (to determine presence of active nests) prior to scheduled clearing and construction activities (May to August). | ▶ Migratory Birds Convention Act<br>▶ SARA Schedule 1 | Spring, summer and fall. |
| | Sensory disturbance (during nesting and fledging) | ▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |
| Horned grebe | Habitat loss or alteration, particularly changes in water quality and quantity. | ▶ Remain as far as possible from lakes to minimize disturbance to nesting birds.<br>▶ Minimize riparian crossings.<br>▶ Implement a minimum 250 m setback from waterfowl nesting and staging areas, i.e., lakes and wetlands.<br>▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31. | ▶ Conduct nest surveys (to determine if nesting habitat) prior to scheduled clearing and construction activities (May to August). | ▶ Migratory Birds Convention Act | Spring, summer and fall. |
| | Sensory disturbance (during nesting and fledging). | ▶ Remain as far as possible from lakes to minimize disturbance to nesting birds.<br>▶ Minimize riparian crossings.<br>▶ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| | Direct mortality from vehicles and/or construction equipment and machinery.<br>Indirect mortality (nest disturbance, increased hunting) | ▶ Implement a minimum 250 m setback from waterfowl nesting and staging areas, i.e., lakes and wetlands.<br>▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Endorse a no-shooting zone within 500 m of the highway. | | | |
| Olive-sided flycatcher | Habitat loss or alteration. | ▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Avoid open, mature spruce habitat, peatland complexes which provide nesting habitat. | ▶ Conduct breeding bird and nest surveys (to determine presence of active nests) prior to scheduled clearing and construction activities (May to August). | ▶ Migratory Birds Convention Act<br>▶ SARA Schedule 1 | Spring, summer and fall. |
| | Disturbance during nesting and fledging. | ▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Avoid open, mature spruce habitat, peatland complexes which provide nesting habitat. | | | |
| | Direct mortality from vehicles and/or construction equipment and machinery.<br>Indirect mortality (nest disturbance) | ▶ Prohibit clearing and construction within a pre-determined radial buffer around active nests from May 1 to July 31.<br>▶ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Peregrine falcon (*anatum* and *tundrius* subspecies) | Habitat loss or alteration. | ▸ Prohibit clearing and construction within a 1 km radius of an active nest site between March 1 and July 31.<br>▸ Implement a 500 m buffer outside of the nesting and fledging season (i.e., March 1 to July 31).<br>▸ Aircraft minimum altitude is 650 m when flying over habitat likely to support raptor nesting (March to August).<br>▸ Highway footprint design should implement a 1 km buffer from all known nests.<br>▸ Maintain a clean work site by providing proper disposal receptacles for food and waste.<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | ▸ Report all wildlife collision mortalities.<br>▸ Conduct raptor nesting surveys (to determine if active) prior to scheduled clearing and construction activities (March to August). | ▸ Migratory Birds Convention Act<br>▸ SARA Schedule 1 (anatum)<br>▸ SARA Schedule 3 (tundrius) | March 1 to July 31 |
| | Disturbance during nesting and fledging. | ▸ Prohibit clearing and construction within a 1 km radius of an active nest site between March 1 and July 31.<br>▸ Implement a 500 m buffer outside of the nesting and fledging season (i.e., March 1 to July 31).<br>▸ Aircraft minimum altitude is 650 m when flying over habitat likely to support raptor nesting (March to August).<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| | Direct mortality from vehicles and/or construction equipment and machinery.<br>Indirect mortality (nest disturbance) | ▸ Report all wildlife collision mortalities.<br>▸ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▸ Maintain a clean work site by providing proper disposal receptacles for food and waste.<br>▸ Endorse a no-shooting zone within 500 m of the highway.<br>▸ Prohibit clearing and construction within a pre-determined radial buffer from May 1 to July 31 if active nests are located. | | | |
| Rusty blackbird | Habitat loss or alteration, particularly changes in water quality and quantity. | ▸ Prohibit clearing and construction within a pre-determined radial buffer from May 1 to July 31 if active nests are located.<br>▸ Avoid locating lay-down areas on and creating winter access to wetland edges or riparian areas and in proximity to important habitats or habitat features.<br>▸ Implement a pre-determined minimum buffer distance around lake shorelines.<br>▸ Minimize the number of riparian crossings . | ▸ Conduct breeding bird and nest surveys (to determine presence of active nests) prior to scheduled clearing and construction activities (May to August). | ▸ Migratory Birds Convention Act<br>▸ SARA Schedule 1 | Spring, summer and fall |
| | Disturbance during nesting and fledging. | ▸ Prohibit clearing and construction within a pre-determined radial buffer from May 1 to July 31 if active nests are located.<br>▸ Avoid locating lay-down areas on and creating winter access to wetland edges or riparian areas and in proximity to important habitats or habitat features.<br>▸ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| | Direct mortality from vehicles and/or construction equipment and machinery<br>Indirect mortality (nest disturbance). | ▶ Prohibit clearing and construction within a pre-determined radial buffer from May 1 to July 31 if active nests are located. | | | |
| Short-eared owl | Habitat loss and alteration | ▶ Minimize the footprint in shrub meadows and open black spruce habitats.<br>▶ Avoid clearing and construction between (May 1 to July 31) within a pre-determined radial buffer around an active nest site. | ▶ Report all wildlife collision mortalities.<br>▶ Conduct nesting surveys (to determine if active) prior to scheduled clearing and construction activities (May to August). | ▶ Migratory Birds Convention Act<br>▶ SARA Schedule 3 | March 1 to July 31 |
| | Nest disturbance during nesting and fledging during construction and operation. | ▶ Minimize the footprint in shrub meadows and open black spruce habitats.<br>▶ Avoid clearing and construction between (May 1 to July 31) within a pre-determined radial buffer around an active nest site.<br>▶ Increase staff awareness by through education on ways to minimize interaction with and habituation of wildlife. | | | |
| | Direct mortality from vehicles and/or construction equipment and machinery.<br>Indirect mortality (nest disturbance). | ▶ Report all wildlife collision mortalities.<br>▶ Provide road signs to indicate sensitive areas and/or wildlife crossing.<br>▶ Endorse a no-shooting zone within 500 m of the highway.<br>▶ Minimize the footprint in shrub meadows and open black spruce habitats.<br>▶ Avoid clearing and construction between (May 1 to July 31) within a pre-determined radial buffer around an active nest site. | | | |

Table 32 (cont'd): Summary of Wildlife Impacts and Proposed Mitigation

| VEC | POTENTIAL IMPACTS TO WILDLIFE | PROPOSED MITIGATION MEASURES | PROPOSED MONITORING | LEGISLATION AND RECOVERY PLANS | SENSITIVE TIMING WINDOWS |
|---|---|---|---|---|---|
| Amphibians | Habitat loss or alteration, particularly changes in water quality and quantity. | ▸ Avoid locating lay-down areas on and creating winter access to wetland edges or riparian areas and in proximity to important habitats or habitat features.<br>▸ Minimize the number of riparian crossings. | ▸ Conduct pre-construction survey to confirm the presence of important habitat features for amphibians. | ▸ None | Year-round |

### 7.2.3.3 Fish and Fish Habitat

#### 7.2.3.3.1 Potential Impacts on Fish and Fish Habitat

Potential Construction Impacts and Mitigation

Construction activities and physical works that have the potential to affect aquatic resources have been generally identified for the Project. These activities include:

- Vegetation clearing and site preparation;
- Blasting activities (where necessary);
- Road construction (including bridge approaches);
- Bridge construction;
- Culvert installation;
- Construction traffic / use of heavy equipment;
- Preparation, use and clean-up of ancillary construction areas (quarry development);
- Water extraction; and
- Construction workforce access.

Table 33 below presents the potential impacts associated with each of the construction phase activities listed above. Avoidance and / or mitigation measures that could be utilized to prevent or minimize these impacts are also described.

Table 33: Potential Impacts from Project Construction on Fish and Fish Habitat

| PROJECT ACTIVITY AND PHYSICAL WORKS | POTENTIAL IMPACT | AVOIDANCE / MITIGATION MEASURES |
|---|---|---|
| Construction Phase | | |
| Vegetation clearing and site preparation | ▸ Habitat loss due to changes in habitat quality from loss of riparian vegetation and changes to stream bank stability.<br>▸ Direct impacts to water quality due to changes in sediment load.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality. | ▸ Minimize disturbance to the riparian area.<br>▸ Promptly revegetate exposed soils.<br>▸ Ensure runoff containing suspended sediment does not enter watercourses by implementing erosion prevention and sediment control measures. |
| Blasting activities | ▸ Direct impacts to fish and / or incubating eggs due to changes in water pressure during blasting.<br>▸ Direct impacts to water quality due to fly rock and toxic by-products entering watercourses.<br>▸ Direct impacts to water quality due to changes to sediment loads.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality. | ▸ Follow guidelines described in Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky, 1998) during blasting activities near fish-bearing waters.<br>▸ Ensure runoff containing blast residues and / or sediment does not enter watercourses. |
| Road construction | ▸ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▸ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality. | ▸ Avoid critical habitat.<br>▸ Ensure runoff containing suspended sediment does not enter watercourses by implementing erosion prevention and sediment control measures.<br>▸ Limit the extent of riparian vegetation clearing.<br>▸ Promptly revegetate exposed soils.<br>▸ Establish spill prevention and response protocols. |

Table 33 (cont'd): Potential Impacts from Project Construction on Fish and Fish Habitat

| PROJECT ACTIVITY AND PHYSICAL WORKS | POTENTIAL IMPACT | AVOIDANCE / MITIGATION MEASURES |
|---|---|---|
| Bridge construction | ▸ Mortality of fish and / or incubating eggs due to instream works.<br>▸ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality.<br>▸ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials. | ▸ Avoid critical habitat.<br>▸ Minimize the duration of instream activities.<br>▸ Do not site structures in unstable stream bank areas.<br>▸ Limit extent of riparian vegetation clearing.<br>▸ Promptly revegetate exposed soils.<br>▸ Follow guidelines described in DFO's NWT Operational Statement, Timing Windows (DFO, 2007a) to avoid instream works during sensitive periods.<br>▸ Apply measures listed in DFO's NWT Operational Statement on Clear-Span Bridges (DFO, 2007b) where possible.<br>▸ Implement erosion prevention and sediment control measures.<br>▸ Establish spill prevention and response protocols.<br>▸ Require the presence of an independent Environmental Monitor during all instream works. |
| Culvert installation | ▸ Mortality of fish and / or incubating eggs due to culvert installation.<br>▸ Habitat loss due to culvert footprint.<br>▸ Habitat loss due to changes in migration / access to instream habitats.<br>▸ Habitat loss due to changes in streamflow.<br>▸ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▸ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes water quality. | ▸ Avoid critical habitat.<br>▸ Minimize the duration of instream activities.<br>▸ Follow best management practices for culvert installation such as those described in Land Development Guidelines for the Protection of Aquatic Habitat (DFO, 1993).<br>▸ Follow guidelines described in DFO's NWT Operational Statement, Timing Windows (DFO, 2007a), to avoid instream works during sensitive periods.<br>▸ Implement erosion prevention and sediment control measures.<br>▸ Require the presence of an independent Environmental Monitor during all instream works. |

Table 33 (cont'd): Potential Impacts from Project Construction on Fish and Fish Habitat

| PROJECT ACTIVITY AND PHYSICAL WORKS | POTENTIAL IMPACT | AVOIDANCE / MITIGATION MEASURES |
|---|---|---|
| Construction traffic / use of heavy equipment | ▶ Mortality of fish and / or incubating eggs due to instream works.<br>▶ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▶ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▶ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes water quality. | ▶ Implement erosion prevention and sediment control measures.<br>▶ Establish spill prevention and response protocols.<br>▶ Follow guidelines described in DFO's NWT Operational Statement, Timing Windows (DFO, 2007a), to avoid Instream works during sensitive periods.<br>▶ Restrict areas where heavy equipment may operate to avoid critical habitat. |
| Preparation, use and clean-up of ancillary construction areas (quarry development) | ▶ Habitat loss due to changes in habitat quality from loss of riparian vegetation.<br>▶ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▶ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▶ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes water quality. | ▶ Locate quarry sites appropriately to avoid watercourses.<br>▶ Implement erosion prevention and sediment control measures (such as sediment control basins).<br>▶ Establish spill prevention and response protocols. |
| Water extraction | ▶ Habitat loss due to changes in overwintering habitat quality.<br>▶ Mortality of fish and / or incubating eggs due to water extraction activities. | ▶ Follow guidelines described in DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut (DFO, 2010), during water extraction activities. |
| Construction workforce access | ▶ Mortality of fish due to changes in angling pressure from increased road use and construction worker access. | ▶ Public education.<br>▶ No-fishing policy for construction workers. |

**Stream Crossing Types**

For large watercourses and streams with high fish habitat value, clear span bridges are the preferred crossing structure, to minimize potential impacts to fisheries resources (DFO, 1993). Clear span bridges can allow for: (1) maintenance of riparian vegetation and channel bottom substrate, (2) reduced footprint size, and (3) unrestricted / natural bed load movement and stream flow thus allowing for natural fish passage capacity. Depending on the habitat characteristics of a particular watercourse, large open bottom (arch) culverts can be designed and installed that also do not limit fish passage. Similar to a clear-span bridge, an open bottom culvert can allow for retention of natural channel bottom substrate and water velocities, which may be appropriate for some fish-bearing watercourses. However, installation of any culvert structure can result in loss of riparian vegetation due to infilling around the culvert and is not appropriate for large watercourses or areas of high fish habitat value.

Standard corrugated steel pipe (CSP) culverts have the potential to inhibit fish migration (DFO, 1993). Installation of CSP culverts can concentrate stream flows increasing water velocity through the culvert. Additionally, they can result in loss of riparian vegetation and the natural stream bottom and have the ability to restrict bed load transport. Thus, standard CSP culverts are not generally appropriate for areas of moderate to higher fish habitat value. Regardless of the type of culvert that is selected for installation at a given watercourse crossing, certain conditions must be preserved at the crossing location. These conditions include: minimizing culvert length, providing appropriate outlet pools, maintaining minimum water levels, limiting culvert grades, and limiting water velocities within the culvert (DFO, 1993).

The fish and fish habitat data for this stretch of the Mackenzie Highway are 12 years old. This data will be updated from studies which will be conducted in spring/early summer 2012, prior to finalizing the preferred crossing structure and its final design, to ensure that appropriate consideration and criteria are used to avoid or minimize impacts to fish and fish habitat.

**Riparian Setbacks**

Healthy riparian ecosystems can protect water quality, stabilize banks, regulate water temperatures, provide nutrient inputs to aquatic habitats, and create cover for fish and other aquatic organisms (BC MOF, 1995; DFO, 1993). DFO recommends that leave strips be provided for “all watercourses that flow into or contain fish or fish habitat. This may include wetlands, ponds, swampy areas or other intermittently wetted areas, small streams, side channels and ditches which may not flow throughout the entire year” (DFO, 1993). The proposed highway alignment will pass within 100 m of several suspected wetland areas, and unclassified water bodies. The potential impacts on fish and fish habitat of encroachment of the highway alignment into the riparian areas surrounding these features include:

- Habitat loss due to changes in habitat quality from loss of riparian vegetation and changes to bank stability;
- Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials;
- Direct impacts to fish and / or incubating eggs due spills of hydrocarbons or hazardous materials;
- Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality.

The most effective measure to prevent impacts on fish and fish habitat from encroachment into the riparian area is avoidance of these areas. Where alternatives exist, the highway should be routed to maintain a maximum distance from wetlands, lakes and streams. Appropriate riparian setbacks that have been identified for the protection of riparian ecosystems and aquatic habitat can range from 10 to 30 m in width for lakes, to 30 to 50 m for wetlands, and from 20 to 100 m for streams and rivers (BC MOF, 1995). The appropriate setback distance for each feature (i.e. wetland, lake, stream) will be determined by a qualified professional once the ecological value and function of the feature has been determined following upcoming studies in spring/early summer 2012.

**Surface Erosion and Sediment Control**

Surface erosion prevention and sediment control measures should be developed and incorporated as part of the construction portion of the Project, when ground disturbance of native soils can be extensive, thus increasing the risk for potential sediment releases into local watercourses. The objective of these measures is to protect water quality within the Project footprint, which indirectly protects downstream fisheries and aquatic resources. Key erosion and sediment control measures will incorporate elements from best management practices for bridge and road construction and culvert installation. These mitigation measures can generally include:

- Removal of excavated material and debris from excavation locations and placement in a stable area above the high-water mark (HWM) or active floodplain of any watercourse, as far as possible from the channel, and outside riparian areas;
- Implementation of land-based erosion prevention measures and proper and responsible construction practices to minimize potential for sediment release to watercourses;
- Presence of a qualified and independent Environmental Monitor on-site during construction;
- Ongoing effectiveness monitoring of sediment and erosion mitigation.

Clearing of vegetation in riparian areas can disrupt native soil material, thus increasing the erosion processes, potentially increasing the sediment load into nearby watercourses and affecting water quality. It is recognized that vegetation clearing within riparian areas may be necessary during the construction phase of the Project. In order to mitigate this activity, the extent of riparian vegetation clearing near watercourses should be minimized to the greatest extent possible, and where appropriate use of sediment control methods (e.g. filtration systems). Site specific vegetation management specifications can be planned and developed to address key construction (and to a lesser extent operation) activities to ensure riparian clearing is minimized and performed responsibly. Information to be integrated in such a framework may include:

- Identification and description of key activity-specific mitigation measures that will be implemented during vegetation clearing activities;
- Maps that establish the limits of clearing;
- A process for ensuring key personnel tasked with clearing understand the clearing limits before activities commence;
- A description of the methods that will be used for vegetation clearing and grubbing;
- A post-construction revegetation plan, as appropriate.

Construction traffic on the highway could introduce sediments (and dust) into the watercourses thus directly affecting water quality. Potential impacts of construction traffic at the watercourse crossings can be minimized if bridge decks are cleaned and maintained in a manner that does not allow excess mud and debris to fall off the bridges and into watercourses. The implementation of dust control measures to address sections of the highway near specific watercourses will aid in mitigating the combination of high traffic load and excessively dry dusty road conditions, in specific seasons, during the construction phase of the proposed Project. This will minimize excessive dust plumes and will aid in preventing dust from settling in watercourses or smothering nearby riparian vegetation. Additionally, high quantities of fine surface material can be readily transported during rain events, which ultimately may enter nearby watercourses. Mitigation measures to prevent sedimentation during rain events may consist of avoiding use of heavy machinery during rain events, minimizing disturbance of riparian areas, prompt revegetation of exposed soils, and implementation of sediment control measures (e.g. sediment retention basins, check dams, silt fencing).

Blasting activities may be necessary during the construction phase of the Project. Fly rock and other debris from blasting activities could introduce debris and sediment into the water that may indirectly affect aquatic biota.  Blasting activities, although temporary, can affect fish and fish habitat at considerable distances from the point of detonation. To mitigate potential impacts, criteria from the DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky, 1998) should be proactively implemented early on in the planning phase of the Project, where applicable.

**Water Extraction**

It is proposed that water required for the construction of the highway be withdrawn from lakes in the vicinity of the construction area. However, water extraction has the potential to directly affect fish and fish habitat and is considered by DFO to be a critical issue in the Northwest Territories and Nunavut (DFO, 2010). These impacts can include mortality, oxygen depletion, and loss of over-wintering and littoral habitat. As such, DFO has developed a protocol that provides standardized guidance to water users. The Protocol for Winter Water Withdrawal from Ice-covered Water bodies in the Northwest Territories and Nunavut (DFO, 2010) should be adhered to for all water extraction activities. Any water body from which more than 100 $m^3$ of water is to be withdrawn over the course of one ice-covered period falls under the limits outlined in the protocol. In addition, DFO's Freshwater Intake End-of-Pipe Fish Screen Guideline should be followed to prevent potential entrainment or impingement of fish (DFO, 1995).

Potential Operational Impacts and Mitigation

The potential for the proposed Project to affect fish and fish habitat is diminished during highway operations and is generally limited to maintenance works. DFO's NWT Operational Statements on Bridge Maintenance (DFO, 2007d) and Culvert Maintenance (DFO, 2007e) should be adhered to during any maintenance of these structures. Additionally, any instream works (where necessary) should be conducted with a qualified and independent Environmental Monitor present and should be carried out in an appropriate timeframe (and applicable permits in place) to avoid sensitive periods. Culverts should be monitored for subsidence or lifting that could potentially impede fish migration.

Vegetation maintenance within riparian areas may be necessary during maintenance works. Maintenance of vegetation in riparian areas can disrupt native soil material, potentially increasing the sediment load in nearby watercourses, affecting water quality. To avoid potential impacts on aquatic resources resulting from vegetation maintenance, the measures outlined in DFO's NWT Operational Statement, Maintenance of Riparian Vegetation in Existing Rights-of Way (DFO, 2007c) should be followed. Additionally, grubbing should not occur during maintenance works. Root structures should be left in place to maintain soil stability and aid in erosion prevention.

Potential impacts from Project operation, as well as recommended avoidance and mitigation measures, are summarized in Table 34, below.

Table 34: Potential Impacts from Project Operation on Fish and Fish Habitat

| PROJECT ACTIVITY AND PHYSICAL WORKS | POTENTIAL IMPACT | AVOIDANCE / MITIGATION MEASURES |
|---|---|---|
| Operations Phase | | |
| Road maintenance | ▸ Habitat loss due to changes in habitat quality from loss of riparian vegetation. | ▸ Follow guidelines described in DFO's NWT Operational Statement, Maintenance of Riparian Vegetation in Existing Rights-of Way (DFO, 2007c), during road right of way maintenance activities. |
| Bridge maintenance | ▸ Habitat loss due to changes in habitat quality from loss of riparian vegetation.<br>▸ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▸ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes water quality. | ▸ Follow guidelines described in DFO's NWT Operational Statement, Bridge Maintenance (DFO, 2007d), during bridge maintenance activities.<br>▸ Implement erosion prevention and sediment control measures.<br>▸ Follow guidelines described in DFO's NWT Operational Statement, Timing Windows (DFO, 2007a), to avoid instream works during sensitive periods.<br>▸ Require the presence of a qualified and independent Environmental Monitor during all instream works. |
| Culvert maintenance | ▸ Habitat loss due to changes in habitat quality from loss of riparian vegetation.<br>▸ Habitat loss due to changes in migration / access to instream habitats.<br>▸ Direct impacts to water quality due to changes in sediment load and / or spills of hydrocarbons or hazardous materials.<br>▸ Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials.<br>▸ Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes water quality. | ▸ Follow guidelines described in DFO's NWT Operational Statement, Culvert Maintenance (DFO, 2007e), during culvert maintenance activities.<br>▸ Monitor culverts for subsidence or lifting that could lead to the potential creation of a barrier to fish movement.<br>▸ Implement erosion prevention and sediment control measures.<br>▸ Follow guidelines described in DFO's NWT Operational Statement, Timing Windows (DFO, 2007a), to avoid instream works during sensitive periods.<br>▸ Require the presence of a qualified and independent Environmental Monitor during all instream works. |
| Road use / public access | ▸ Mortality of fish due to changes in angling pressure from increased road use and public access. | ▸ Public education. |

Monitoring

A Construction Environmental Management Plan (CEMP) should be developed for the Project, prior to the commencement of construction, which outlines the environmental obligations set out for the Project during the construction phase.  The CEMP provides the framework for the development and implementation, by the contractors, of Environmental Protection Plans (EPPs) for carrying out construction works in a manner that meets the environmental objectives of the Project.  EPPs for construction activities with the potential to impact fish and fish habitat resources such as those listed in Table 34 (e.g. culvert installation, bridge construction) should refer to and follow environmental best management practices for working in and around aquatic habitats such as the Land Development Guidelines for the Protection of Aquatic Habitat (DFO, 1993).

Compliance monitoring, by qualified independent Environmental Monitors, is key to ensuring that mitigation measures and best management practices are being implemented as required and that measures are functioning to protect the environment as intended.  Compliance monitoring will be conducted by appropriately trained monitors who will identify non-compliance and detect any unforeseen issues that may impact the environment or lead to non-compliance. Every effort should be made to hire monitors from the PKFN, and as required support members with appropriate training to encourage longer term management of the fisheries resources for the highway.

Specific monitoring tasks that apply to fish and fish habitat resources include:

- Monitoring all instream works including bridge construction and culvert installation activities;
- Ongoing effectiveness monitoring of sediment and erosion mitigation;
- Monitoring installed culverts for subsidence or lifting that could lead to the creation of a barrier to fish movement.

#### *7.2.3.3.2 Summary of Mitigation for Potential Impacts on Fish and Fish Habitat*

The following are a general summary of proposed recommended mitigation measures to be considered during both construction and use (operations) of the highway crossings. Studies will be conducted in spring/early summer 2012 on the portions of the alignment (i.e. approximately 17 potential crossings identified at this point) that have not yet been field investigated for fish presence and habitat (riparian and aquatic) quality as well as for existence of other key features (i.e. wetlands), which may support important aquatic values in the vicinity of the Project. Field assessments will be conducted to characterize existing baseline conditions, in order to confirm the appropriate use/implementation of mitigation measures.

### Mitigation Measures for Project Construction

Mitigation during construction will benefit from development and implementation of a CEMP that integrates the following mitigation into construction practices and provides environmental protection plans.

1. Follow guidelines and BMPs applicable to work in and around watercourses, including:
   - DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut (DFO, 2010);
   - DFO's Freshwater Intake End-of-Pipe Fish Screen Guideline;
   - DFO's NWT Operational Statement, Timing Windows (DFO, 2007a);
   - DFO's NWT Operational Statement on Clear-Span Bridges (DFO, 2007b);
   - Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky, 1998);
   - Land Development Guidelines for the Protection of Aquatic Habitat (DFO, 1993).
2. Locate structures and work areas to avoid any known fish habitat or habitats that may be identified in pre final design site assessments of fish habitat. Measures to avoid fish habitat may include:
   - Selecting an appropriate watercourse crossing structure for habitat conditions present at each watercourse crossing location;
   - Restricting areas where heavy equipment may operate;
   - Avoiding unstable stream bank areas;
   - Planning and locating quarry sites or other ancillary areas appropriately to avoid watercourses.
3. Establish spill prevention and response protocols.
4. Minimize the duration of instream activities and require the presence of an independent Environmental Monitor during all instream works.
5. Minimize disturbance to the riparian area.
6. Promptly revegetate exposed soils.
7. Ensure sediment-laden runoff does not enter watercourses by implementing erosion prevention and sediment control measures.
8. Ensure runoff containing blast residues and / or sediment does not enter watercourses.
9. Implement a no-fishing policy for construction workers.

Mitigation Measures for Project Operations

1. Follow guidelines and BMPs applicable to work in and around watercourses, including:
   - DFO's NWT Operational Statement, Timing Windows (DFO, 2007a)
   - DFO's NWT Operational Statement, Maintenance of Riparian Vegetation in Existing Rights-of Way (DFO, 2007c);
   - DFO's NWT Operational Statement, Bridge Maintenance (DFO, 2007d);
   - DFO's NWT Operational Statement, Culvert Maintenance (DFO, 2007e), if/where culverts are installed;
2. Implement erosion prevention and sediment control measures.
3. Require the presence of a qualified and independent Environmental Monitor during all instream works.
4. Monitor culverts for subsidence or lifting that could lead to the potential creation of a barrier to fish movement.

### 7.2.4 Socioeconomic Components

The assessment of potential socioeconomic impacts is focused on the community of Wrigley, located at the southernmost point of the propsed MVH extension. There are no other permanent settlements located along the proposed alignment in the Pehdzeh Ki Ndeh - Dehcho region; however, some economic, cultural and recreational activities that take place along the Mackenzie River may be impacted. In many cases, the possible impacts are positive and will likely be beneficial to the community. In these cases, optimization measures are proposed to ensure the benefits are experienced by the community and where possible, further enhance the potential benefits.

A key source of information included in this section is the "Project Description Report for the Construction of the Mackenzie Valley Highway Gwich'in Settlement Area" (Gwich'in, 2011) produced by the Gwich'in Tribal Council in anticipation of the proposed segment of the MVH extension through their territory. The Gwich'in PDR provides a detailed summary of two recent studies focused on the economic impact analyses and subsequent opportunities available from the proposed highway. The highlights of the two studies are presented below along with a discussion of other general anticipated benefits and impacts of the MVH extension to the Pehdzeh Ki Ndeh - Dehcho Region and the community of Wrigley.

### 7.2.4.1 Demography

#### 7.2.4.1.1 Potential Impacts on Territory and Population Density

It is anticipated that the construction of the MVH extension will result in increased access to the community of Wrigley and an increased number of persons passing through the community throughout the year. The improved accessibility to the community of Wrigley and traditional territory of the Dehcho people could result in Dehcho territorial lands being acquired by outside investors, such as resource development companies. There is potential for a shift in development patterns in the region. The potential loss of land and access to the land itself may result in significant adverse impacts to Dehcho culture, communities and the generations.

There is also potential for an increase in population density throughout the region as the all weather road will provide year-round access to existing towns and previously remote areas of the Mackenzie Valley. However, population density is expected to remain very low.

#### 7.2.4.1.2 Potential Impacts on Population

By 2025, it is anticipated the current population of Wrigley (113 persons in 2010) will grow minimally to 115 persons (Bureau of Statistics, 2010). However, with the development of the all weather road, there is potential for a greater increase in population in Wrigley and throughout the Pehdzeh Ki Ndeh - Dehcho Region. Given the level of out-migration that has occurred in Wrigley since 1996, any marginal increase in population, such as that related to the Project, could be be considered a positive effect of the Project as a growing population will lead to increased economic activities in the area. As part of the construction of the MVH project, it is likely that there will be a temporary peak in local population due to the presence of workers.

While there is potential for growth of the local community due to the all-weather road, there is also increased potential for out-migration. It has been noted by community members of Wrigley that the MVH extension project may cause an increase in the gender imbalance within the community. It is believed that the construction of the all-weather road will increase the opportuniies for out-migration from the community, particularly of women. This may be due to the presence of a predominantly male population of workers, who will temporarily reside in the area, who may develop relationships with residents of local communities. It may also be a result of increased accessibility to other communities, and therefore increased accessibility to jobs, facilities and other points of interest.

#### 7.2.4.1.3 Potential Impacts on Language, History and Cultural Identity

Migration in and out of local communities and the presence of foreign workers may impact the dynamics and relationships within families, towns, and across the territory. With the all-weather road, there are both increased opportunities for outward migration of the local population and the potential for foreign employees and their families to populate the region both temporarily and on a longer-term basis. There is also increased potential for residents from other villages in the Mackenzie Valley to relocate. These changes in community members and new dynamics and relationships may adversely impact the traditional language and cultural identity of the Pehdzeh Ki Ndeh - Dehcho region and the community of Wrigley in particular. Traditional practices may be affected as well.

##### 7.2.4.1.4 *Mitigation of Potential Impacts on Demography*

In order for Wrigley to respond positively to potential impacts related to demographic change, consideration of the development of local community infrastructure and programs will help to minimize impacts. Examples of such mitigation measures include:

- Ensure the Dehcho people have access to traditional territories and resources;
- Ensure cultural and community facilities are unaffected and/or enhanced by the project;
- Ensure that local infrastructure has the capacity to respond to potential population growth (including both temporary peaks in population and long-term growth);
- Ensure language and cultural education are included in school curriculums;
- Encourage development of community programs supporting local women to further develop connections within the community and promote educational and economic opportunities;
- Support the training and development of young people (i.e construction and engineering) so they are in place to lead the required labour force. The community of Wrigley must also utilize their own community work force leaders as mentors and develop opportunities in the community.

#### 7.2.4.2 *Socioeconomic*

In September 2009, Pacific Analytics Inc. and Terra-Firma Consultants prepared the "Mackenzie Valley All-Weather Road Economic Analysis" for the Government of the Northwest Territories Department of Transportation (DOT, 2009). As acknowledged by the Gwich'in PDR, this analysis provided a comprehensive study that quantified the various economic impacts of the Mackenzie All-Weather Road (AWR) (The MVH Extension). The following sections provide a summary of the 2009 Mackenzie Valley All-Weather Road Economic Analysis produced by the DOT.

Since certain economic impacts are directly related to the dollars invested, it should be noted that the study used the following cost estimates (provided by DOT in October 2008) for calculating the economic impacts:

- Construction cost at $1.67 billion (of which $1.3 billion is for road building, $223 million is for bridge construction and $178 million for engineering);
- An annual maintenance cost of $13 million.

*It should be noted that the anticipated economic impacts provided below are in consideration of the completed highway as a whole, from Wrigley to Tuktoyaktuk, and not for its component parts in the various Land Claim regions. However, the anticipated potential economic benefits are focused on the* Pehdzeh Ki Ndeh - *Dehcho Region and the community of Wrigley.*

*7.2.4.2.1 Potential Impacts on Educational Attainment*

The Project is anticipated to have a positive effect on education and training opportunities for residents of Wrigley and the Pehdzeh Ki Ndeh - Dehcho Region. The magnitude of this positive effect is dependent on the success of local hiring initiatives such as mentorship and apprentice programs, workshops, etc.

There is also a potential for positive effects on the region's educational facilities, students and teachers as the Project improves access to northern locations.

*7.2.4.2.2 Potential Impacts on Employment and the Future Workforce*

For the overall MVH extension from Wrigley to Tuktoyaktuk, one of the expected economic impacts is long term and short term employment as a result of the construction and maintenance of the MVH, estimated at:

- 7,718 person-years of employment in the Northwest Territories and 6,281 more person-years of employment in the rest of Canada during the period of construction;
- 128 permanent jobs in the NWT for ongoing maintenance of the highway, which is estimated to require an annual maintenance budget of $13 million.

Although this document does not commit any organization or agency to the delivery of training and education of a future workforce, it is important to identify opportunities that could be undertaken now in preparation for the future.

Construction of the MVH extension will present business and employment opportunities for general labourers, equipment operators, surveyors, environmental monitors, camp staff (cooks, camp managers, and custodians), expeditors, engineering and technical staff, and others. Although the construction of the MVH extension is a one time opportunity, a well trained and educated local workforce would serve the needs of future infrastructure development as well as make the development of that infrastructure in the Pehdzeh Ki Ndeh - Dehcho Region more attractive. The economic and social benefits presented above provide a vision of opportunities beyond the construction of the highway relative to, but not limited to:

a) The management and operation of the highway (equipment operators, highway patrol, maintenance foreman, expeditors, engineering and technical staff, environmental monitors, etc.);

b) Management of access to the land (enforcement, environmental and wildlife monitors, technical planning staff, etc.);

c) Tourism and associated community based service businesses (environmental and wildlife monitors, professional guides, communications and promotions specialists, business administration professionals, chefs, restaurant managers, expeditors, logistics specialists, etc.);

d) Resource and Exploration opportunities and associated community-based service businesses (environmental and wildlife monitors, technical and engineering specialists, camp support staff, expeditors, logistics specialists, business administration professionals, etc.).

The development of both the MVH extension and the MGP, and opportunities associated with subsequent resource exploration and development, could potentially provide an opportunity for the community of Wrigley to develop associated community-based services. These services may include pollution prevention and spill response and cleanup, waste management facilities and the provision of emergency services.

In terms of the NWT as a whole, an economic loss to the NWT GDP related to the construction of the annual winter-road is expected following the development of the entire all weather road. Although this will save the DOT $1.3 million every year in winter road construction, it will also result in the loss of $0.8 million to the NWT GDP, including six permanent jobs and $152 000 in government revenues. Although these annual benefits will be lost because the winter road will no longer be constructed, the anticipated annual benefits associated with operation of the MVH extension will replace and exceed this loss (DOT, 2009).

*7.2.4.2.3 Potential Impacts on the Local and Regional Economy*

Potential Impacts on the Structure of the Northwest Territories Economy

New economic patterns and structures will emerge to take advantage of the lower costs and lower risks provided by the MVH. Some examples that are provided in the September 2009 study include:

- New hydrocarbon fields can be developed sooner and more efficiently, and can have a lower overall cost structure, opening up the Northwest Territories to a greater number of smaller oil and gas companies;
- The Highway can help spread the work over a longer period of time where spur roads off the MVH extension or access from the MVH extension to barge terminals on the Mackenzie River are feasible, thus reducing the cyclical intensity of activity and the associated inflationary pressures;
- The Highway will allow for the mobilization of more equipment from southern contractors, and increase competition between contractors;

- Other important economic, but un-quantifiable impacts include the potential for Northwest Territories-based businesses to provide additional supplies and services to the oil and gas sector via the Highway.

The introduction of a reliable transportation network, such as the MVH extension, provides opportunity for the development of other infrastructure and resources in an efficient and sustainable manner. Also, while the development of the MVH extension within the Pehdzeh Ki Ndeh – Dehcho Region may provide access for the orderly development of resources and infrastructure, on the other hand, there are also opportunities for economic activity in the Pehdzeh Ki Ndeh - Dehcho Region and the community of Wrigley that would not otherwise have been realized, such as the development of businesses to provide additional supplies and services to users of the MVH extension and the opportunity to attract higher revenues for the lands that will be posted for resource exploration.

Potential Impacts on the Cost of Living

It is anticipated that the construction of the MVH extension will decrease the cost of living for residents and improve the overall economic well being for all Mackenzie Valley regions. The decrease in the cost of living will primarily be due to a reduction in the cost of shipping and distribution of goods. It is estimated that the MVH extension will make $15.7 million more available to residents each year, which should contribute approximately $5.5 million to the NWT GDP. This will result in the creation of an additional 41 permanent jobs indirectly resulting from the construction of the all-weather road (DOT, 2009).

Although the community of Wrigley is already accessible by an all-weather road, it is still anticipated that residents will see a reduction in their cost of living as an increasing number of vehicles and goods will be passing through the region. Although such benefits cannot be quantified at this time, residents of Wrigley might experience a significant portion of the benefits as 5 110 commercial transport trucks, currently utilizing the Dempster Highway, could be re-directed through the Pehdzeh Ki Ndeh – Dehcho Region.

Potential Impacts on Tourism

With the construction of the MVH extension, it is anticipated by Northwest Territories Tourism officials that tourist visitation will increase by 20% (an additional 2 500 to 2 700 new tourists each year throughout the Mackenzie Valley region). Based on an historical average spending per person of $644 (excluding airfares) and prepaid package costs of $284 (some of which do not accrue to businesses in the Northwest Territories), a conservative increase in tourist expenditures of $2 million a year is expected. This translates into $550 000 more purchasing power in the Northwest Territories each year, 10 new permanent jobs and almost $100 000 more in government revenues each year.

Additionally, it is anticipated that an increase in tourism numbers provided by the MVH extension will also result in longer stays in the Northwest Territories and across the North by the creation of a driving loop connecting the Northwest Territories and Yukon via the Dempster Highway.

The extent to which the MVH extension will change tourism at or near Wrigley is not clear and will depend on such factors as facilities available to travelers, time of day for ferry crossings of the Mackenzie near Fort Simpson, and the identification of recreational opportunities unique to the area and, possibly to the west of the Mackenzie. The ferry schedule affects the time of day when people arrive in Wrigley, and therefore whether or not they may stop in the community for services.

The existence of the MVH extension could be utilized to promote tourism activities unique to the region. Increased tourism exposure, via traffic on the MVH, could provide an opportunity for the community of Wrigley to expand existing tourist activities and services to become a key destination point along the way.

The danger for the Pehdzeh Ki Ndeh - Dehcho Region is that if MVH traffic does not have a reason to stop in the region, the benefits will accrue to a lesser extent. The reasons to stop are either because of the opportunities for services and/or the opportunities for business, and/or the opportunities for tourism.

##### *7.2.4.2.4 Mitigation of Potential Impacts on Socioeconomic*

Effects on the socioeconomic conditions in Pehdzeh Ki Ndeh – Dehcho Region and the community of Wrigley can be optimized or mitigated by the following:

- Encouraging the development of programs that create and improve the connectivity between education facilities, students and teachers throughout the region to improve accessibility to educational resources;
- Promoting and supporting business opportunities throughout the project development phases and into the operations phase (including monitoring and maintenance);
- Promoting training and accreditations that will provide longer term employment benefits in order to offset the loss of employment related to the winter road;
- Promoting the new highway and encouraging increased use of the route to ensure increased access to goods for local communities (resulting in lower cost of goods due to a reduction in transportation costs and risks associated with transport of goods);
- Increasing reliability of supply and general availability of consumable goods through management and planning of transportation schedules through the region;
- Encouraging development of businesses related tourism (i.e. residences, restaurants, tours, gas stations) and promoting new and existing businesses.

### 7.2.4.3 Individual, Family and Community Wellness

#### 7.2.4.3.1 Potential Impacts on Health Conditions

Members of PKFN have expressed fear that drugs and alcohol may become more prevalent in the community following the development of the MVH extension. This fear may be rooted in the idea that new persons entering the community may promote the use of illegal substances or alcohol or may distribute these substances. Increased connectivity between different regions could make the distribution of drugs and alcohol easier. Also, the fear may be a reaction to the concept of an all-weather highway that connects the north coast with southern Canada, which may present new opportunities for shipping and distribution of drugs. Finally, increases in local wage incomes during the MVH construction and operation may also contribute to the creation of a drug or alcohol dependency problem through increasing drug and alcohol-users' ability to finance their habit.

Any possible increase in drug or alcohol use or the presence of substances in local communities will have negative effects on the local social fabric and community well-being. It could also result in an increased demand on social services such as emergency, medical and policing services. Another potential adverse impact of the project could be related to potential accidents and malfunctions that result in injuries, such as:

- Potential accidents and spills during construction and operations (transport of goods);
- Increase in number and severity of traffic accidents (number due to increase in number of vehicles on the road and severity due to increased speeds that can be traveled).

#### 7.2.4.3.2 Potential Impacts on Family Concerns and Community Conditions

It is anticipated that the all-weather road will provide an overall benefit to local household incomes through increased economic opportunities. Additionally, it is expected that a decrease in the cost of living will be experienced as the volume and frequency of goods passing through the region increases. It is also anticipated that the improved accessibility throughout the region will encourage cultural, community, and family interactions

#### 7.2.4.3.3 Potential Impacts on Community and Social Services

Although Wrigley is currently accessible from the South via an all-weather road, the construction of the MVH extension is still anticipated to reduce the cost of providing government services and programs through an increased connectivity to communities and regions. Transitioning from an end point of the existing Mackenzie Highway to a thoroughfare community of the MVH extension should decrease the cost of and improve the communities access to health, education, social and recreational services, capital programs, and local municipal services and programs. The Highway will provide the valley residents with cheaper, easier and safer access to these services. It will also promote family, community, and recreational interactions by providing year-round access between communities.

While an increase in population may be viewed as a positive, the associated increase in demand for community services and infrastructure could be considered adverse if already operating at capacity. Key services and infrastructure selected as indicators of change in demand for services and infrastructure are: emergency and protection, health, education and recreation. Potential effects on these services can arise in two ways:

- Reduction or disruption in access to community services by the existing population as a result of an increase in demand from in-migration of workers; or
- An increase in demand for emergency services in the event of any unexpected workplace events and accidents.

##### 7.2.4.3.4 Mitigation of Potential Impacts on Individual, Family and Community Wellness

The MVH may present numerous opportunities and benefits that can be experienced by the local populations. Careful consideration will be needed throughout design, construction and operations phases to help and support the Dehcho First Nations, and the PKFN in particular, to focus on the opportunities that best suit their capabilities and interests.

As this is a remote location in close proximity to natural resources important to the Dehcho First Nation and to the Mackenzie River, careful consideration should be given to planning for spill prevention, emergency response, and waste management. In particular, consideration can be provided to local residents who may be able to support the provision of such services on a ongoing basis. The latter will require support of appropriate training and education.

In an effort to mitigate the impact of increased social problems and challenges, such as a possible increase in drug and alcohol consumption,the following measures are proposed:

- Strictly enforce a no alcohol and drug policy at construction and maintenance camps;
- Explore wage payment options that reduce availability of 'cash-in-hand';
- Prepare a traffic management plan in consultation with GNWT DOT;
- Ensure that trained response team(s) are available to deal with accidents and spills.

#### 7.2.4.4 Community Infrastructure and Utilities

##### 7.2.4.4.1 Potential Impacts on Community Infrastructure and Utilities

The identification of a transportation and utilities corridor through the Mackenzie Valley will be a likely outcome of the development of the MVH. The concept of a transportation and utilities corridor provides the opportunity to position development within a common corridor within the Mackenzie Valley to take advantage of access via the MVH extension and to minimize the development footprint on the land. Within the transportation and utilities corridor, infrastructure may include pipelines, transmission lines, communication infrastructure (i.e., fibre optic cable in the highway embankment) along with the Highway.

If the community of Wrigey has any infrastructure and/or utilities located within the right-of-way for the all weather road, there is potential for adverse impact on the said existing infrastructure and utilities during the construction phase of the project.

During construction phase, the use of the winter road will be reduced and users might have to use alternative means of transportation or routes. It may impact travel time and accessibility.

There is also potential for an adverse impact upon the community of Wrigley's drinking water as a result of project construction. The impacts and appropriate mitigation measures related to water quality are presented in detail in Sections 7.2.3.3 on Fish and Fish habitat (also called aquatic environment) and 7.2.2.6 on Groundwater.

##### *7.2.4.4.2 Mitigation of Potential Impacts on Community Infrastructure and Utilities*

In an effort to mitigate the impact of increased demand for local community services and infrastructure, the following measures are proposed:

- Development of a health and safety management plan in accordance with community requirements;
- Proper planning and effort to recognize and not disturb existing community infrastructure and/or utilities and during construction;
- Construction of temporary bypass roads or alternate transportation means to avoid disturbing traffic;
- With regards to community drinking water, additional attention should be placed upon the mitigation measures related to impacts on water quality presented in Section 7.2.3.3 on Fish and Fish habitat (also called aquatic environment) and Section 7.2.2.6 on Groundwater

As a means of encouraging economic activity in Wrigley, an assessement of whether or not there are opportunities to vary ferry schedules to benefit Wrigley should be considered.

## 7.3 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

The following table provides a concise summary of the potential impacts, the mitigation measures identified to avoid or minimize the potential impacts and optimization measures designed to enhance the potential benefits. In most cases, the first mitigation measure to be implemented would be the undertaking of in-depth studies in order to obtain a more complete understanding of the existing environment (i.e. archaeological sites, economic activities, traditional land use, wildlife corridors, etc.).

Table 35: Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| Traditional and Other Land Uses | | |
| Reduced availability to wildlife resources, such as caribou, moose, bears, migratory birds, vegetation, fish and small game | - | ▸ Regulate non-traditional hunting and fishing activities;<br>▸ Minimize project footprint and avoid sensitive areas used for traditional and cultural activities;<br>▸ Follow all measures identified to protect wildlife and vegetation species (see below). |
| Potential disturbance to traditional activities sites (campout and other cultural/traditional events) | - | ▸ Analyze or undertake in-depth investigative studies to identify all sites;<br>▸ Implement protection measures for known sites and avoid identified locations. |
| Disuse of cabin sites due to vicinity of MVH extension | - | ▸ Relocate cabins or provide appropriate compensation. |
| Reduced cultural value to ceremonial areas such as burial sites due to increased year-round traffic and potential disturbance to sites | - | ▸ Avoid sensitive historical and cultural sites;<br>▸ Ensure a buffer area is maintained around significant cultural, spiritual or historical sites. |
| Impacts to archaeological heritage sites | - | ▸ Conduct a thorough archaeological investigation along the proposed alignment and in nearby areas (done by a qualified archaeologist);<br>▸ Visit all previously identified sites in order to determine proximity to the proposed highway alignment;<br>▸ Clearly delineate project areas (including storage areas, borrow sites, access routes) in order to ensure all areas are properly investigated;<br>▸ Avoid all identified archaeological sites by a minimum of 100 m and recorded graves by at least 500 m;<br>▸ Recover artefacts from potentially impacted sites;<br>▸ All activities in the vicinity should cease in the event that unanticipated cultural finds are encountered. |
| Increased year-round access to areas adjacent to the Mackenzie Valley for PKFN members | + | ▸ Ensure maintenance of the road at all times in order to take advantage of increased access to areas adjacent to the Mackenzie Valley for PKFN members. |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| Reduced costs related to the Proposed Mackenzie Gas Project | + | ▸ Complete construction of the MVH extension prior to commencing work on the MGP in order to take advantage of the highway during construction of the MGP;<br>▸ Use the same staging areas for storage of materials in order to reduce the footprint on the land. |
| Increased opportunities for Natural resource exploration and development | + | ▸ Complete the extension project in a timely fashion in order to provide increased access to potential exploration sites;<br>▸ Provide training opportunities to local residents in order to increase skills and develop capacity for employment opportunities in future projects. |
| **Vegetation** | | |
| Temporary disturbance of vegetation communities and wetlands | - | ▸ Minimize project footprint;<br>▸ Attempt translocation and monitor;<br>▸ Revegetation of cleared areas not required for the operation with indigenous species;<br>▸ Sediment and erosion control;<br>▸ Maintain natural hydrology of wetlands and streams. |
| Permanent loss of vegetation communities and wetlands | - | |
| Disturbance to / loss of rare plants | - | ▸ Conduct rare plant survey work;<br>▸ Attempt translocation and monitor;<br>▸ Collect and contribute voucher specimens to herbariums. |
| Introduction of invasive species | - | ▸ Limit opportunities for colonization by invasive species. |
| **Wildlife** | | |
| Habitat loss | - | ▸ Minimize project footprint;<br>▸ Identify important habitats adjacent to the alignment;<br>▸ Conduct pre-construction surveys. |
| Habitat fragmentation | - | |
| Habitat avoidance | - | ▸ Establish buffers areas around habitat and implement minimum setbacks for seasonally important habitat;<br>▸ Timing considerations;<br>▸ Minimize wildlife interactions. |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| Sensory disturbance (auditory, visual or olfactory) | - | ▸ Implement a minimum 800 m horizontal setback from seasonally important habitat at all times;<br>▸ Prohibit clearing and construction activity within a 1 km radial buffer around identified seasonally important habitat from September 1 to May 1 (carnivore denning season);<br>▸ Increase staff awareness of ways to minimize interaction with and habituation of wildlife;<br>▸ Prohibit recreational off-road vehicle use year round wherever it is enforceable. |
| Direct/Indirect mortality | - | ▸ Provide road signs to indicate sensitive areas and/or wildlife crossing;<br>▸ Monitor wildlife vehicle collisions;<br>▸ Nest clearing surveys;<br>▸ Endorse a no-shooting zone within 500 m of the highway;<br>▸ Implement a 1 week voluntary hunting closure along the highway (including 8 km on either side) to permit lead animals to pass. |
| **Fish and Fish Habitat** | | |
| Habitat loss due to:<br>▸ Loss of riparian vegetation and changes to stream bank stability<br>▸ Culvert footprint<br>▸ Changes in migration / access to instream habitats<br>▸ Changes in streamflow<br>▸ Changes in overwintering habitat quality | - | ▸ Minimize disturbance to the riparian area;<br>▸ Avoid critical habitat;<br>▸ Limit the extent of riparian vegetation clearing;<br>▸ Follow best management practices for culvert installation such as those described in *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO, 1993)];<br>▸ Restrict areas where heavy equipment may operate to avoid critical habitat;<br>▸ Follow guidelines described in *DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut* (DFO, 2010), during water extraction activities;<br>▸ Follow guidelines described in DFO's NWT Operational Statement, *Maintenance of Riparian Vegetation in Existing Rights-of Way* (DFO, 2007c), during road right of way maintenance activities;<br>▸ Follow guidelines described in DFO's NWT Operational Statement, *Bridge Maintenance* (DFO, 2007d), during bridge maintenance activities;<br>▸ Follow guidelines described in DFO's *NWT Operational Statement, Culvert Maintenance* (DFO, 2007e), during culvert maintenance activities;<br>▸ Monitor culverts for subsidence or lifting that could lead to the potential creation of a barrier to fish movement. |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| Direct impacts to water quality due to:<br>▸ Changes in sediment load<br>▸ Fly rock and toxic by-products entering watercourses<br>▸ Spills of hydrocarbons or hazardous materials | - | ▸ Promptly revegetate exposed soils;<br>▸ Ensure runoff containing suspended sediment does not enter watercourses by implementing erosion prevention and sediment control measures;<br>▸ Follow guidelines described in *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) during blasting activities near fish-bearing waters;<br>▸ Ensure runoff containing blast residues and / or sediment does not enter watercourses;<br>▸ Establish spill prevention and response protocols. |
| Indirect impacts (i.e. downstream) to fish and / or incubating eggs due to changes in water quality | - | |
| Direct impacts to fish and / or incubating eggs due to spills of hydrocarbons or hazardous materials | - | ▸ Establish spill prevention and response protocols. |
| Mortality of fish and / or incubating eggs due to:<br>▸ Instream works<br>▸ Culvert Installation<br>▸ Water extraction activities<br>▸ Changes in angling pressure from increased road use and construction worker access | - | ▸ Avoid critical habitat;<br>▸ Minimize the duration of instream activities;<br>▸ Follow guidelines described in DFO's NWT Operational Statement, *Timing Windows* (DFO 2007a) to avoid instream works during sensitive periods;<br>▸ Apply measures listed in DFO's NWT Operational Statement on *Clear-Span Bridges* (DFO 2007b) where possible;<br>▸ Require the presence of an independent Environmental Monitor during all instream works;<br>▸ Follow best management practices for culvert installation such as those described in *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993);<br>▸ Restrict areas where heavy equipment may operate to avoid critical habitat;<br>▸ Follow guidelines described in *DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut* (DFO 2010), during water extraction activities;<br>▸ Public education;<br>▸ No-fishing policy for construction workers. |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| **Geophysical Environment** | | |
| Geohazards | - | ▸ Good design; route location and siting;<br>▸ Mapping of seepage zones, permafrost and sediments sensitive to erosion. |
| **Contaminated Sites** | | |
| Fuel Spills due to:<br>▸ Accidents and malfunctions of construction equipment<br>▸ Accidents and malfunctions of vehicles transporting people or materials<br>▸ Accidents involving vehicles transporting potential contaminants | - | ▸ Designate safe refuelling and vehicle maintenance sites;<br>▸ Develop an Emergency Response Plan that includes employee/contractor training, equipment maintenance, fuel and hazardous waste management practices, contingency plans, and spill responses in order to reduce the potential of groundwater contamination;<br>▸ Ensure that vehicles used to haul hazardous materials on the road meet standards for the environmental conditions on the highway;<br>▸ For road sections close to the Mackenzie River and at regular intervals along the road, consideration should be given to providing for storage of equipment and materials to support spill cleanup with particular reference to fuel spills;<br>▸ Consideration should be given to training (selected) personnel in local communities to support spill cleanup and to respond to emergencies, including knowledge of proper health and safety practices related materials likely to be transported on the highway. |
| **Groundwater** | | |
| Creation of groundwater fed wetlands due to interception of near surface groundwater flows | - | ▸ Anticipate and design for groundwater conditions;<br>▸ Mapping of seepage areas, permafrost zones and sediments sensitive to erosion will facilitate the most appropriate design and the need for any route re-alignments. |
| Loss of wetlands due to draining of existing wetlands through road ditches and associated crossings | - | |
| Formation of icings and aufies due to exposure/interception of groundwater flows at road cuts | - | |
| Reduced slope stability due to interception of groundwater flows | - | |
| Formation of new groundwater seepage areas, or changes in seepage rates, due to road cuts and blockage of drainage courses | - | |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| Creation of wetlands and saturated soils due to blockage of drainage courses, affecting groundwater discharge and recharge rates | - | |
| Interception of groundwater at borrow sites, which may affect local groundwater flows and icing conditions | - | |
| Approach fills at bridge crossings may affect local groundwater flows and re-direct these flows | - | |
| Culvert sites and the associated fills will likely affect local groundwater flows, causing one or more of the impacts described above | - | |
| Impacts on groundwater quality due to:<br>▸ changes in surface water quality and/or the spill of contaminated materials<br>▸ poorly managed sewage from construction camps | - | ▸ See mitigation measures discussed in fish and fish habitat section;<br>▸ Management of sewage generated during construction activities. |
| Demography | | |
| Acquisition of Dehcho territorial lands by outside investors, such as resource development companies | - | ▸ Ensure the Dehcho people have access to traditional territories and resources;<br>▸ Ensure Dehcho residents are consulted and have input into the development of the region. |
| Migration (outward* and inward) of population<br>**PKFN mention possible outward migration of women in particular* | ± | ▸ Encourage development of community programs supporting local women to further develop connections within the community and to promote educational and economic opportunities. |
| The potential for the erosion of language, culture, traditional practices in the Pehdzeh Ki Ndeh - Dehcho region | - | ▸ Ensure cultural and community facilities are unaffected and/or enhanced by the project;<br>▸ Ensure that local infrastructure has the capacity to respond to potential population growth;<br>▸ Ensure language and cultural education is included in school curriculums;<br>▸ Support the training and development of young people (i.e construction and engineering) so trained young people are in place and capable to meet the needs of the required labour force. Local work force leaders should act as mentors and develop opportunities in the community. |

Table 35 (cont'd): Summary Table of Potential Impacts and Mitigation/Optimization Measures

| POTENTIAL IMPACT | + / - | MITIGATION/OPTIMIZATION MEASURES |
|---|---|---|
| **Socioeconomic** | | |
| Increased education and training opportunities and access to other facilities/services available in other communities | + | ▸ Encourage programs that support the increased connectivity between education facilities, students and teachers throughout the region, while improving local accessibility to educational resources. |
| Reduced cost of living | + | ▸ Monitor costs related to distribution of goods<br>▸ Implement a reliable system of supply of consumable goods to communities along the MVH alignment. |
| New business opportunities that are directly and indirectly associated with the construction and operation of the Highway | + | ▸ Promote and support business opportunities at the appropriate time;<br>▸ Promote training and accreditations that will provide longer term employment benefits. |
| Increased tourism spending throughout the Pehdzeh Ki Ndeh - Dehcho region | + | ▸ Encourage development of businesses related to tourism (i.e. residences, restaurants, tours, gas stations) and promote new and existing businesses. |
| **Individual, Family and Community Wellness** | | |
| Easier access to healthcare, recreation and education resources | + | ▸ Ensure maintenance of the road at all times in order to take advantage of increased accessibility to services and facilities available in other communities. |
| Increase in cultural, community, and family interactions | + | |
| Increase in wage income during MVH construction and operation may lead to social and community challenges[16] | - | ▸ Support preventive education and social and health programs;<br>▸ Explore wage payment options that reduces availability of 'cash-in-hand'. |
| Increased traffic during construction and operation of the MVH | - | ▸ Prepare a traffic management plan in consultation with GNWT DOT;<br>▸ Ensure the installation of clear signage along the highway (i.e. speed, presence of wildlife corridor). |
| Potential for accidents and spills | - | ▸ Implement an Environmental Management Plan;<br>▸ Ensure that trained response team(s) are available to deal with accidents and spills. |
| **Community Infrastructure and Utilities** | | |
| De facto creation of a transportation and utilities corridor through the Mackenzie Valley | + | ▸ Encourage development within the common corridor to take advantage of access via the MVH extension and to minimize development footprint on the land. |
| Increase in demand for community services and infrastructure | - | ▸ Development of a health and safety management plan in accordance with community requirements. |
| Limited access of the winter road during construction | - | ▸ Construction of temporary bypass roads or alternate transportation means to avoid disturbing traffic. |
| Potential impacts to community drinking water | - | ▸ Monitor quality of drinking water regularly throughout construction |

[16] PKFN identified, during the door-to-door survey, a potential increase in access to drugs and alcohol as a possible impact of the MVH extension Project.

## 7.4 CUMULATIVE IMPACTS

Cumulative impacts are those impacts (biophysical, socio-cultural or economic) that result from a proposed development acting in combination with other past, present, or reasonably foreseeable future developments (MVEIRB, 2004). There are four basic steps involved in conducting a cumulative impacts assessment (CEA):

a) Identify the valued components likely to be affected by this project in combination with other developments

b) Identify the other human activities and developments that could affect these same valued components;

c) Determine the combined impacts of the proposed development in combination with the other developments and activities on these valued components;

d) Identify ways to manage these cumulative impacts.

It is noted that in context with item (b) above the developments do not have to be specific projects, but may address the reasonable expectation of a development(s) of a project(s) or activity(ies) in the time frame of the cumulative assessment.

An assessment of cumulative impacts provides a more complete understanding of what might happen to Valued Environmental Components (VECs) beyond the influence of the proposed project alone. MVEIRB use the cumulative impacts assessment (CEA) in decision making, and land and resource managers use it as they review specific proposals and plan for future development.

The assessment of impacts of the Mackenzie Highway in the Pehdzeh Ki Ndeh - Dehcho Region north of Wrigley to the Blackwater River identifies residual impacts of a local nature generally low in magnitude with no significant impacts providing the mitigation proposed is followed and successful. This CEA considers the potential additive and synergistic impacts of the residual impacts of the proposed project acting in combination with the residual impacts of projects and activities (developments) in the vicinity of the Highway within the Pehdzeh Ki Ndeh – Dehcho Region and adjacent sections of the proposed all-weather Mackenzie Highway.

For the all-weather Highway within the Pehdzeh Ki Ndeh - Dehcho region, the following assessment of cumulative impacts has involved the application of basic questions adapted from a framework prepared by Kavik-AXYS Inc. (2002).

- Is the project likely to have negative environmental impacts on VECs in the Pehdzeh Ki Ndeh – Dehcho Region?
- If so, will the residual adverse environmental impacts that remain after mitigation combine with the impacts of other projects, past, present, or reasonably foreseeable future projects or activities?
- What is the significance of the overall cumulative environmental impacts, including the impact of the project?
- If the proposed project, acting in combination with other projects in the area, is likely to create a “significant negative cumulative impact”, are there further mitigation measures that could reduce or eliminate the project’s contribution to these impacts so that the combined impact is unlikely to be significant or threaten the VEC?

### 7.4.1 Spatial Boundaries

The cumulative impacts assessment considers other projects or activities that may interact with VECs and associated residual impacts from the proposed project within the Pehdzeh Ki Ndeh – Dehcho Region (western half primarily) and the proposed Mackenzie Highway sections north of the Dehcho Region, including the Sahtu Private Lands. It is important to also take into account the all-weather road that reached Wrigley, at the south end of the proposed project, in 1994; the impacts of which can be expected to interact with the impacts of the proposed project and the proposed highway north of the Pehdzeh Ki Ndeh - Dehcho Region.

### 7.4.2 Temporal Boundaries

The temporal boundaries for the cumulative impacts assessment considers that activities in the Pehdzeh Ki Ndeh - Dehcho Region, specifically those in the lands used by the PKFN, have a very long history, which has a cultural value and lifestyle that is important when considering projects or activities (developments) that may interact with the VECs and associated residual impacts of the proposed project. In practice, the activities are primarily those of the PKFN, and other Dehcho Nation people, who travel and transport on the Mackenzie River and more recently, transport of oil by pipeline, and travel via a winter road. The proposed project temporal boundary will extend well into the future because of the prospect for the all-weather highway to encourage or enable more extensive opportunities for development. However, in practical terms for a CEA, the projects or activities (developments) must have some basis for consideration and this makes projections beyond times frames in the order of 50 years speculative and too vague for assessment purposes.

The above suggests a reasonable time frame for the CEA is from 50 years past to 50 years in the future, This is considered sufficient to identify reasonably foreseeable project or activities and to identify those past and present project or activities that have not been reasonably reflected in the baseline of the existing conditions described herein.

### 7.4.3 Valued Components

While this assessment of cumulative impacts draws from the MGP EIS, the focus of the valued components reflects those VECs most at risk and the associated human and cultural impacts.

The impacts discussed in this PDR for the MVH in the Pehdzeh Ki Ndeh – Dehcho Region, focus substantially on changes to bio-physical and socioeconomic and cultural VCEs.

#### *7.4.3.1 Bio-physical VECs*

1. Impacts to vegetation and wildlife habitats locally;
2. Impacts to wildlife, especially large mammals and species important to the traditional uses of the local and regional study areas. Many of these impacts result from the effects of sensory disturbance and possible local habitat change;
3. Impacts to fish; while considered low due to the alignment primarily following an existing route for the winter road, there are indirect risks to the fish and aquatic habitat, due to impacts to soils;
4. Impacts to soils due to (1) disturbance of groundwater and thermokarst features and possible more extensive surface disturbance, and (2) due to erosion along the right-of-way;
5. Impacts of spills of contaminants caused by accidents and malfunctions on soils, groundwater and surface water.

#### *7.4.3.2 Socioeconomic and Cultural VECs*

1. Impacts on traditional uses of the lands adjacent to the proposed all-weather Mackenzie Highway;
2. Impacts on social services:
3. Impacts on the community services;
4. Impacts on community and culture;
5. Impacts on archaeological and heritage resources due to right-of way expansion along the winter road alignment, and any possible re-alignments.

### 7.4.4 Past, Present and Future Projects, and Activities Considered

The projects and activities (developments) considered for the cumulative impacts assessment are summarized below. The primary developments are for oil and gas, and the general expectation for increased traffic between the southern part of the Northwest Territories and the Mackenzie Delta region. The role of mine development is considered too speculative to be considered by more than the recognition as a reason that traffic along the proposed highway will increase to service mineral exploration and potential future mine.

#### 7.4.4.1 Past and Existing Projects and Activities

##### 7.4.4.1.1 *Traditional Land Use and Culture*

This section of the Mackenzie Highway all-weather road has a long history of use by First Nations people of, and a dependence upon, the ecological resources of the hinterland. The PKFN culture has subsisted in this landscape through the continual development of traditional culture and life styles that has grown through generations. As noted below, this landscape and culture is evolving as transportation opportunities have developed in the area. Improved access (due to a winter road and then the all-weather road that reached Wrigley in 1994) has facilitated greater economic activity related to opportunities built on traditional harvest, which includes the collection of wildlife and plant resources used to meet subsistence, ceremonial and other cultural needs. The sustainability of the harvest and landscape is a primary concern for all Dehcho First Nations communities, as was evident from the concern expressed by the PKFN when the existing oil pipeline leaked some 50 km south of Wrigley in 2011.

In addition, traditional land use is being challenged by the exploration for oil and gas, and possibly mineral deposits, north and east of this section of the highway; activities which have some potential to bring economic benefits to the area. Such activities are also a potential threat to the traditional resources and their harvest, and a source of conflict among the stakeholders who would have an interest in these activities and the economic benefits.

The small population in the area is largely composed of members of the Dehcho First Nations. As development occurs, the ability of the existing community to retain the culture of the PKFN and other Dehcho First Nations communities will be challenged. In addition, health and wellness within the community is challenged as expectations and opportunities change.

The ability of the local traditional people, their use of traditional resources and the associated culture, to survive, and for benefits to accrue to the people of the area depends substantially on the ability of the people to manage their traditional resources, accommodate changes to transportation and technology, and adjust to change. The pace of change is expected to increase as the all-weather highway extends north through the Pehdzeh Ki Ndeh - Dehcho region to areas with substantial economic activity and development potential.

##### 7.4.4.1.2 *Transportation of Materials and People*

Transportation along the Mackenzie Valley is already changing access to hunting and trapping areas, providing better access during winter, increased access from Wrigley south to markets and other opportunities for business, education and recreation. However, change due to access has largely been focused on movements north during the winter and south for the summer and fall seasons.

**Winter Road:** The winter road was initially completed to a point 18 km south of Wrigley in 1977. The last 18 km of the winter road in to Wrigley was completed in 1994, providing access to Wrigley and north of the community to traditional winter resources and lands. Such access will now extend to all seasons and for all peoples, whether they live in the area, south of the area or north of the area. The type, volume and size of vehicles that will be able to travel through this area are expected to increase significantly. The increase in traffic to more northerly areas of economic activity also brings increased potential for spills and contamination of waters and lands adjacent to the proposed highway.

**Mackenzie River:** Transportation of goods and people on the Mackenzie River has a long history and played an important role in the exploration and development of the Mackenzie Valley and its hinterland. Transport on the Mackenzie River is expected to continue, likely with lower volumes of goods and people. This mode of transport will remain seasonal, being restricted to the open water period between breakup and freeze up.

**Oil Transportation:** An existing oil pipeline owned by Enbridge may be accompanied by a second pipeline that is in the regulatory process seeking approval by Imperial Oil and known as the Mackenzie Valley Gas Pipeline. Pipelines bring short term local economic activity related to construction labour, goods and services requirements. Operational benefits to the local economy are very limited. Operations have a potential to damage local and even regional traditional resources in the event of spills and contamination of water and soils.

### *7.4.4.2 Proposed Future Projects and Activities*

#### *7.4.4.2.1 Traditional Uses and Culture*

The all-weather highway will expose the people of the PKFN to economic, political and social forces that emanate from sources far removed from their lands. These changes will have a synergistic and cumulative impact on the people, traditional resources and landscape of this area. To realize benefits from the proposed highway and to minimize the impacts on the landscape, the people of this area will need an effective voice in the way decisions are made that could affect their culture, traditional resources, land, water and the landscape of the region in which they live. Such a process is evolving through the ongoing negotiations, and will be important to the future of thePKFN and other First Nations adjacent to this section of the proposed highway.

Traditional land uses and the culture based upon traditional uses of the land and waters are expected to continue. The challenge in the future will be sustaining the traditional resources upon which the culture, and land and water uses depend. The geographic area in which traditional resources remain abundant may change due to the impacts of the MVH in the Pehdzeh Ki Ndeh - Dehcho Region acting in combination with other past and future developments along the transportation corridor on the east side of the Mackenzie River. It is likely that the way in which traditional resources are harvested will adapt to the changing distribution and abundance of the traditional resources. Efforts will be needed to plan for the cumulative impacts and to manage the traditional resources.

As noted above, the opportunities afforded by improved access also bring challenges such as those for health and wellness of the community.

The residual cumulative impacts could be significant for the traditional people of this section of the MVH; impacts that could be both positive and negative.

*7.4.4.2.2 Non-traditional Use of Ecological Resources*

The creation of an all-weather road along the Mackenzie Valley north of Wrigley will allow more people have access to the area more easily.  This could create an increased demand for activities related to the harvest of ecological resources (eg. hunting, fishing and guiding), increasing pressure on traditional wildlife and plant resources harvested there. As a result, First Nations interests in these areas may be threatened. It will be important to provide cumulative impact management of traditional resources in this area to address any potential increase in the commercial exploitation of the ecological resources.

In addition to meeting immediate subsistence and cultural needs that may be affected by a reduced availability of ecological resources, other economic uses for wildlife resources harvested in these areas will need to be addressed. The quality of the local traditional resources and the capabilities of the local PKFN have spawned a local artisan industry for the creation of fur based clothing that is internationally recognized. This is closely tied to potential socioeconomic impacts in Wrigley and should be considered in the development of an approach to the management of traditional resources in the area. Left unmanaged, this cumulative impact could have a significant impact on the people of this section of the MVH in the Pehdzeh Ki Ndeh – Dehcho Region, and indeed traditional peoples throughout the Mackenzie Valley.

*7.4.4.2.3 Labour Demand*

The opening of the all-weather highway essentially allows for a more mobile labour force able to respond more easily to changes in the need for labour throughout the Mackenzie Valley region, whether for oil and gas mining, commercial, government, tourism or other developments. This mobility can result in increased labour supply for the Wrigley area, and/or cause labour in the Wrigley area to migrate either temporarily or permanently. The impact of labour mobility on the population in the Wrigley area will depend on whether labour is outgoing or incoming, and whether temporary or permanent. At this time, the outcome of labour mobility is unclear, but could have a significant impact on the area.

#### 7.4.4.2.4 *Land and Water Management*

At present, land and water management for the 95 km of the proposed highway north of Wrigley remains the responsibility of the Government of the Northwest Territories and the Government of Canada. However, through ongoing negotiations with the Dehcho Nation, through the Dehcho Land Use Board, the Dehcho people and the PKFN have input to the process and priorities for land and water management.

As noted above in context with the cumulative impacts on traditional use and culture of the First Nations in the future:

"…the people of this area will need an effective voice in the way decisions are made that could affect their culture, traditional resources, land, water and the landscape of the region in which they live. Such a process is evolving through the ongoing negotiations, and will be important to the future of the Pehdzeh Ki First Nation and other First Nations adjacent to this section of the proposed highway."

#### 7.4.4.2.5 *Mackenzie Valley Gas Pipeline Project (MGP)*

The MGP is being developed by Imperial oil Resources Ventures Limited in conjunction with the Mackenzie Valley Aboriginal Pipeline Limited Partnership, ConocoPhillips Canada (North) Limited, Exxon Mobil Canada Properties and Shell Canada Limited, The purpose of this project is to develop three onshore natural gas fields in the Mackenzie Delta, and to transport natural gas and natural gas liquids by pipeline to market. In the Pehdzeh Ki Ndeh - Dehcho Region the primary project facility and activity is the pipeline and transmission of the products.

The MGP EIS report (Volume 12, Section 13) concludes that overall there would be no significant cumulative impacts due to the gas pipeline project.

For this section of the proposed highway, the principle cumulative impacts would likely accrue if the construction of the gas pipeline and proposed highway overlapped causing a significant influx of workers and demand for services, infrastructure and resources. This is currently not expected in this section of the proposed highway.

The MGP, the MVH in the Pehdzeh Ki Ndeh - Dehcho Region and the Enbridge pipeline will create a corridor of disturbance to fish and fish habitat, vegetation, wildlife habitats and wildlife behaviour. The extent of this disturbance on fish and wildlife cannot be assessed with the information available. In particular sensory disturbance from the highway will need to be assessed in combination with the impacts of the corridor of disturbance to determine the nature and extent of any cumulative impacts on wildlife.

Accidents or malfunctions along the pipeline could result in spills of oil that could interact with spills that may arise as a result of accidents or malfunctions on the MVH in the Pehdzeh Ki Ndeh - Dehcho Region. The contamination of water and habitats, and the associated emergency response, could affect traditional resources and activities if response plans are not well prepared to minimize such impacts.

*7.4.4.2.6 Oil and Gas Exploration and Development*

There is oil and gas exploration north of the proposed highway in the vicinity of Norman Wells and South to the Great Bear River. Additional exploration activity and possible increased production, expansion of production facilities, and transport of oil and gas will result in the increased flow of people goods and services through this section of the proposed highway. The increased economic activity will generate a flow of people, goods and services could increase economic activity in the vicinity of Wrigley but also increase the risk of soil and water contamination affecting traditional resources and related harvests by First Nations.

The potential for increased economic activity at Wrigley may be limited, as people and goods are likely to be in transit. Services are more likely to locate close to the oil and gas fields. Unless First Nations have a financial interest in the oil and gas exploration activity and production, the economic benefits to the Pedzheh Ki First Nation are likely limited.

Records suggest that as oil and gas production increases, and as the transport of people and goods and services increases, the risk of spills of fuels and other contaminants can be expected to increase. As contamination of soils and waters increases the threat and impact to traditional resources will increase. In this context the people of the area can be involved in response measures to address a range of spill scenarios for which appropriate training and equipment can be provided. In addition, the highway should be designed and constructed to reduce the risk of accidents and malfunctions in this relatively pristine landscape.

*7.4.4.2.7 Tourism*

No specific tourism development in the vicinity of the proposed section of the highway has been identified at the time of writing. However, consultation with the Dehcho Nation, especially the PKFN, indicates that a perceived benefit of the proposed highway is tourism. How tourism would benefit the local population is not clear at this time, but opportunities may exist related to the provision of tourism in the geographic hinterlands next to the highway at and north of Wrigley.

**North of the Pehdzeh Ki Ndeh – Dehcho Region:** It is more likely that tourism north of the Pehdzeh Ki Ndeh - Dehcho region would be supported by communities north of the Dehcho Region. However, depending on services and facilities available in the area at and north of Wrigley, it is possible for the PKFN to deliver tourism experiences such as travel on the Mackenzie River. This section of the highway could also provide en route services to people travelling further north, as the first service area north of Fort Simpson. Such travellers may include northern people travelling to communities or work, or southern people exploring the northern regions of Canada.

Perhaps tourism will be enhanced by a vision of a great circle route through the Northwest Territories and the Yukon, rather than simply destination tourism within the hinterland of the MVH.

**Along and on the East of the Mackenzie River:** The knowledge and experience of the Dehcho Nation in the lands along the proposed highway and to the east could provide guiding and hunting experiences. While these opportunities exist now, access and facilities limit the opportunities. The proposed highway will provide all year access, but not the facilities. No planned facilities or tourism developments have been identified at the time of writing.

**Along and on the West of the Mackenzie River:** The Mackenzie Mountains and the lands west of the Mackenzie River afford landscapes and traditional resources that may provide destinations for potential tourism opportunities. No planned tourism developments west of the Mackenzie have been identified at the time of writing.

*7.4.4.2.8 Transportation of Materials and People*

The primary cumulative impacts of the proposed highway north of Wrigley accrue to the impacts of movement of people, goods and services north to the north part of the Mackenzie Valley, and the movement of people and resources south from the north part of the Mackenzie Valley to southern Canada and the USA.

**Winter Road:** While the winter road has already created much of the footprint of the proposed highway, and enabled winter travel north of the Pehdzeh Ki Ndeh - Dehcho region, it has not provided all-weather transport and this has limited the number of people using the road and the range of goods and services transported. The cumulative impact of the increased traffic to serve regions north and south of the proposed highway in this section is to sensory disturbance on traditional resources (wildlife and avifauna), increased mobility of the labour force, increased demand for services, including emergency services, increased pressure on traditional resources, increased challenges to the traditional culture and landscape, and increased risk of spills of contaminants (and possible impacts on traditional resources).

It is noted that as more people travel into this area, the prospects for loss of cultural heritage and archaeological artifacts increases. Efforts must be made to discourage loss of such artifacts and resources.

**Mackenzie River:** Although transport of people and goods on the Mackenzie River is expected to decline, the river is expected to continue to service communities along its banks, and to provide possible recreational use, and some industrial use (for the transport of heavy equipment) from time to time.

### 7.4.5 Summary of Cumulative Impacts Potential

The potential for this proposed section to act cumulatively with other projects or activities (developments) is primarily related to the impacts of the overall proposed Mackenzie Highway all-weather highway project on the transport of people, goods and services between regions to the south and north of the 102 km section north of Wrigley. Cumulative impacts of the MVH in the Pehdzeh Ki Ndeh - Dehcho Region will interact with the other sections of MVH and developments all along the Mackenzie Valley to increase volumes of traffic transporting people, goods and services. These interactions will give rise to:

- Change that has already begun, due the all-weather road south from Wrigley, may create increased challenges for the Dehcho Nation, specifically the PKFN in Wrigley, to retain its culture and cultural values, and will likely affect wellness and health and related services. The PKFN community will likely experience both benefits and challenges arising from this proposed project that will be balanced with cultural values tied to the use and significance of their traditional territories. These changes can be significant for the traditional peoples of the area if opportunities to participate in the management of change are not afforded the people most affected.
- Increased transport of people, goods and resources brings increased risk of accidents and malfunctions that give rise to spills and consequent contamination of soils and water. The indirect impacts are damage to and loss of traditional resources, and synergistic impacts to business and commerce based on these resources.
- Increased transport of people, goods and resources brings increased risk of sensory disturbance to traditional resources (wildlife, and avifauna). The loss of productivity and/or the reduced use of habitats close to the Mackenzie River could negatively impact the harvest success and require increased effort to maintain the current levels of harvest. In turn, this could increase the cost and quality of the traditional resources used in business and commercial transactions, and possibly reduce the tourism potential over time. Such impacts could be significant if the management of the traditional resources is not properly implemented, or if it is ineffective and does not help sustain the culture .
- Increased transport of people, goods and resources may bring increased demand for services at Wrigley, including but not limited to medical services, emergency response services, water, sanitation, accommodation, housing, and garbage disposal (for residential and business sources).

### 7.4.6 Mitigation of Cumulative Impacts

As change to the environment and people of the area north of Wrigley has already begun with the advent of the winter road, and because the people living in Wrigley perceive benefits from the proposed project, the cumulative impacts discussed above in Section 7.4 require:

- Design considerations to minimize accidents and malfunctions to reduce the risk of spills;
- Monitoring to determine whether remedial works are required for wildlife that use areas close to, or adjacent to, the highway, with respect to reducing accidental wildlife vehicle collisions;
- Consideration of emergency response planning, potentially including training of local people in aspects of spill response suited to the types of spills expected and the response approaches required. Emergency planning should consider not only spills and any associated contamination, but such things as vehicle accidents, wildlife collisions, medical facilities and medical evacuation;
- Ecological resource management in conjunction with hunting, fishing and guiding management strategies to sustain traditional resources in the hinterland of the highway;
- Long term planning to support appropriate services at Wrigley for road users;
- Opportunities for the people of the MVH in the Pehdzeh Ki Ndeh - Dehcho region to meaningfully participate in decisions related to the challenges and opportunities the MVH brings to them;
- Studies are recommended to assess health and wellness change at Wrigley that could be associated with changes that may have occurred due to the arrival of the all-weather road in 1994. Such a study should be designed to provide guidance with respect to future planning for health and wellness in Wrigley and, indeed, to benefit such planning further north as more communities are exposed to the all-weather road;
- It is recommended that the Dehcho Nation people and the PKFN in particular, be supported to enable them to assess the impact of change on their culture and community, on a continual basis as the MVH project progresses until the nature of change actions needed to sustain the cultures can be addressed.

# 8 ENVIRONMENTAL MANAGEMENT PLAN

The preliminary environmental management plan (EMP) presented in the following sections provides a general framework for the management of the potential environmental impacts identified previously and an initial structure for the environmental management plan to be developed and used in later stages of the project. It is important to stress that this preliminary EMP must be considered as a dynamic document, which will be reviewed, edited and updated through the project's life. It should be considered a practical working tool to be consulted and applied by the selected contractor.

## 8.1 LEGAL AND OTHER ENVIRONMENTAL REQUIREMENTS

The construction and operation of the MVH will be governed by a series of laws, regulations and treaties. Authorizations and permits will have to be obtained before initiating any activities and their respective requirements will be taken into consideration in the preparation of the EMP. A non exhaustive list of legal and environmental requirements is presented here after:

- Land Use Permit;
- Quarry Permit;
- Explosives Permit;
- Water Licence;
- Fisheries Authorization and/or Letter of Advice;
- Archaeology Permit.

A detailed list of those legal requirements will have to be established during the completion of the detailed impact study.

## 8.2 ORGANIZATION AND RESPONSIBILITIES

All the key agencies involved in the construction and operation of the MVH will have to be identified as well as the environmental specialists of each of those agencies and their respective responsibilities. This information will have to be updated during the development of the project to reflect a clear chain of command. The following is a preliminary list of stakeholders and their main responsibilities.

### 8.2.1 Contractor

Prior to commencing construction, the contractor will be responsible for completing the EMP in accordance with all the permits and authorizations required. The contractor will submit the EMP to the promoter for acceptance. The contractor will also be responsible for updating the EMP during the construction phase, if needed, and will ensure that all environmental measures described in the EMP are applied during the construction phase. He will also identify a list of key personnel that will be involved in the chain of communication and emergency response procedure.

### 8.2.2 Promoter

The promoter will be responsible for assessing that all environmental measures presented in the EMP are applied. In order to accomplish this task, he can assign a monitoring supervisor who will ensure the proper implementation of the EMP by the contractor.

### 8.2.3 Governmental Agencies

The contractor and promoter can ask for governmental agencies for approvals or recommendations on specific elements of the project. Government agencies that issue the various permits and authorization required for the project may send specialists to audit the project to ensure that the prescribed requirements are being respected.

## 8.3 COMMUNICATION

The contractor will be responsible for developing a strategy that will ensure information circulation within the project's organization. He willreceive feedback on the general matters affecting work activities.

The contractor will ensure communication on environmental aspects through:

- The initial training sessions of all employees;
- Coordination meetings: Environmental matters will be an item on the agenda of regular coordination meetings such as Management meetings, Project meetings, Production meetings, etc;
- Management Review.

The contractor will receive feedback from:

- The coordination meetings mentioned above;
- Discussions during daily inspections on site;
- Reports related to on-site incidents: Specific debriefing will be organized following significant on site incidents (accidents, spills, leaks, etc.).

The communication to external parties (association, competent authorities, communities, etc.) is the responsibility of the Pehdzeh Ki First Nation, unless it is decided to delegate this task to the contractor or an independent subcontractor.

## 8.4 SYSTEM DOCUMENTATION

Records of environmental compliance will have to be produced. They could include certificates, inspections, test and measurement reports, deviations and audit reports as well as training records. Whatever the form used for these records, they will have to be managed in compliance with the final EMP requirements. The contractor will make sure that the documents are periodically reviewed and revised where necessary and that the current versions are available at all locations where activities essential to the functioning of the EMP are performed.

## 8.5 TRAINING

Personnel performing work activities that may affect the environment should be competent in performing this work as to minimize the risk of an unwanted impact on the environment. The competencies may have been obtained from past experiences or from proper training sessions. This can be consolidated by the implementation of a “buddy system”, which gives the opportunity to a new employee to work in cooperation with another more experienced worker who is familiar with the job and requirements.

The contractor will provide training and various tools to promote awareness on environmental aspects and related work instructions. Awareness is also promoted through information documents, review of work plans, issuance of work instructions and, highlighting of related incidents on other projects.

Training is given mainly for new workers and staff engineers or managers in order for them to dispatch the information to their staff and workmen on site. Records of these trainings must be kept.

The following is a list (non exhaustive) of training normally planned and conducted by the contractor (or similar function):

- Introduction training: To each employee or worker, including subcontractor, who begins work on the construction site, a specific introduction will be given to ensure full conformity to the legal, contractual and environmental procedures to be applied on site. This introduction can be done at the same time as the safety introduction;
- Visitor information;
- Reporting on pollution events;
- Main environmental regulations and impacted aspects;
- Spill emergency response procedure.

## 8.6 MONITORING PROCEDURE

A monitoring plan that considers all construction and operation related impacts on the physical, biological and socio-cultural components must be elaborated. Its main purpose is to verify that the recommended mitigation measures are applied as stipulated and attain the level of efficiency expected to minimize the impact’s effect. In this case, all mitigation measures in this report as well as those that will be identified in subsequent phase of the project will have to be incorporated in the final EMP.

This plan will include the preparation of a monitoring tool that will facilitate the work of the employee responsible for on-site inspection. Such a tool may take various forms but is generally comprise of a field book including maps locating the identified potential impacts and tables were the inspector can note his observations. It should include the methodology employed, the monitoring frequency, the personnel assigned to this activity, the equipment needed, etc.

The results of these monitoring activities will be recorded and communicated in respect with the communication strategy.

## 8.7 FOLLOW-UP PROCEDURE

The follow-up program is implemented to document sensitive aspects of the project, to verify effectiveness of identified impacts and to confirm the efficiency of mitigation measures. The necessity of a follow-up program will be determined in a future stage of the project. However, this program, if needed, should include the list of environmental aspects to monitor, the methodology to be used for each aspect, the monitoring frequency, the personnel assigned to this activity, the equipment needed, etc. and results will have to be recorded and communicated.

For each proposed program, the following information shall be supplied:

- The action (or actions) recommended and the purpose;
- The frequency at which this or these actions should be implemented;
- The party that is responsible for the application of the follow-up activity;
- The specialized equipment, material or standards that must be used or followed to conduct the monitoring activities efficiently;
- The description of the special training required to realize these activities;

Finally, the results of these follow-up activities will be recorded and communicated in respect with the communication strategy.

## 8.8 SOCIAL MANAGEMENT PLAN

The social management plan includes the specific plans that will address social impacts in affected areas. The social impact management plan involves three key activities:

- Make provisions for affected communities and persons to contact the promoter and discuss concerns;
- Ensure effective communication between the promoter and the affected communities and individuals throughout all project development phases;
- Ensure that the MVH development initiates, encourages and supports sustainable development throughout the affected and surrounding areas.

These activities are outlined in detail in the following sections.

### 8.8.1 Provisions for Communities/Persons to Contact and Discuss Concerns

With a project of this size and importance, the determination of an appropriate and effective system to receive complaints is vital. A defined procedure for treating complaints is necessary during the development process to ensure that all complaints received are treated appropriately. Such a system enables the developer to maintain a good relationship with the public and enables him to address complaints in a timely and satisfactory manner, in order to avoid judicial proceedings. The contractor and/or the promoter will have to elaborate a detailed procedure for dealing with complaints during all project phases.

### 8.8.2 Communications with Affected Communities and Individuals

Communication with the public, and most importantly members of communities directly impacted by the project, is integral to the successful development of the MVH. In order to keep the population informed, throughout all phases of the project, progress updates and future activities will be communicated regularly and information will be made available to the public through various media.

#### *8.8.2.1 Public Notices*

The contractor will publish notices of potentially disruptive works a minimum of seven days prior to the undertaking of such activities. For example, as construction activities impact new communities, these communities must receive at least one week’s advanced warning. Activities that may be considered disruptive include those activities that may impact local traffic circulation, utilities and/or other services as well as all activities that may cause increased noise, vibrations, dust and/or pollution in the nearby areas. Notices will be published a minimum of three days in at least one regional newspaper. Notices will also be communicated via audio and visual media (i.e. news and radio).

#### *8.8.2.2 Coordination with Agencies and Organizations*

For the successful integration of the MVH, coordination with numerous agencies is required. These include the MVEIRB, MVLWB, AANDC, Village and Community Councils, NGOs and other relevant authorities in order to provide access to all public and social services.

#### *8.8.2.3 Job Opportunities*

The promoter and contractor will ensure that job postings and descriptions of positions are available both online and at key locations, throughout pre-construction, construction and operations phases. The list of available positions will be kept up to date by the human resources department.

Both promoter and contractor will ensure that hiring follows the following priority list:

1. Local communities candidates;
2. Canadian candidates;
3. International candidates.

Therefore, qualified personnel from local communities will be given first priority for jobs. Where no suitable person from local communities is available for a position, candidates from other locations in Canada will be considered. Finally, if there are no Canadian candidates available, international applicants will be considered.

### 8.8.3 Development Programs in support of Sustainable Community Development

The MVH presents many opportunities to improve the sustainability of local communities along the alignment. The promoter and contractor will collaborate with other agencies to ensure that all possible benefits of the MVH are realized.

Prior to construction, the contractor and promoter will host meetings in local communities along the alignment with business owners and representatives of business associations. Regional and national urban planners, representatives of MVEIRB, MVLWB should participate in these meetings. The purpose of these meetings will be to identify strategies to ensure growth and development of existing businesses throughout construction and operations phases.

To mitigate possible negative impacts on existing businesses, the contractor will ensure that traffic circulation and parking facilities around businesses are not disrupted by the development of the highway.

## 8.9 ACCIDENTS OR MALFUNCTIONS

The EMP should include an Emergency Response Plan (ERP) that addresses accidents or malfunctions. The purpose of an ERP is to ensure a quick, effective and appropriate response to emergencies in order to protect the public and personnel involved in MVH from fatalities and irreversible health effects, and the environment from damages.

The contractor will draw up an ERP in compliance with local legal requirements and specific characteristics related to the project. All the employees will be aware (induction, trainings, etc.) of this plan in order to be ready in case of emergency situations.

This plan will include all the necessary information, instructions, plans, phone numbers which are useful in case of an emergency situation. The information of the ERP will have to be updated regularly. The aim of the ERP is to ensure that appropriate responses are taken quickly and correctly to:

- Safeguard Life and Property;
- Ensure coordination between Available Resources;
- Minimize the impacts of Natural and Human-induced Emergencies;
- Encourage affected persons to be Self Sufficient in the period immediately following the Emergency.

## 8.9.1 Emergency Response Procedures

### *8.9.1.1 Emergency Alert*

In the event of an incident, the Contractor, his workers, the subcontractors or members of the public should contact the appropriate responder (health personnel, fire services, police, etc.). Therefore, relevant contact information should be clearly posted in various areas around the work site.

### *8.9.1.2 Spill Contingency Plan and Oil Pollution Emergency Plan*

The following procedure describes the roles of the Contractor's managers, the Promoter and the Emergency Response Team in bringing under control an emergency situation involving spilled hydrocarbons (fuel, lubricating oils etc.).

- The person who first discovers the spill or leak shall, without jeopardizing his own safety, checks if anyone is injured. He shall then inform someone from the Contractor's managers;
- The Contractor's managers on becoming aware of the occurrence of a hydrocarbon spill or release will immediately notify the Emergency Response Team. The Emergency Response Team will ascertain the level of the emergency and initiate the relevant response;
- The Emergency Response Team will arrange to have the area isolated, ensure that all ignition sources have been removed if safe to do so;
- The Emergency Response Team will request any further support as necessary;
- If external support is needed, the Contractor's managers will notify fire services and any other relevant agency and advise them of the location of the incident and the nature of the hazardous material;
- Once the emergency is brought under control the Contractor's managers will give the "All Clear", if necessary, on advice of the Fire Services and other relevant authorities;
- An investigation into the cause of the spill should be conducted and a deviation report produced to determine where deficiencies occur and how to prevent them in the future.

### *8.9.1.3 Natural Disasters*

The following procedure describes the roles of the Contractor's manager and the Emergency Response Team in bringing under control an emergency situation involving a natural disaster:

- In the event of an oncoming natural disaster (earthquake or snowstorm), the site will be secured and evacuated under the supervision of the Contractor's manager, and with the help or resources of emergency response team;
- External emergency health personnel, fire services, and police will be called to the site as needed;
- An inspection of the site and works will be carried out by the Emergency Response Team and other designated staff to determine if there has been any damage;
- Once the site has been determined to be safe the Contractor's managers will give the "All Clear" to resume work.

#### *8.9.1.4 Fire*

The following procedure describes the roles of the Contractor's managers and the Emergency Response Team in bringing under control an emergency situation involving fire:

- The person who first discovers the fire shall, without jeopardizing his own safety, check if anyone is injured. He shall then inform one of the Contractor's managers;
- The level of emergency will be determined by this manager who will then contact the Fire and ambulance Services and the Electrical Utility Company (as necessary);
- If the fire can be handled on-site then workers trained to do so shall use fire fighting equipment available;
- Once the fire is brought under control the Contractor's Managers will give the "All Clear" on advice, if necessary, of the Fire Services;
- An investigation into the cause of the fire should be conducted and a deviation report produced to determine where deficiencies occur and how to prevent them in the future.

### 8.9.2 Training, Resources and Equipment

Training should be conducted to adequately prepare workers and subcontractors for emergencies, use of emergency response equipment and knowledge of the resources available from external agencies. These trainings will complement the information received during the safety sessions provided to all working personnel. First aid/ first response training should be provided to selected workers the names of whom must be communicated to all workers. Practice drills could also be done to allow workers to become more familiar with the emergency response / evacuation procedures and reinforce the training received.

Emergency response equipment will be available at specific on-site locations to allow a quick response. A list of emergency contact numbers will also be maintained up to date by the contractor and dispatched at specific on-site locations. All members of the emergency response team as well as main managers will receive a copy of this list every time an update is completed. Phones will be made available on-site at specific, well identified, locations to allow anyone to contact the emergency team at any time.

Emergency evacuation plans will be maintained up to date and posted on-site at well-identified specific locations. These plans will be explained during specific trainings. They will, as a minimum, show the location of extinguishers, indicate the direction of evacuation, and identify the assembly points and the location of the map's location on the site.

This section serves primarily in describing an Emergency Response Plan and supplying a framework and guide to complete the emergency response plan to be prepared during a future stage of the project. It should also be adjusted during the construction, so that it remains relevant.

As mentioned previously, the EMP should be revised by the contractor based on newly available information provided in later stages of the project. Site-specific mitigation measures will be clearly indentified and detailed. Other information will be added to the EMP based on celements such as:

- Fuel Storage System and Maintenance;
- Refuelling Operations;
- Waste Management;
- Disposal of waste oil;
- Use and disposal of wood preservatives containing Polychlorinated phenols (PCBs);
- Drainage Design;
- Road cuts and earth movement;
- etc.

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# Appendix 1 Winter Road and Optimized Alignment

DESSAU


Winter Road

Other Road

Settlement Boundary

Existing bridge

Bridge to be built or re-built

1 Map Sheet

PKFN trails

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government*
*- NTDB, 1 : 250 000, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**INDEX**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C113-00 |
| Drawn : | G. Lemay | Scale : | 1:525 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km

Projection UTM zone 10N, WGS84

DESSAU

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Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
Primary Borrow Source (MacKenzie Gaz Project)
Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

*Sources :*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 1-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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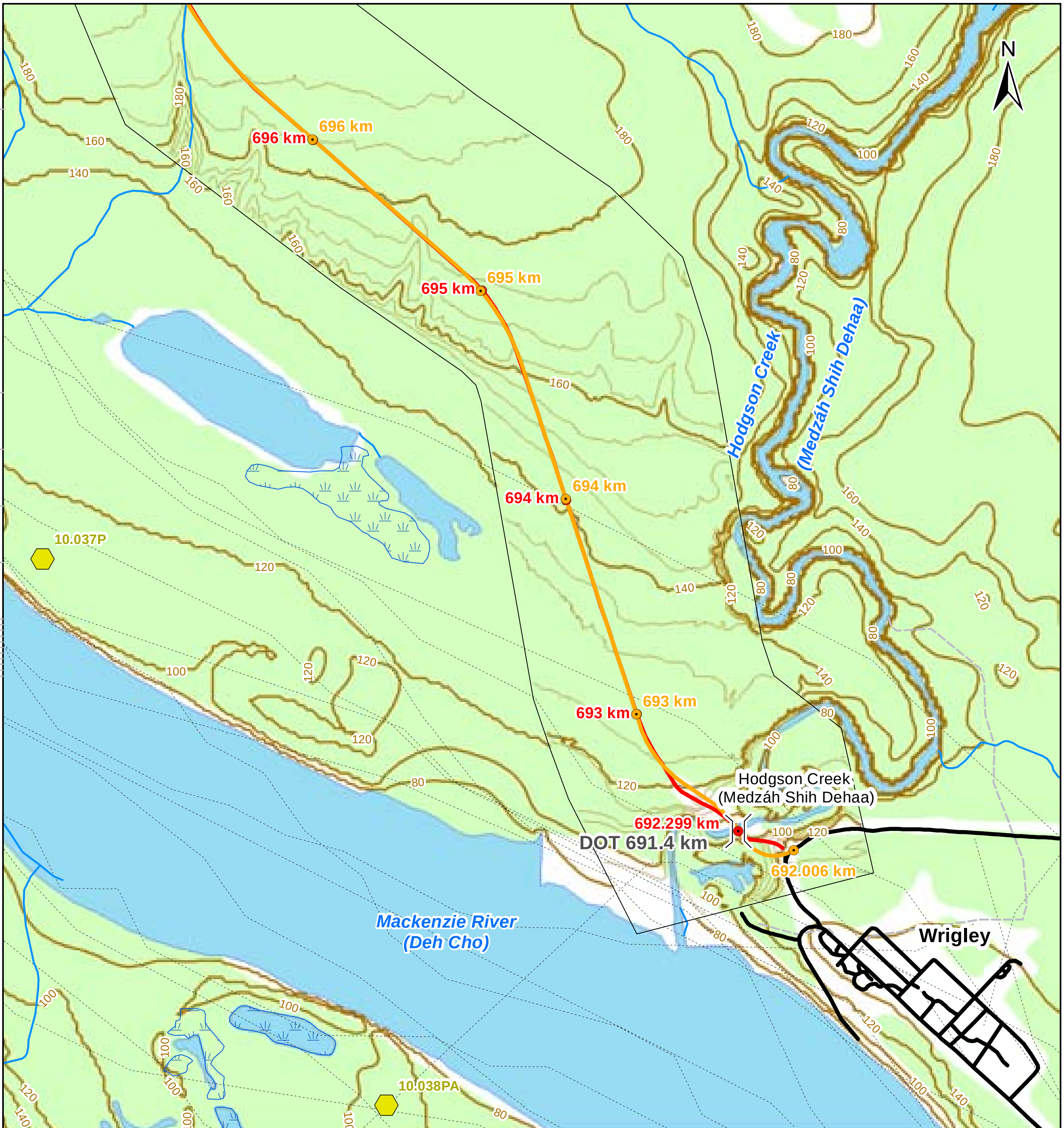


| | |
|---|---|
| Optimized Alignment - KM Marker | Sand |
| Winter Road - KM Marker | Wetland |
| Optimized Alignment | River |
| Optimized Alignment Alternative | Waterbody |
| Winter Road | Wooded Area |
| Other Road | Rare Plant Location |
| Gas Pipeline | Ungulate Observations |
| Settlement Boundary | Sahtu Private Lands |
| Existing bridge | EBA Data Acquisition Limit |
| Bridge to be built or re-built | Existing Borrow Source |
| Contour line (in meters) | Primary Borrow Source (Mackenzie Gas Project) |
| Trail | Secondary Borrow Source (Mackenzie Gas Project) |
| PKFN trails | |

**PKFN Main Traditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
*- CanVec, Canada Government.*
*- LiDAR EBA.*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 1-T**

| | | | |
|---|---|---|---|
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| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

DESSAU

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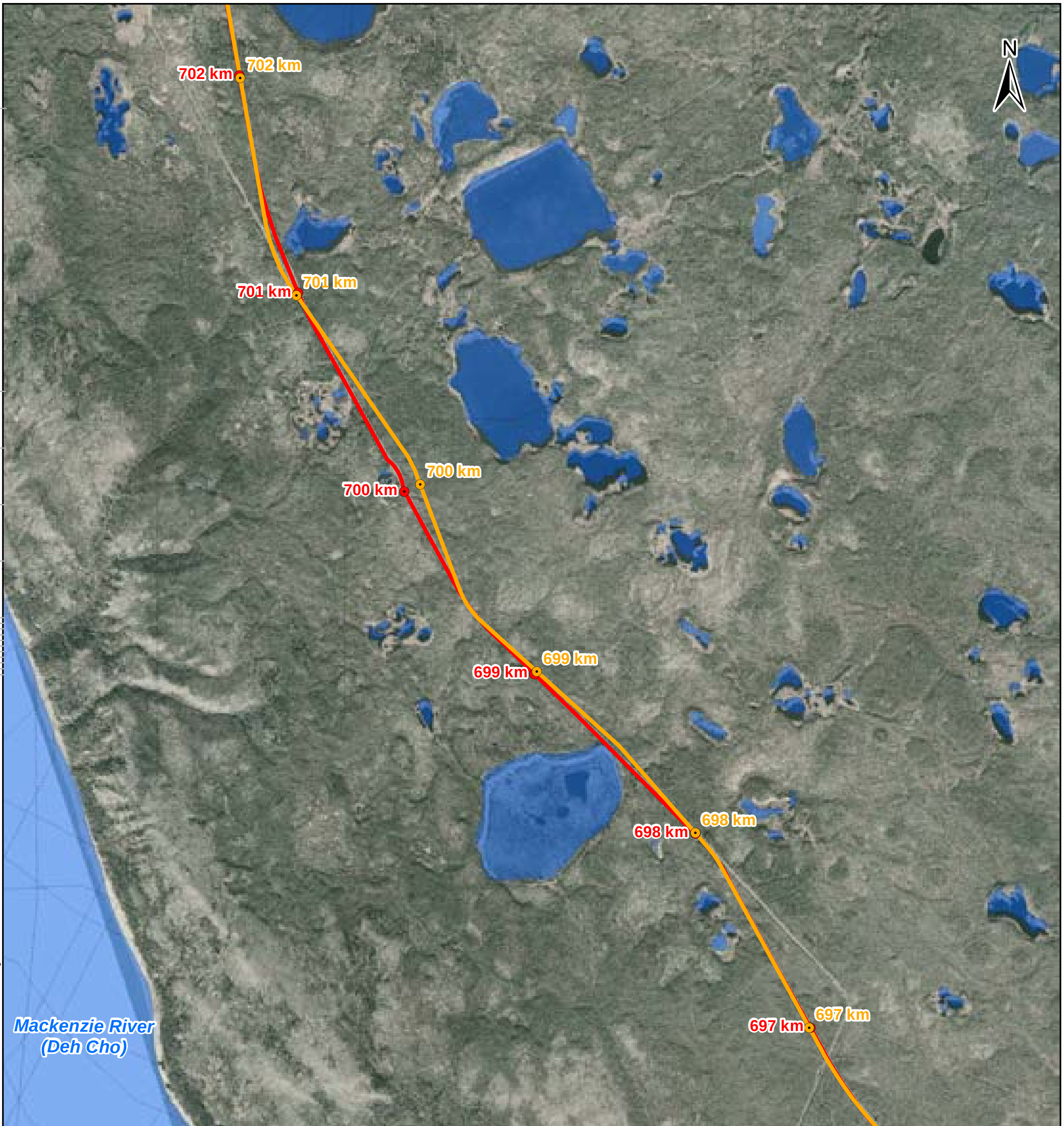


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 2-P**

| | | | |
|---|---|---|---|
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| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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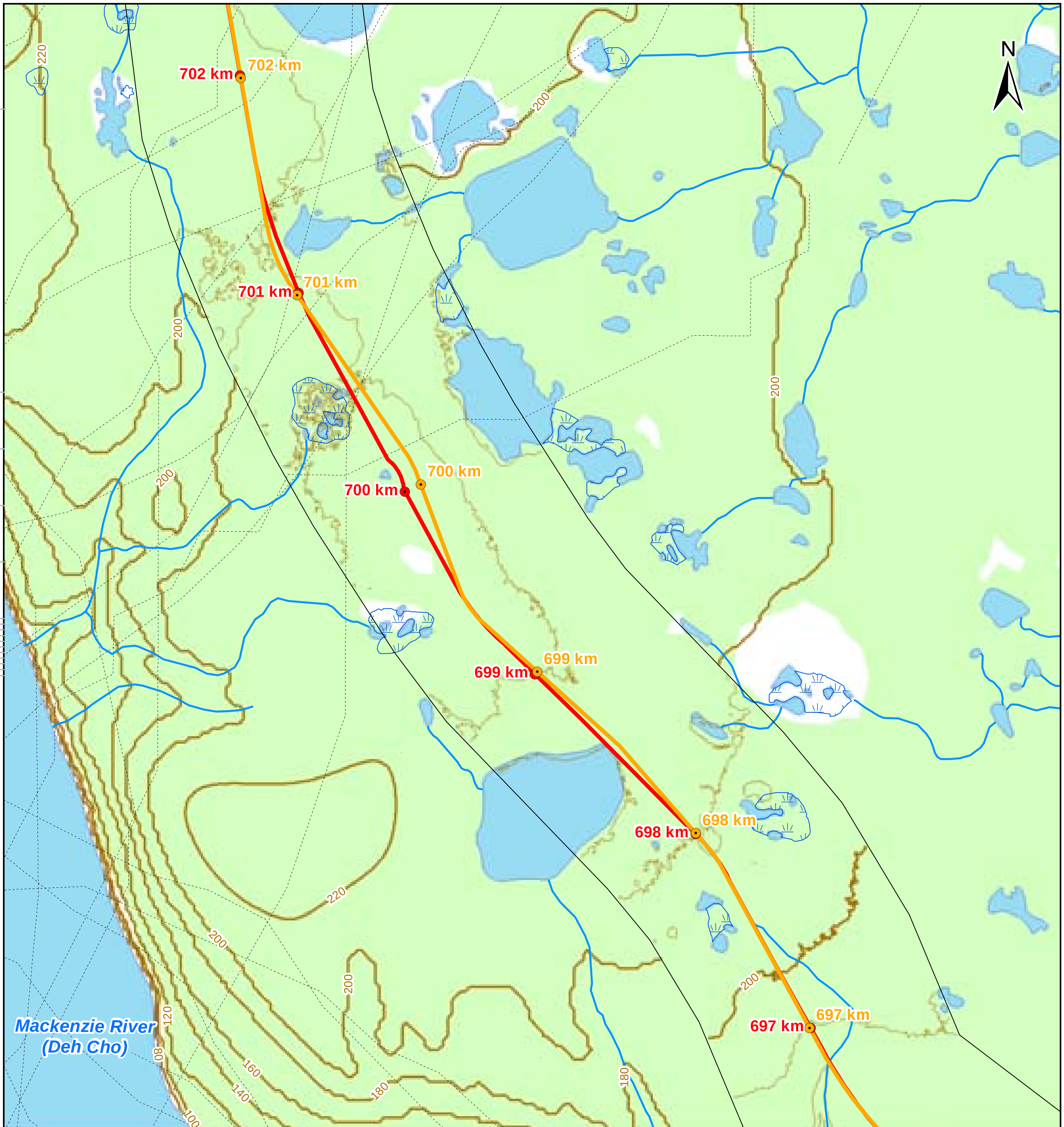



- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Contour line (in meters)
- Trail
- PKFN trails

- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- EBA Data Acquisition Limit
- Existing Borrow Source
- Primary Borrow Source (Mackenzie Gas Project)
- Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
*- CanVec, Canada Government.*
*- LiDAR EBA.*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 2-T**

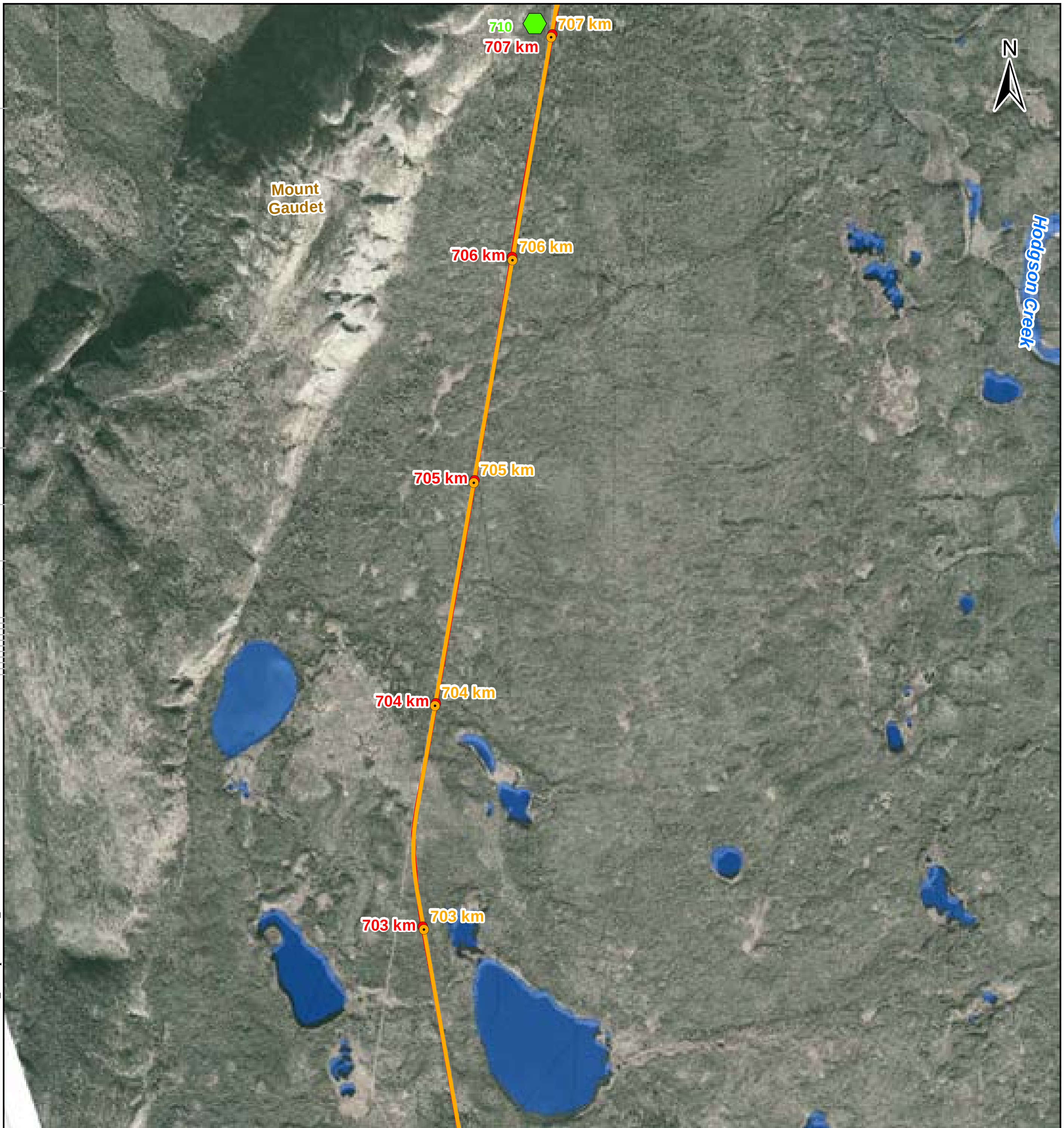
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd




Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
Primary Borrow Source (MacKenzie Gaz Project)
Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

*Sources :*
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*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 3-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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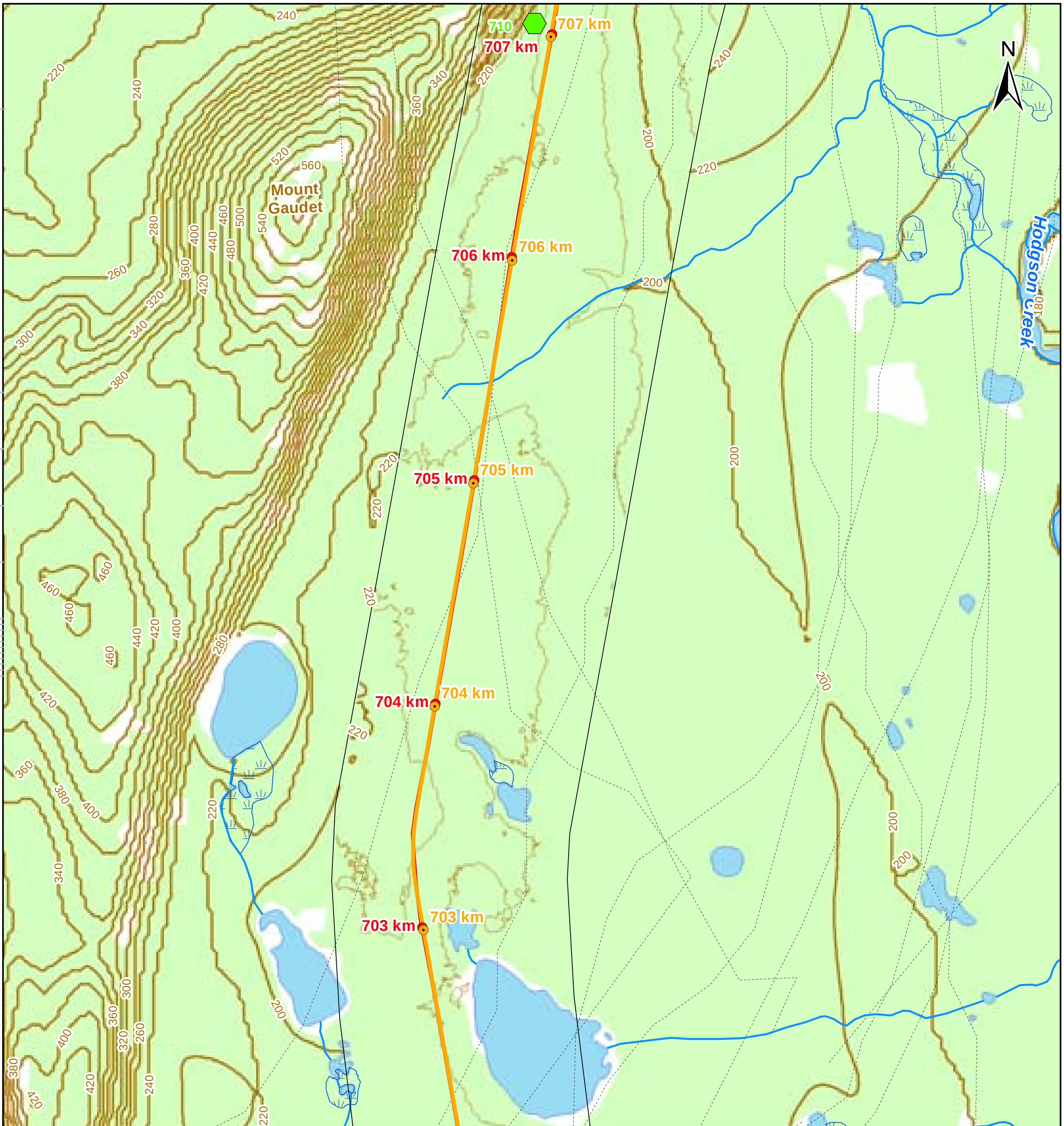


| | | | | | |
|---|---|---|---|---|---|
| | Optimized Alignment - KM Marker | | Sand | | Burial Area |
| | Winter Road - KM Marker | | Wetland | | Hunting Cabins and Traplines |
| | Optimized Alignment | | River | | Moose Pasture Area |
| | Optimized Alignment Alternative | | Waterbody | | Spiritual and Cultural Sites |
| | Winter Road | | Wooded Area | | Water Proximity Concern |
| | Other Road | | Rare Plant Location | | Traditional Hunting Ground |
| | Gas Pipeline | | Ungulate Observations | | |
| | Settlement Boundary | | Sahtu Private Lands | | |
| | Existing bridge | | EBA Data Acquisition Limit | | |
| | Bridge to be built or re-built | | Existing Borrow Source | | |
| | Contour line (in meters) | | Primary Borrow Source (Mackenzie Gas Project) | | |
| | Trail | | Secondary Borrow Source (Mackenzie Gas Project) | | |
| | PKFN trails | | | | |

**PKFN Main Traditional Activity Site**

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
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- *LiDAR EBA.*
- *Mackenzie Gas Project, 2007*
- *PKFN, 2011*
- *© Deh Cho First Nations, 2004*
- *Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 3-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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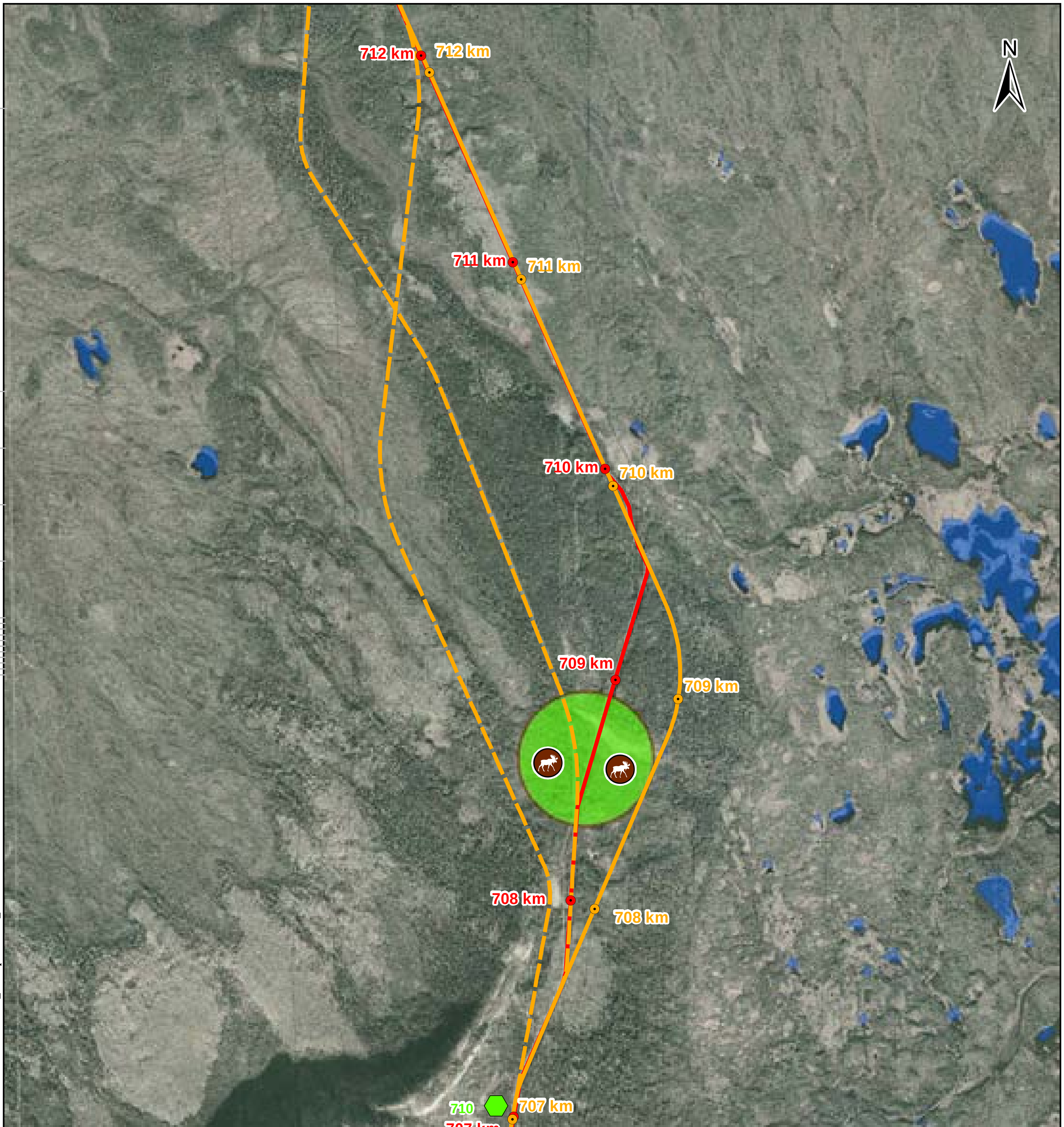


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
Primary Borrow Source (MacKenzie Gaz Project)
Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

*Sources :*
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*- Mackenzie Gas Project, 2007*
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*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 4-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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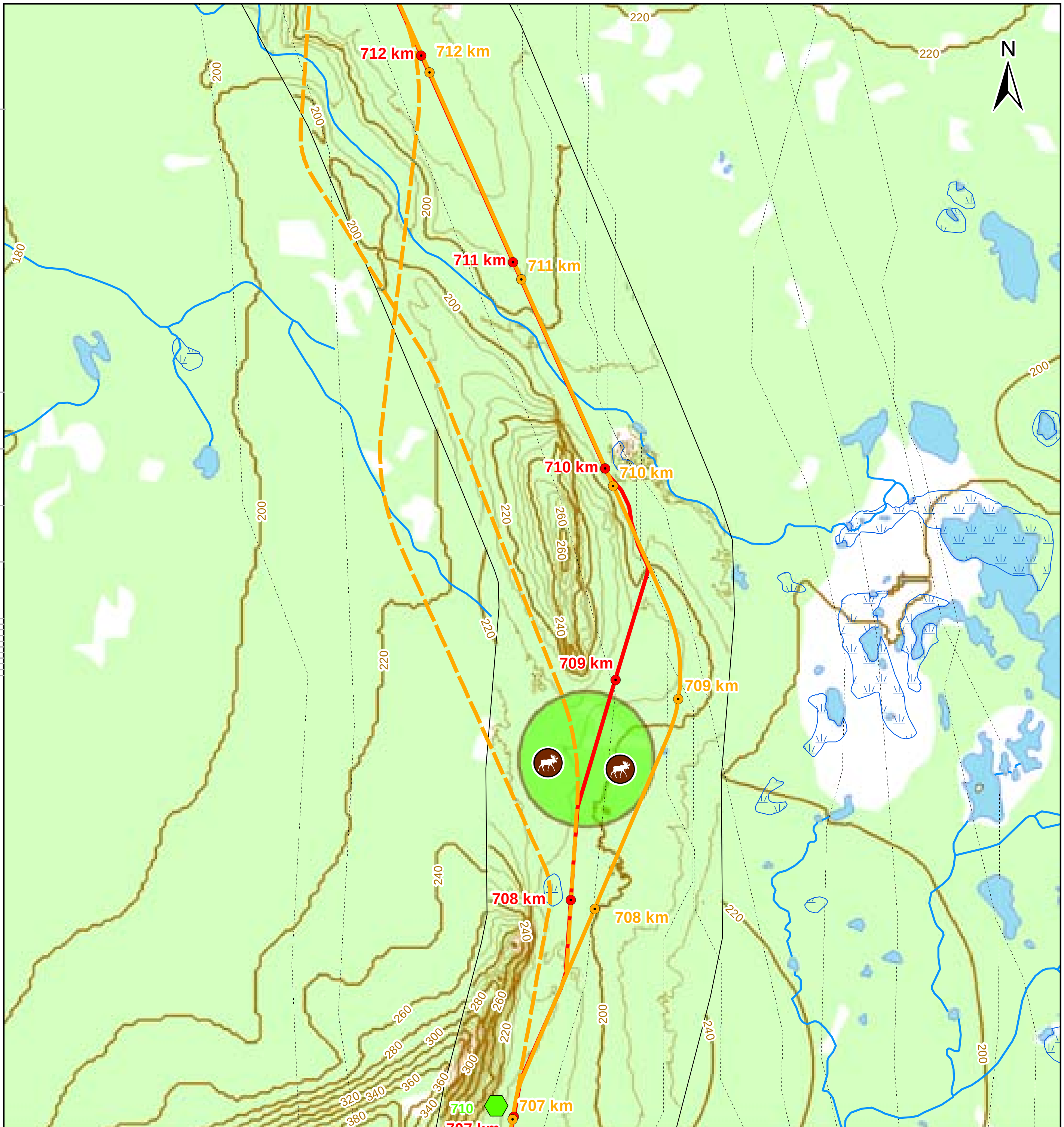


| | | | |
|---|---|---|---|
| Optimized Alignment - KM Marker | Sand | **PKFN Main Traditional Activity Site** | |
| Winter Road - KM Marker | Wetland | Burial Area | |
| Optimized Alignment | River | Hunting Cabins and Traplines | |
| Optimized Alignment Alternative | Waterbody | Moose Pasture Area | |
| Winter Road | Wooded Area | Spiritual and Cultural Sites | |
| Other Road | Rare Plant Location | Water Proximity Concern | |
| Gas Pipeline | Ungulate Observations | Traditional Hunting Ground | |
| Settlement Boundary | Sahtu Private Lands | | |
| Existing bridge | EBA Data Acquisition Limit | | |
| Bridge to be built or re-built | Existing Borrow Source | | |
| Contour line (in meters) | Primary Borrow Source (Mackenzie Gas Project) | | |
| Trail | Secondary Borrow Source (Mackenzie Gas Project) | | |
| PKFN trails | | | |

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
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*- Mackenzie Gas Project, 2007*
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 4-T**

Prepared : G. Colaneri
Drawn : G. Lemay
Checked : D. Aubin

No : 068-P0037500-202-001-GO-C116-00
Scale : 1:25 000
Date : February 27, 2012

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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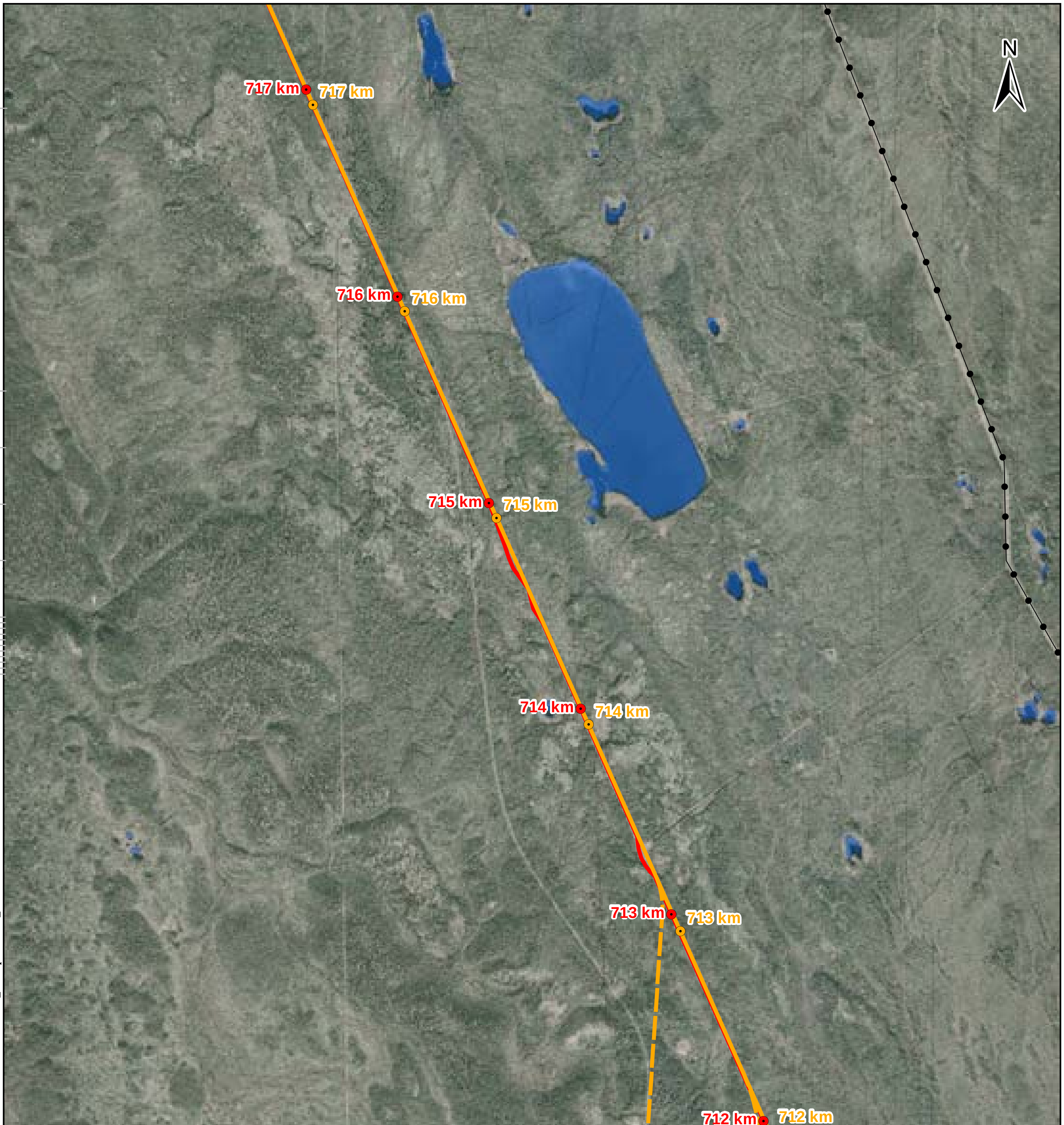


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 5-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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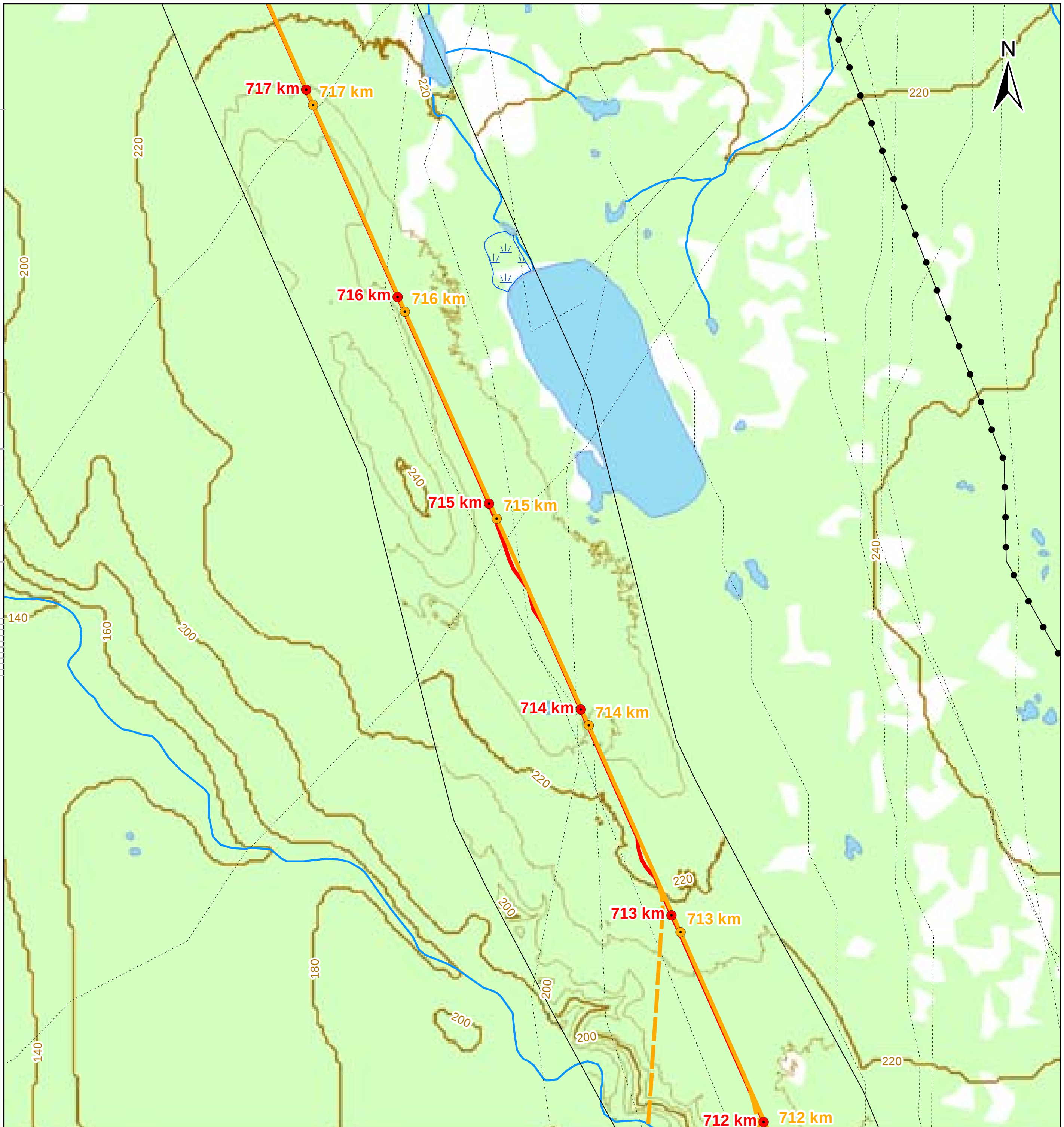


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- EBA Data Acquisition Limit
- Existing Borrow Source
- Primary Borrow Source (Mackenzie Gas Project)
- Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

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*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 5-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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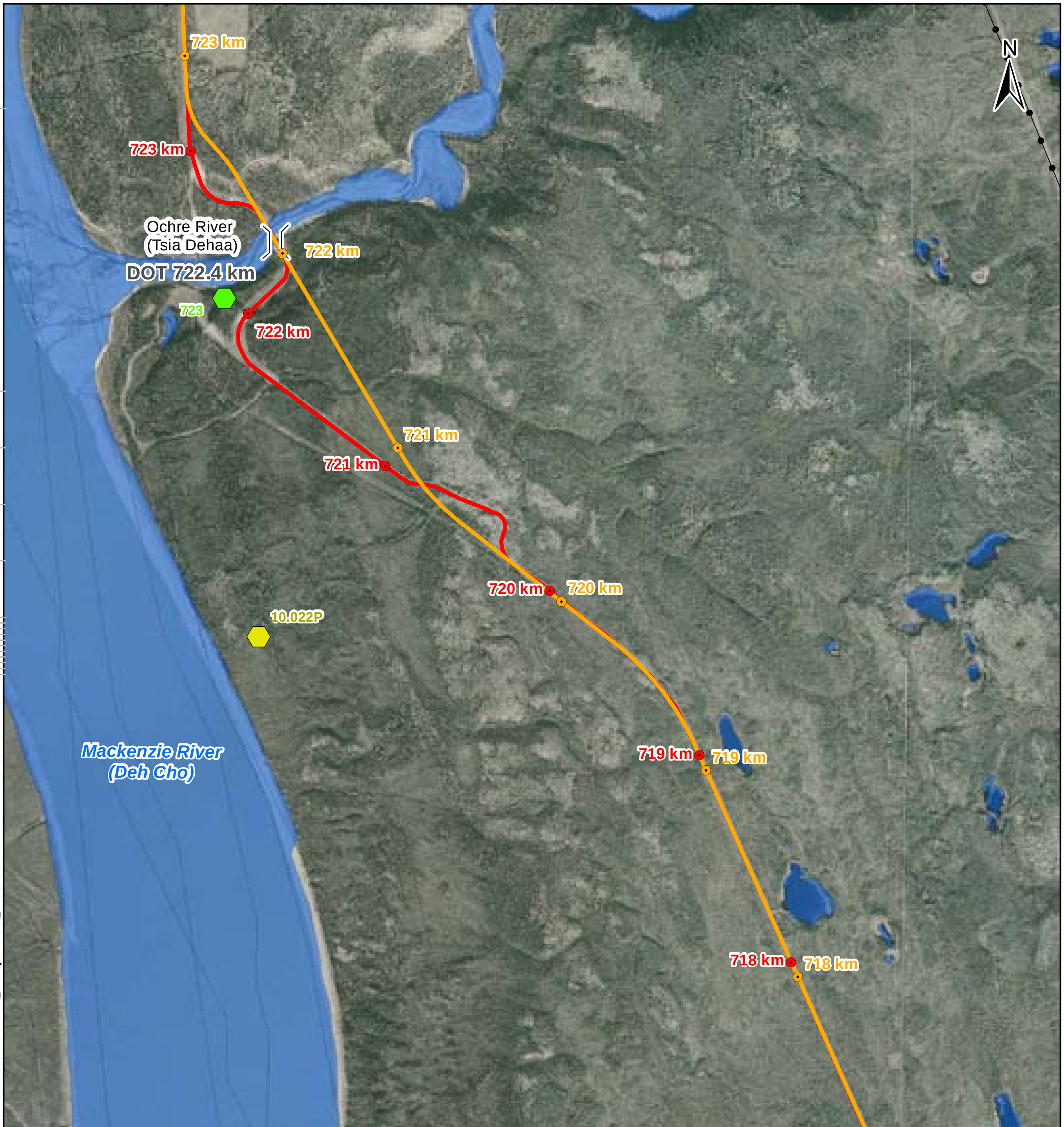


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 6-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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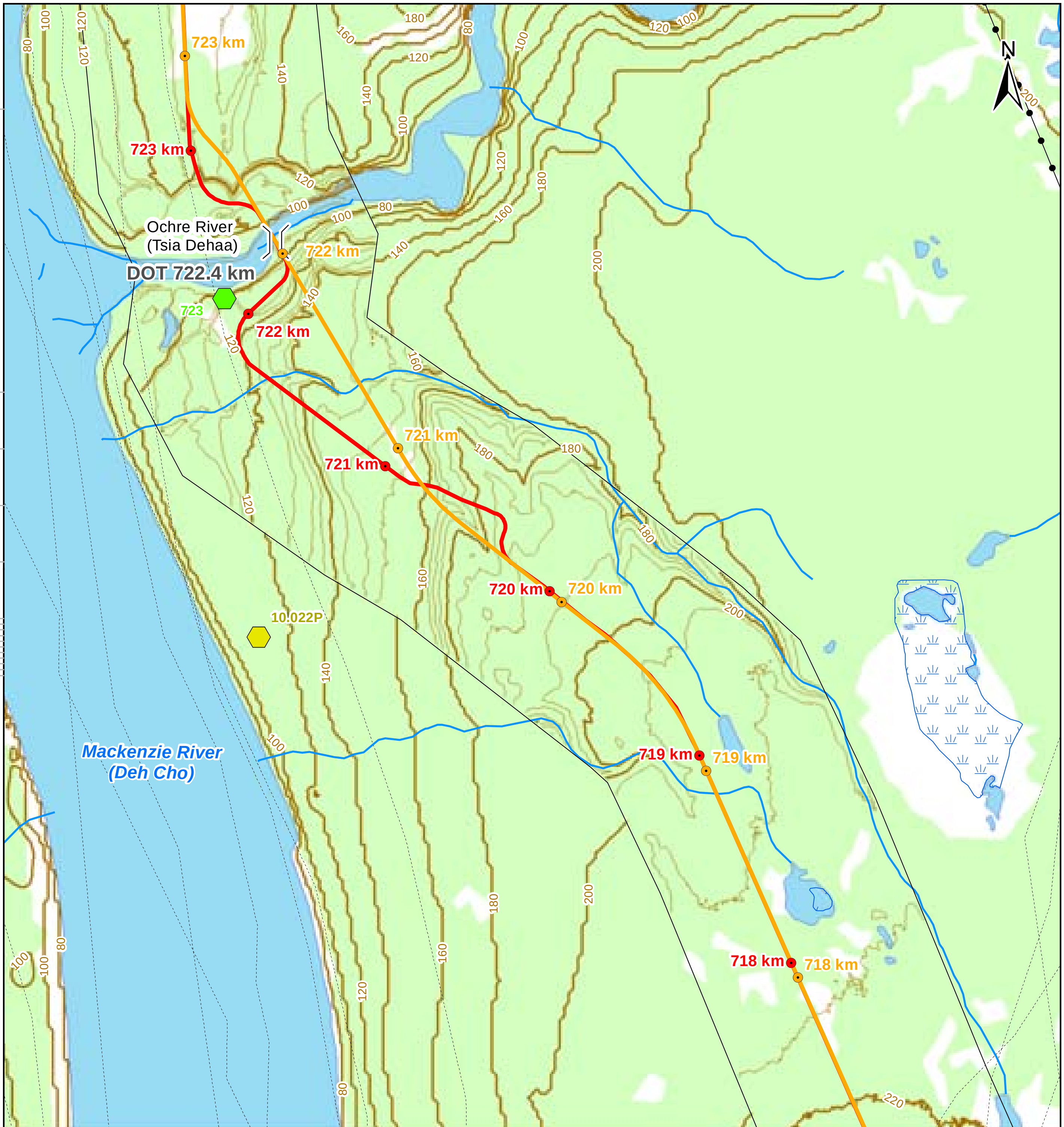


| | | | |
|---|---|---|---|
| Optimized Alignment - KM Marker | Sand | | |
| Winter Road - KM Marker | Wetland | | |
| Optimized Alignment | River | | |
| Optimized Alignment Alternative | Waterbody | | |
| Winter Road | Wooded Area | | |
| Other Road | Rare Plant Location | | |
| Gas Pipeline | Ungulate Observations | | |
| Settlement Boundary | Sahtu Private Lands | | |
| Existing bridge | EBA Data Acquisition Limit | | |
| Bridge to be built or re-built | Existing Borrow Source | | |
| Contour line (in meters) | Primary Borrow Source (Mackenzie Gas Project) | | |
| Trail | Secondary Borrow Source (Mackenzie Gas Project) | | |
| PKFN trails | | | |

**PKFN Main Traditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
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*Note : Detailled contours are available only in the EBA Acquisition Limit.*

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 6-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

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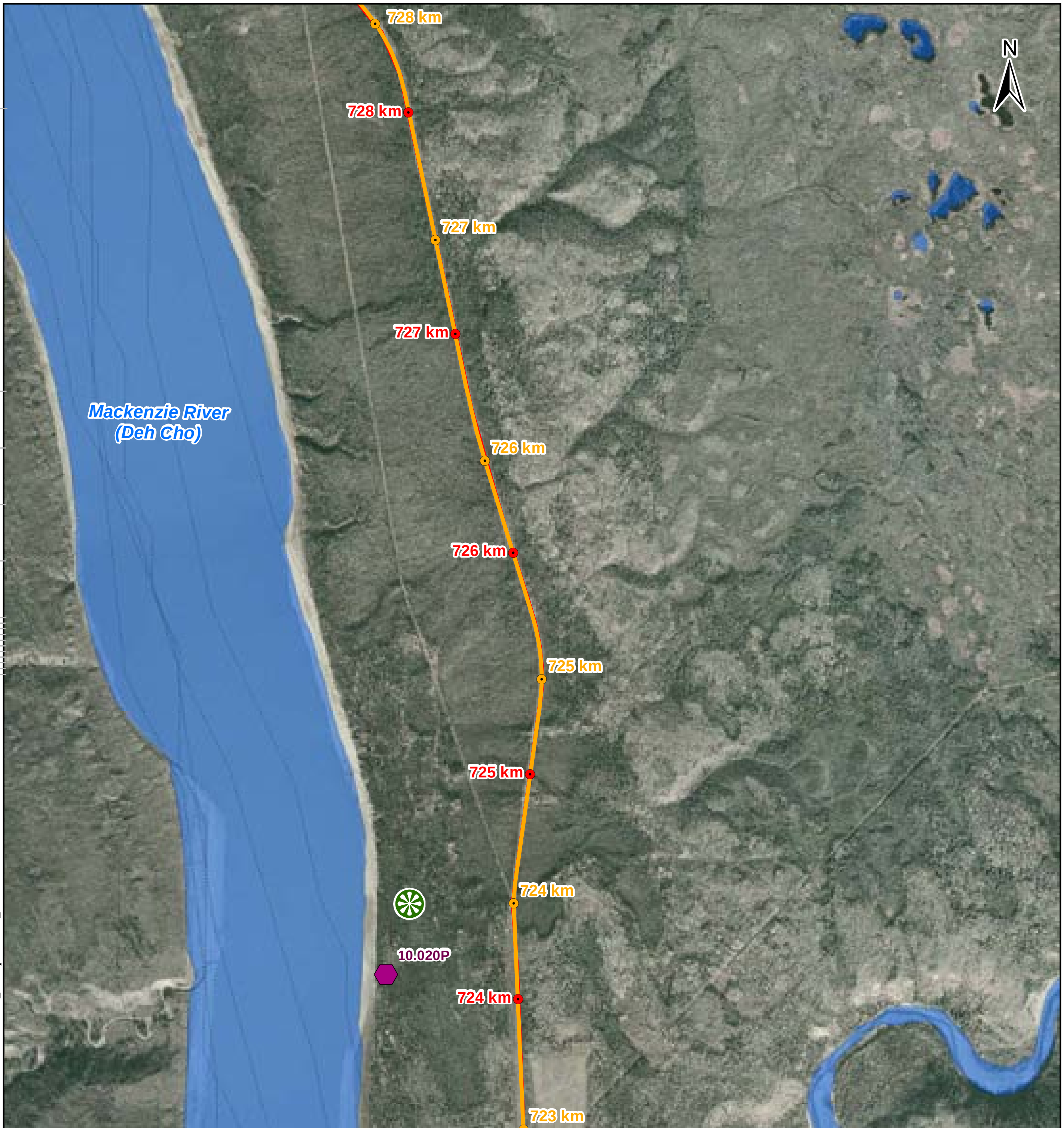


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
Primary Borrow Source (MacKenzie Gaz Project)
Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**
Burial Area
Hunting Cabins and Traplines
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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 7-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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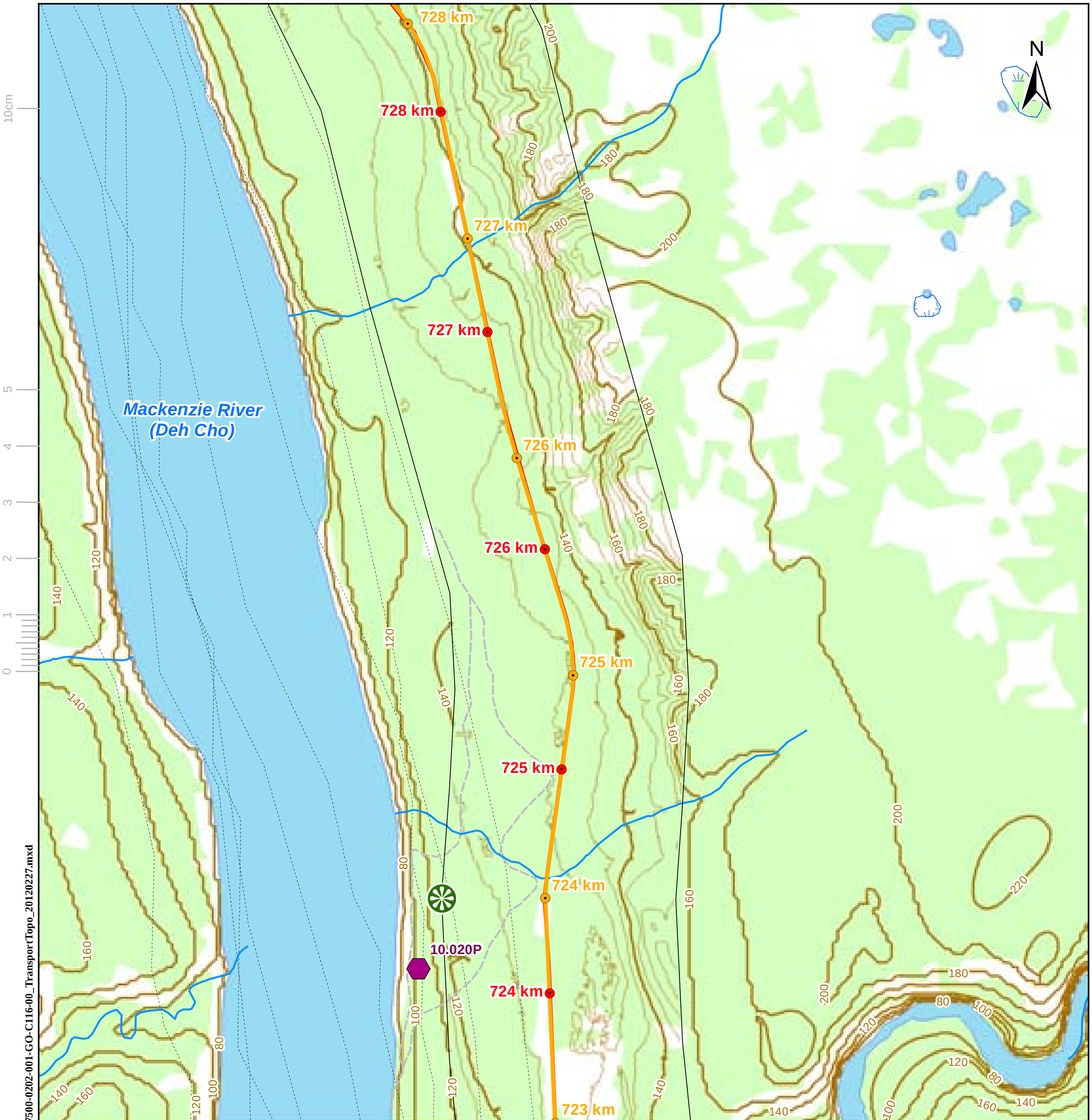


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
Contour line (in meters)
Trail
PKFN trails

Sand
Wetland
River
Waterbody
Wooded Area
Rare Plant Location
Ungulate Observations
Sahtu Private Lands
EBA Data Acquisition Limit
Existing Borrow Source
Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

Burial Area
Hunting Cabins and Traplines
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Water Proximity Concern
Traditional Hunting Ground

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 7-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
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0 1 km

Projection UTM zone 10N, WGS84

DESSAU

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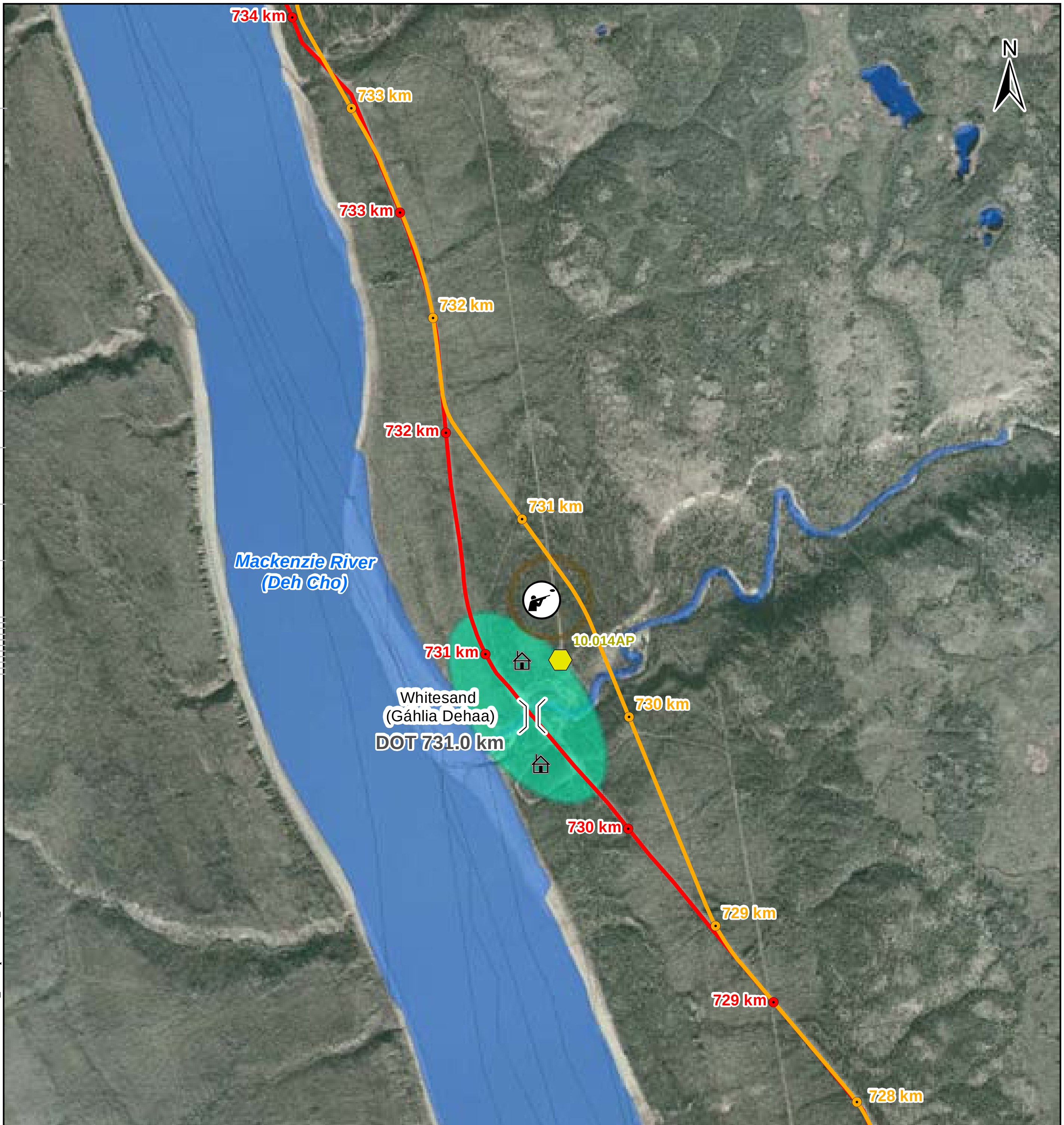


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails

- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
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**PKFN MainTraditional Activity Site**

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 8-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
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0 1 km

Projection UTM zone 10N, WGS84

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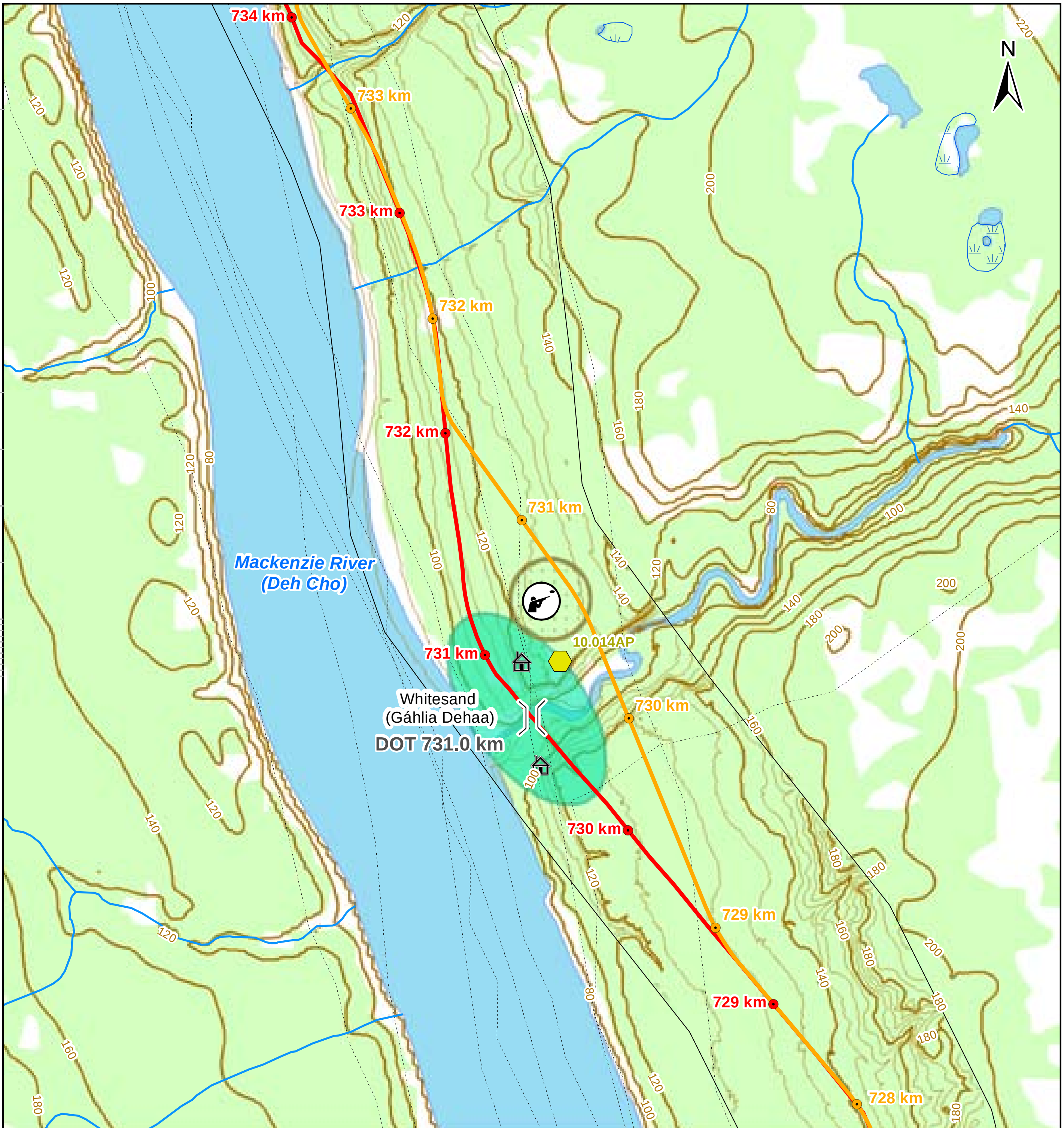


FORMAT : 8,5" x 11"
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- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- EBA Data Acquisition Limit
- Existing Borrow Source
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**PKFN Main Traditional Activity Site**

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

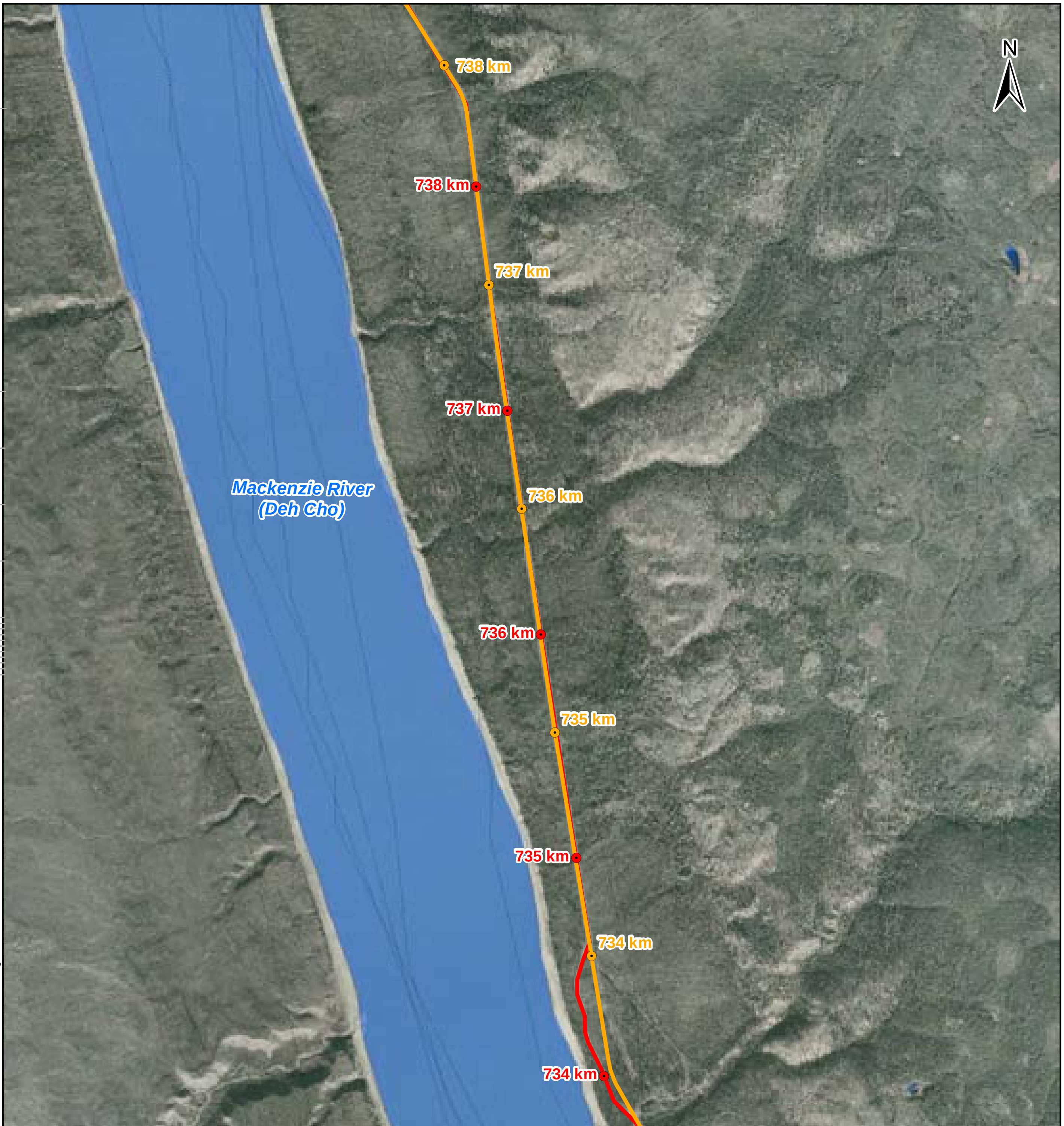
**Winter Road and Optimized Alignment**
**Sheet 8-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 — 1 km

Projection UTM zone 10N, WGS84

DESSAU




- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
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*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 9-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km
Projection UTM zone 10N, WGS84

DESSAU

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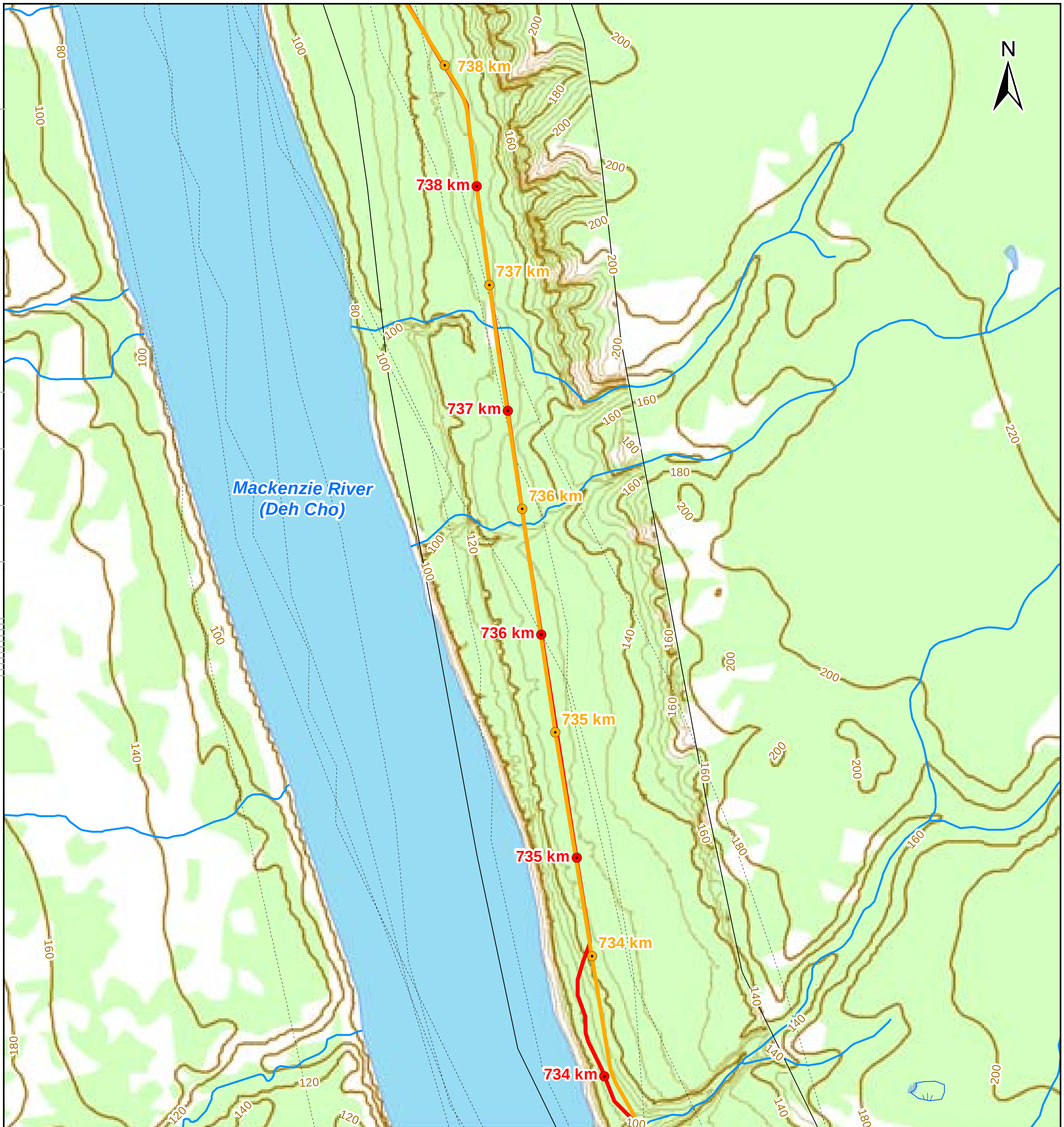


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
Contour line (in meters)
Trail
PKFN trails

Sand
Wetland
River
Waterbody
Wooded Area
Rare Plant Location
Ungulate Observations
Sahtu Private Lands
EBA Data Acquisition Limit
Existing Borrow Source
Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 9-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
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0 1 km

Projection UTM zone 10N, WGS84

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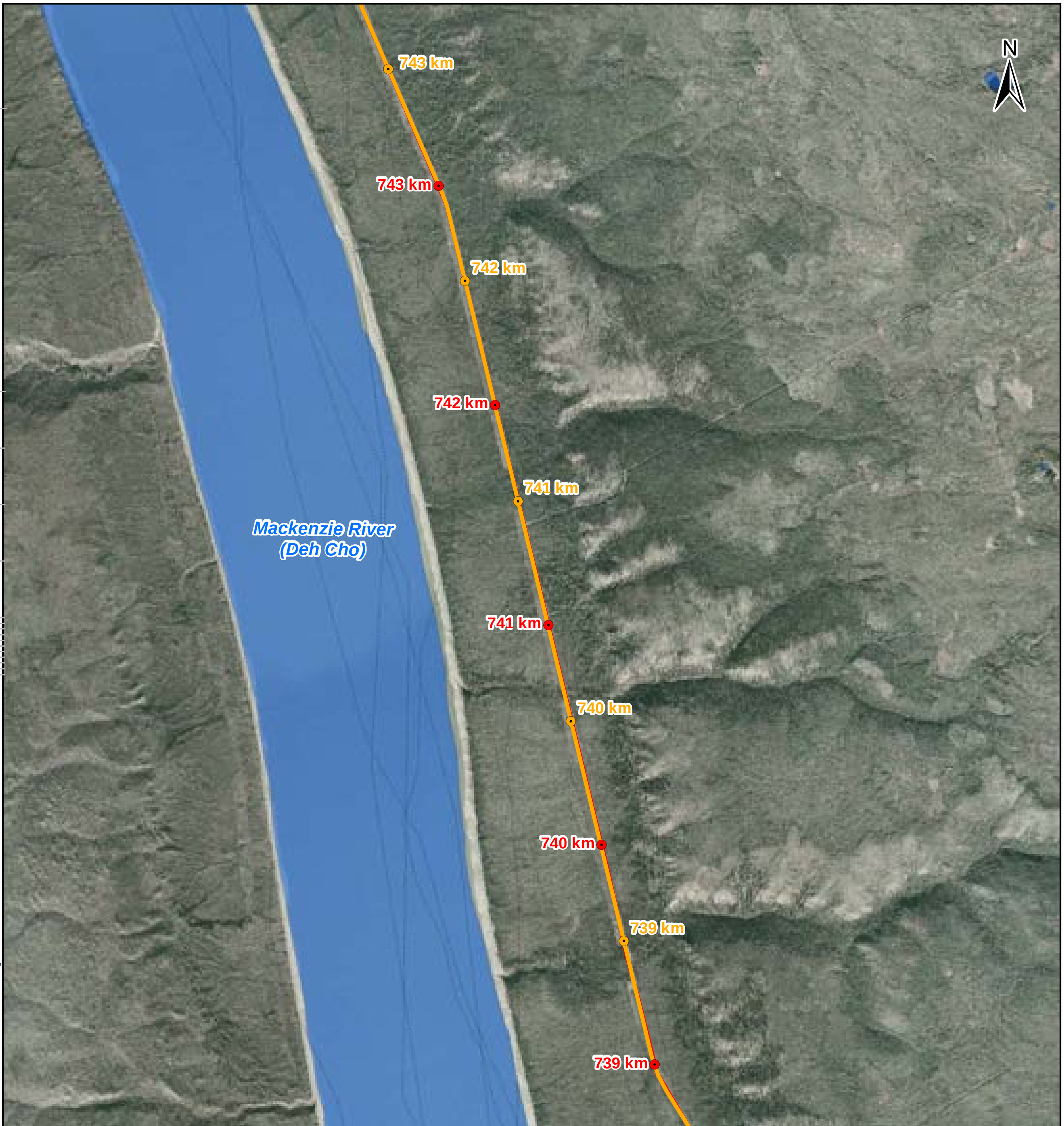


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
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Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 10-P**

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Projection UTM zone 10N, WGS84

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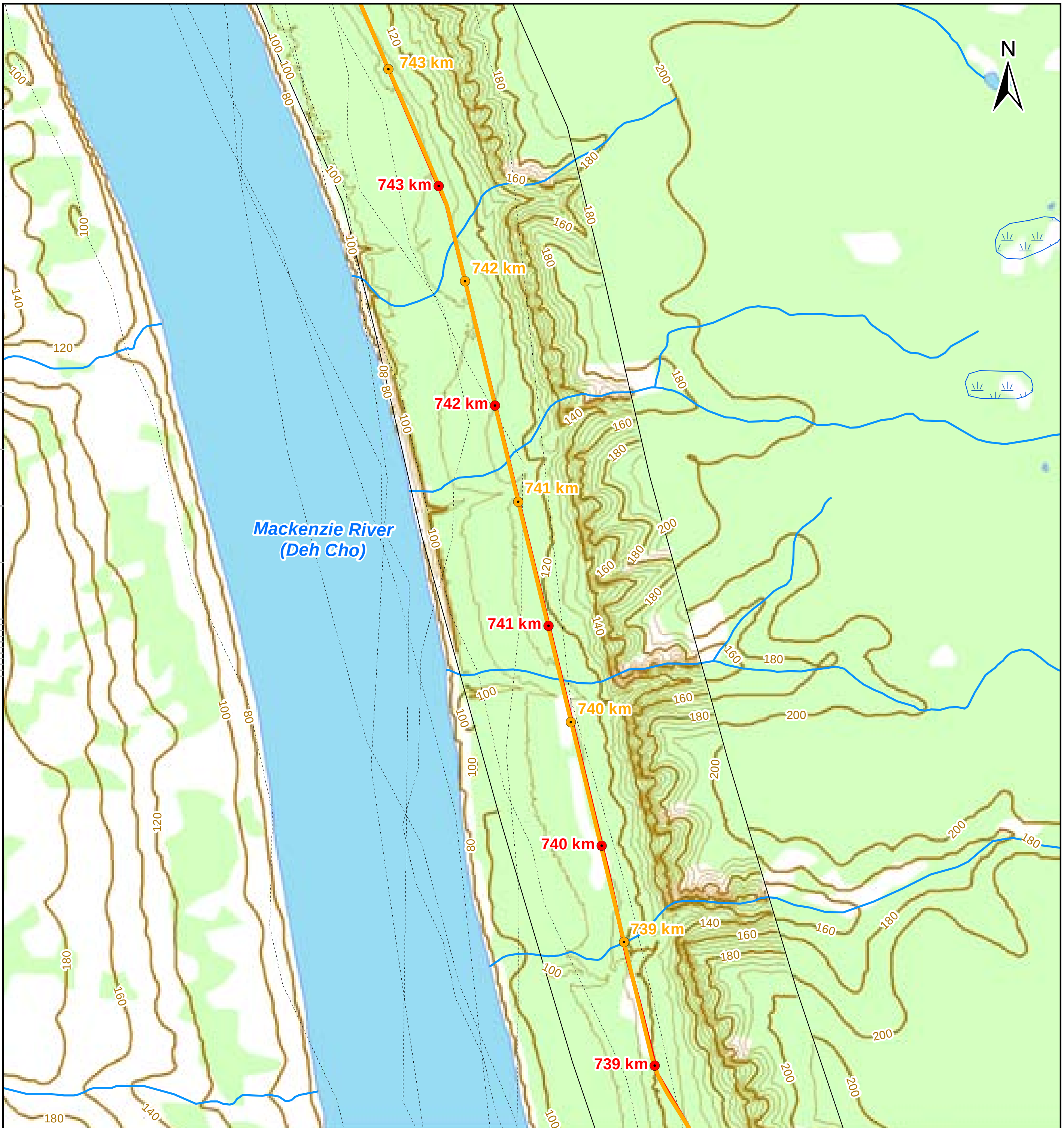


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- EBA Data Acquisition Limit
- Existing Borrow Source
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Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 10-T**

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Projection UTM zone 10N, WGS84

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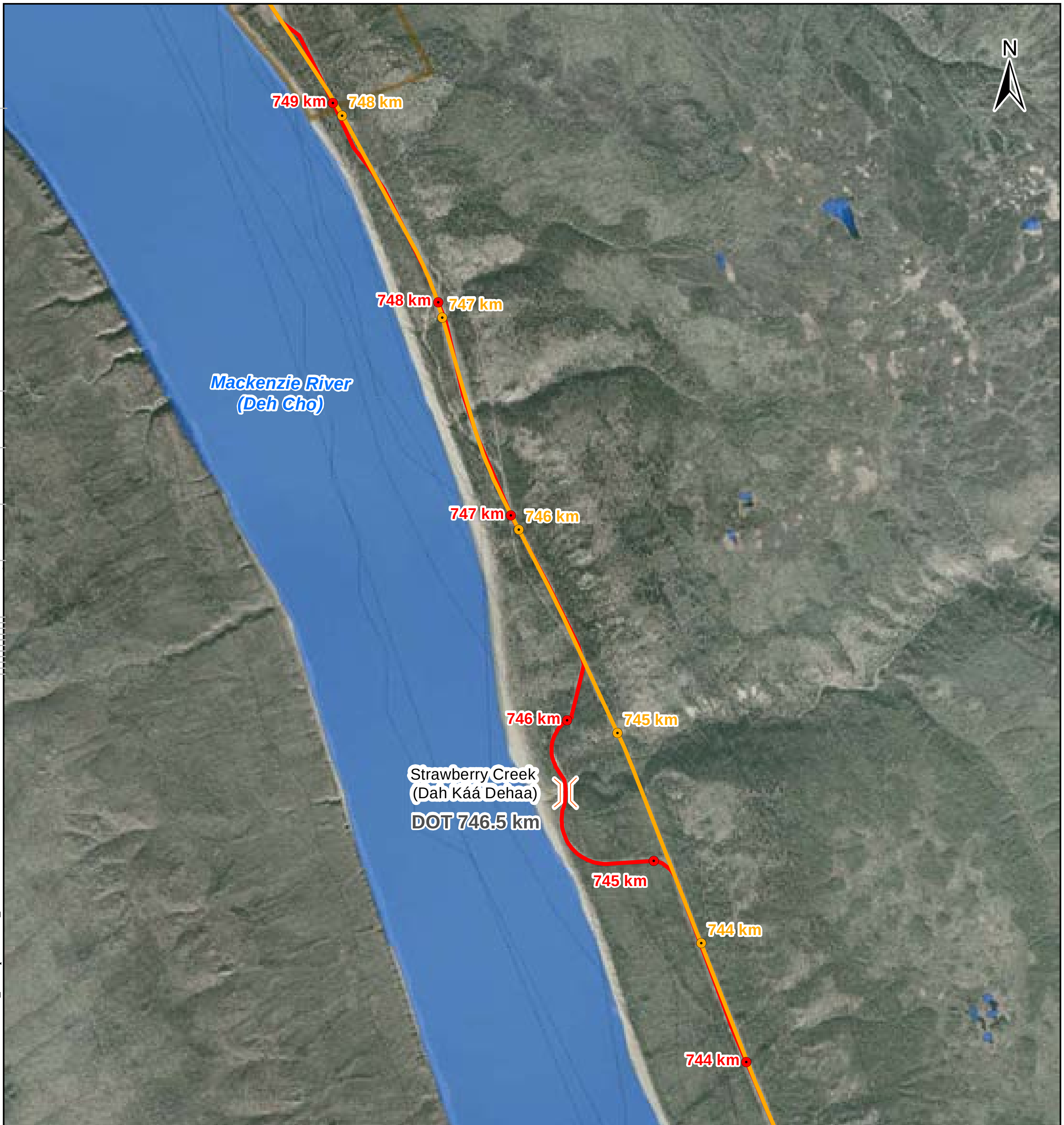


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 11-P**

| | | | |
|---|---|---|---|
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0 1 km

Projection UTM zone 10N, WGS84

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- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- EBA Data Acquisition Limit
- Existing Borrow Source
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**PKFN Main Traditional Activity Site**

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 11-T**

| | | | |
|---|---|---|---|
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0 — 1 km

Projection UTM zone 10N, WGS84

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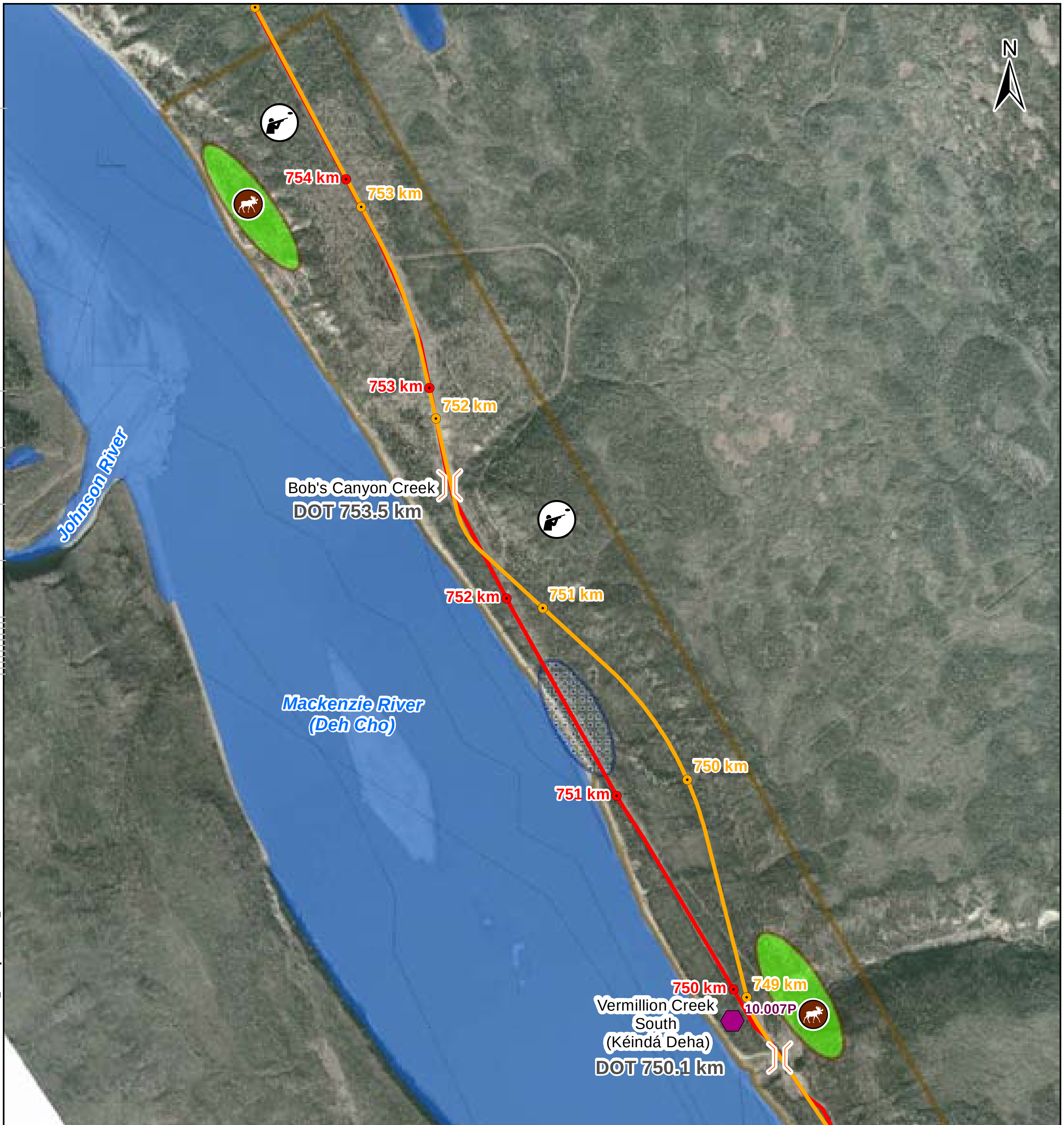


10cm 5 4 3 2 1 0

- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails

- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
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**PKFN MainTraditional Activity Site**

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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 12-P**

| | | | |
|---|---|---|---|
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0 1 km
Projection UTM zone 10N, WGS84

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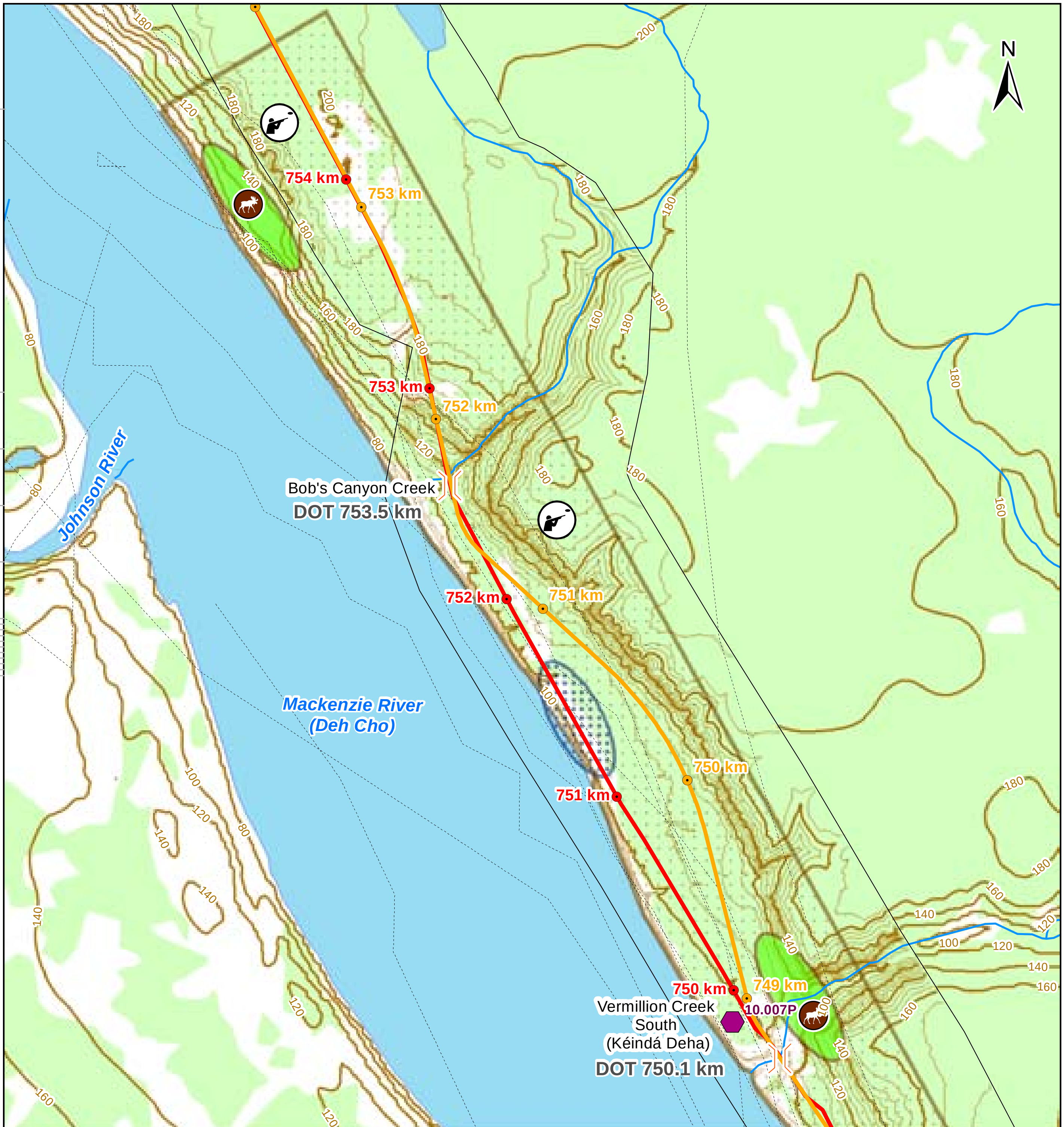


| | | | | | |
|---|---|---|---|---|---|
| | Optimized Alignment - KM Marker | | Sand | **PKFN Main Traditional Activity Site** | |
| | Winter Road - KM Marker | | Wetland | | Burial Area |
| | Optimized Alignment | | River | | Hunting Cabins and Traplines |
| | Optimized Alignment Alternative | | Waterbody | | Moose Pasture Area |
| | Winter Road | | Wooded Area | | Spiritual and Cultural Sites |
| | Other Road | | Rare Plant Location | | Water Proximity Concern |
| | Gas Pipeline | | Ungulate Observations | | Traditional Hunting Ground |
| | Settlement Boundary | | Sahtu Private Lands | | |
| | Existing bridge | | EBA Data Acquisition Limit | | |
| | Bridge to be built or re-built | | Existing Borrow Source | | |
| | Contour line (in meters) | | Primary Borrow Source (Mackenzie Gas Project) | | |
| | Trail | | Secondary Borrow Source (Mackenzie Gas Project) | | |
| | PKFN trails | | | | |

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 12-T**

| | | | |
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| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
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0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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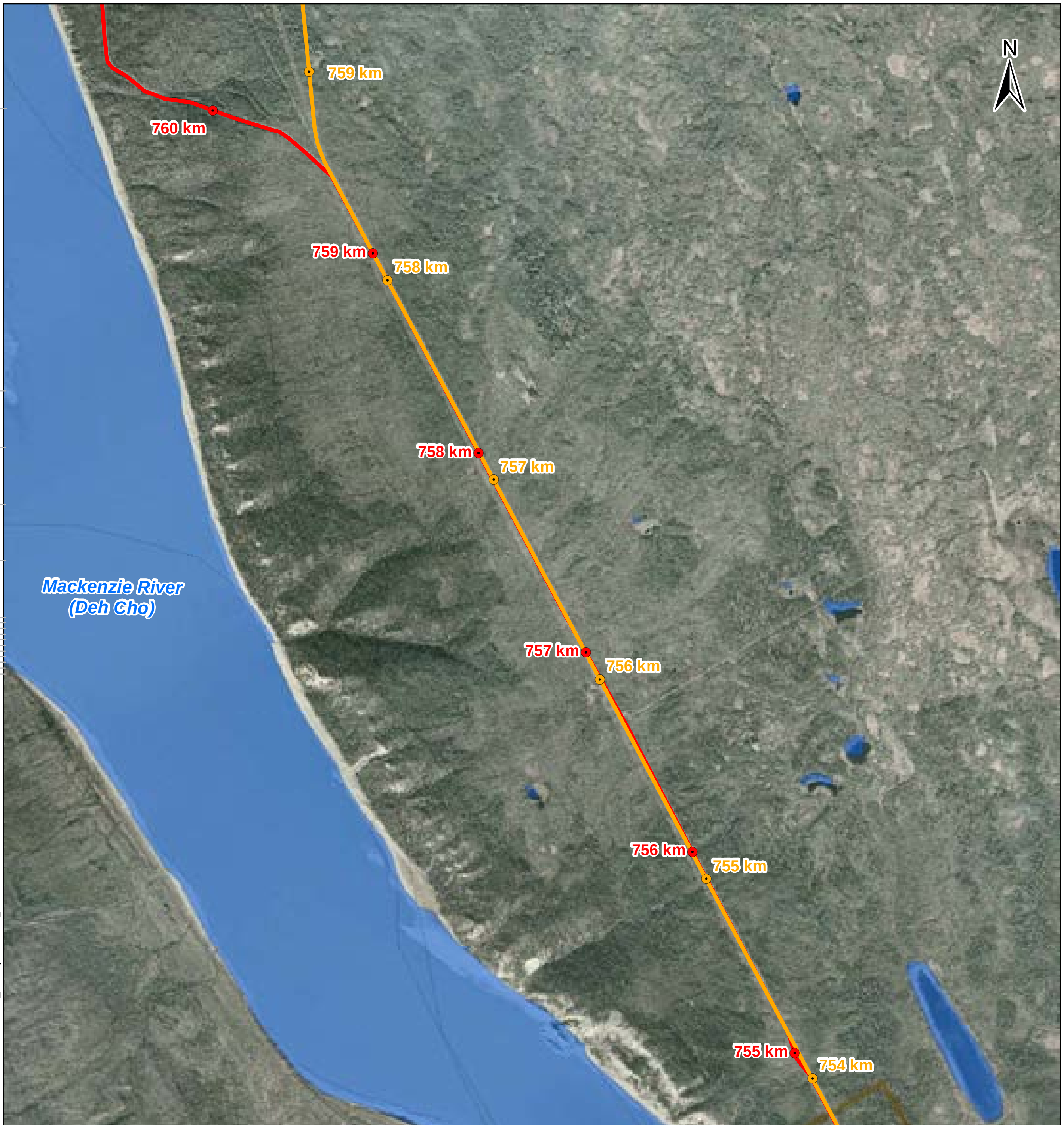


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
PKFN trails

Rare Plant Location
Ungulate Observations
Sahtu Private Lands
Existing Borrow Source
Primary Borrow Source (MacKenzie Gaz Project)
Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

Burial Area
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Moose Pasture Area
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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 13-P**

Prepared : G. Colaneri
Drawn : G. Lemay
Checked : D. Aubin

No : 068-P0037500-202-001-GO-C115-00
Scale : 1:25 000
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Projection UTM zone 10N, WGS84

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Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
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Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
Contour line (in meters)
Trail
PKFN trails

Sand
Wetland
River
Waterbody
Wooded Area
Rare Plant Location
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Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)

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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**Winter Road and Optimized Alignment**
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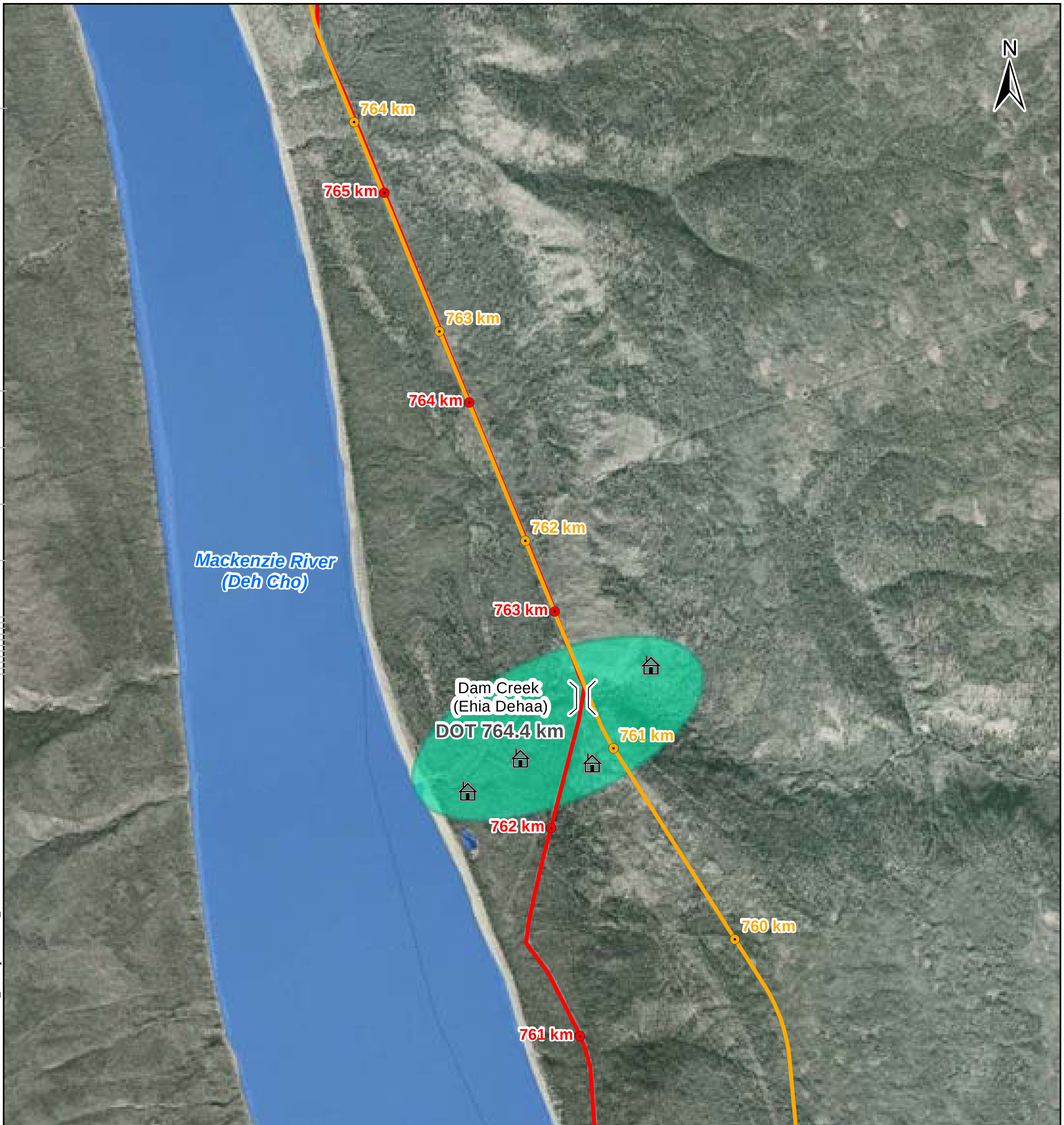


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**Winter Road and Optimized Alignment**
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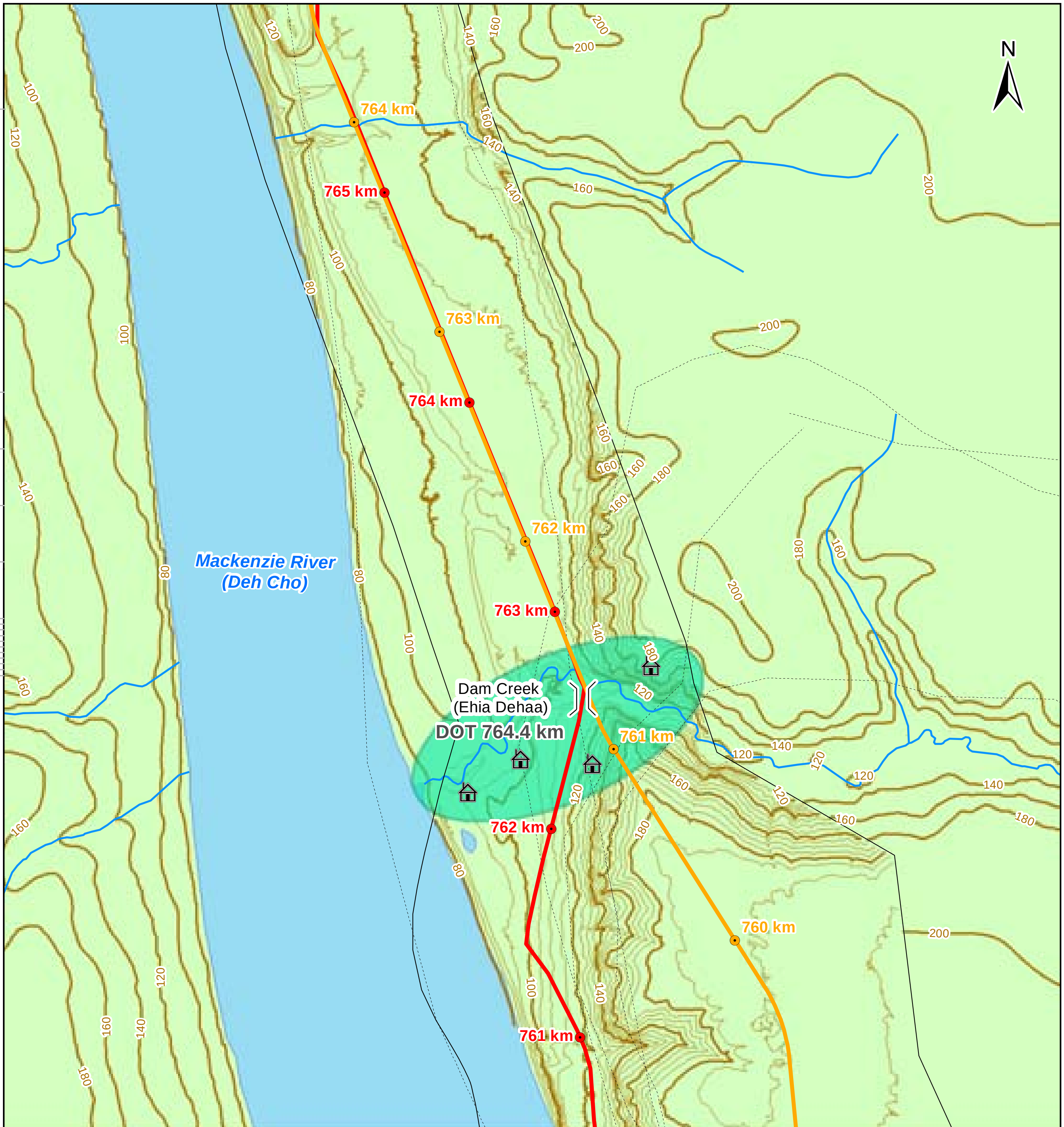


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**Winter Road and Optimized Alignment**
**Sheet 14-T**

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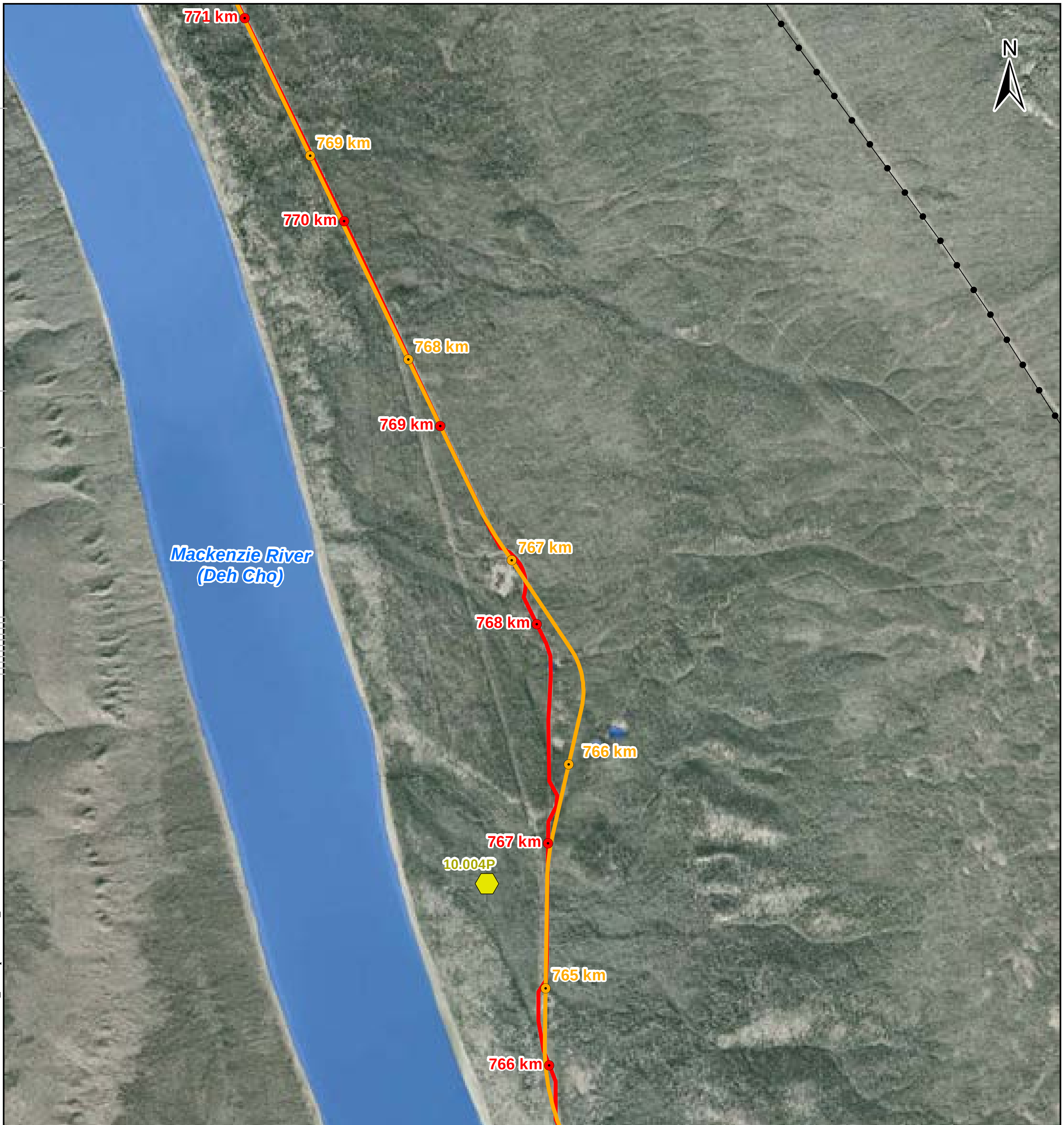


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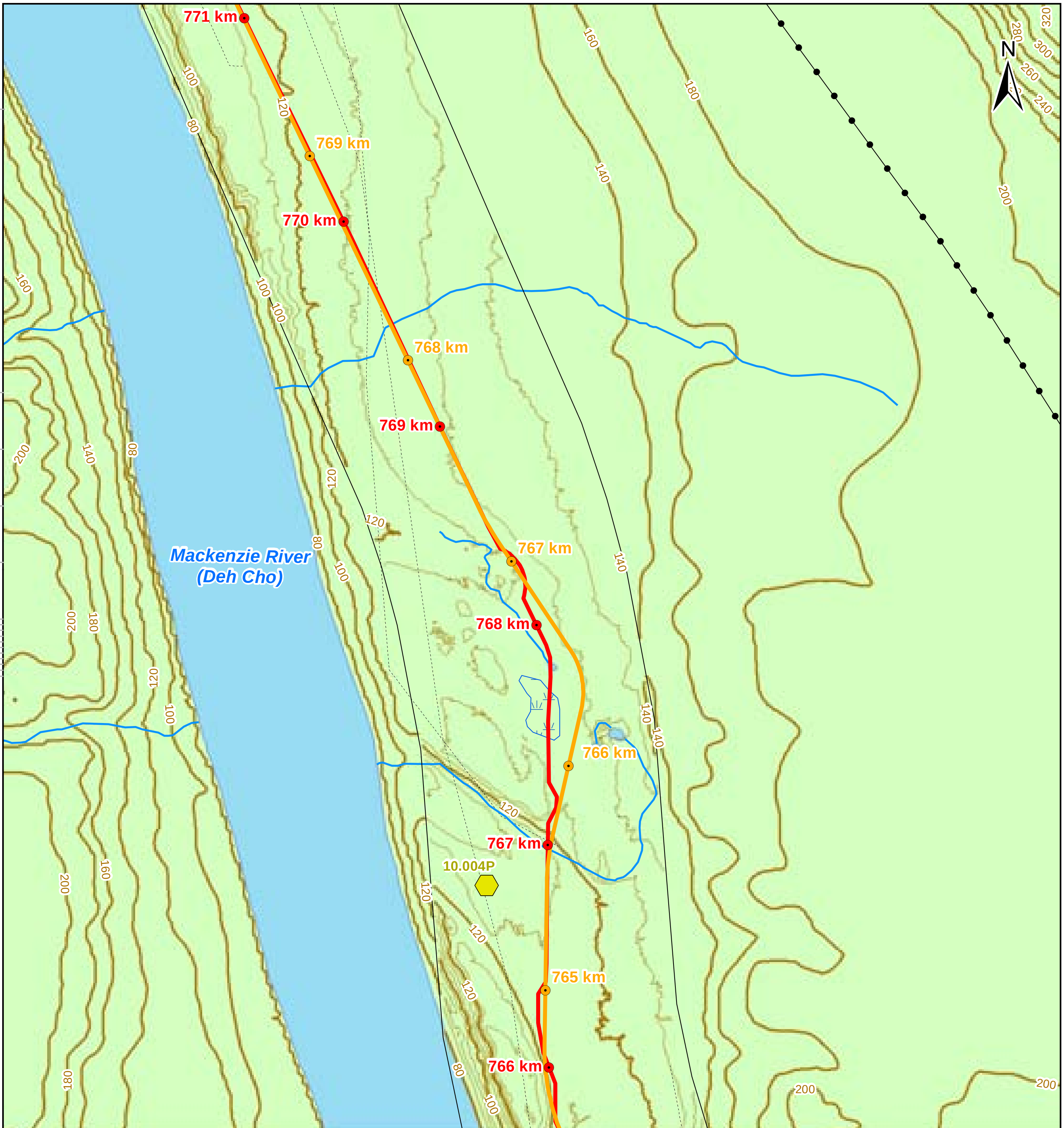


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- Optimized Alignment
- Optimized Alignment Alternative
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*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 15-T**

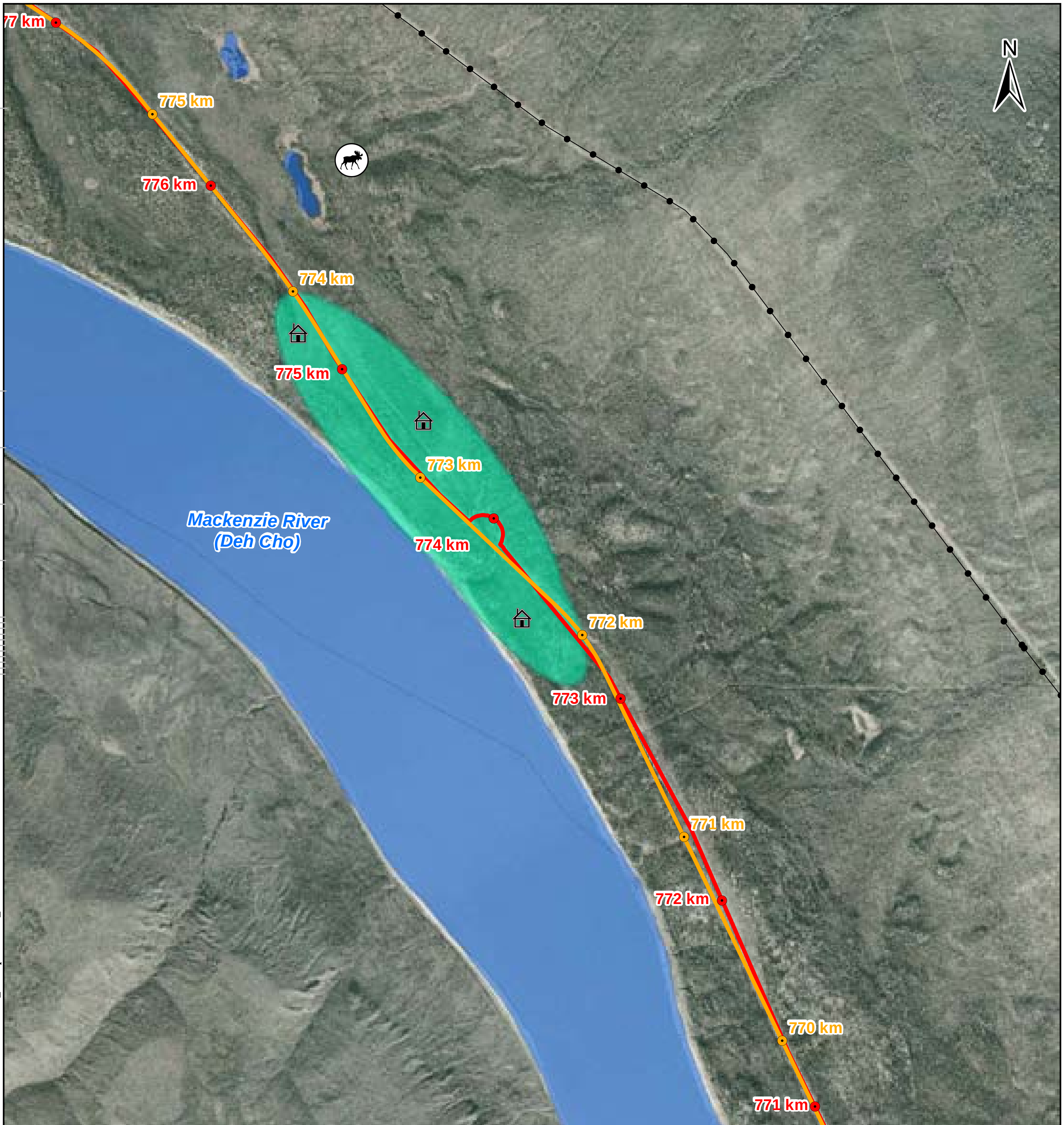
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 — 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P0037500-MackenzieHighway\EN\v5_cad\GO\01-MXD\068-P0037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd




- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails

- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**Winter Road and Optimized Alignment**
**Sheet 16-P**

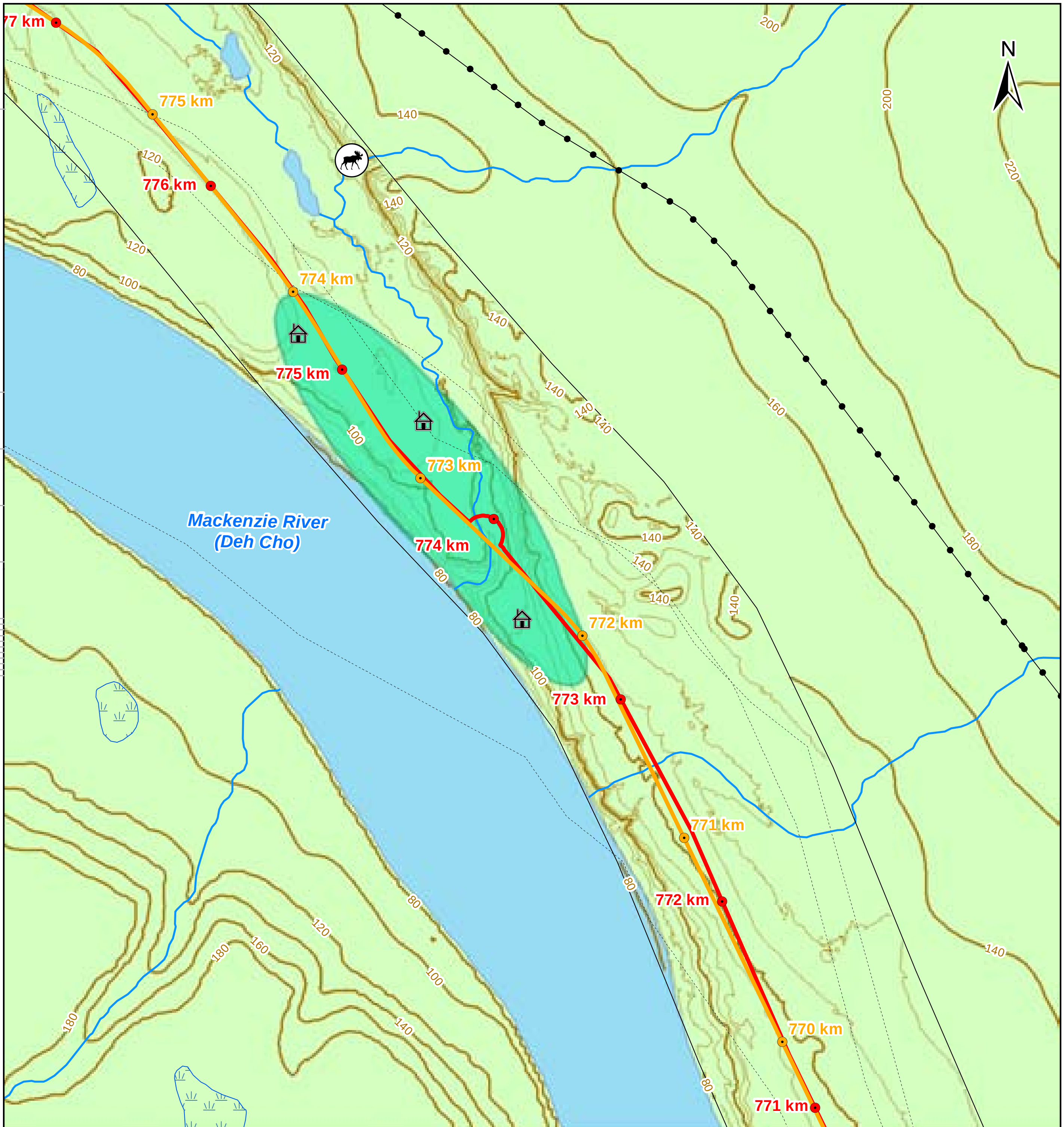
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C115-00_TransportPhoto_20120227.mxd




Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
Contour line (in meters)
Trail
PKFN trails

Sand
Wetland
River
Waterbody
Wooded Area
Rare Plant Location
Ungulate Observations
Sahtu Private Lands
EBA Data Acquisition Limit
Existing Borrow Source
Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
*- CanVec, Canada Government.*
*- LiDAR EBA.*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 16-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\ENV\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd


- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
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*- Northwest Territories, Centre for Geomatics*
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*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 17-P**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 — 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
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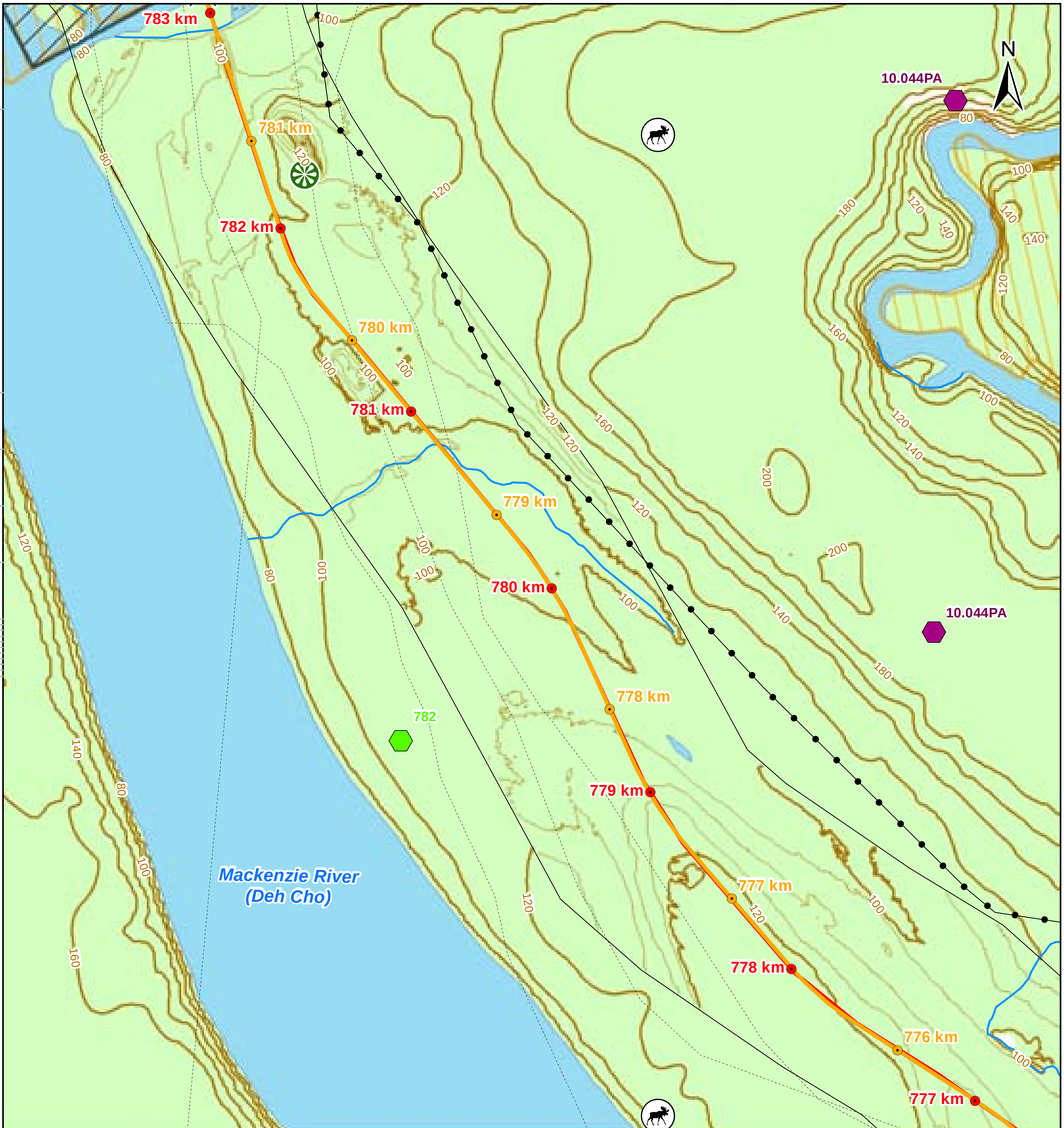


Optimized Alignment - KM Marker
Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
Contour line (in meters)
Trail
PKFN trails

Sand
Wetland
River
Waterbody
Wooded Area
Rare Plant Location
Ungulate Observations
Sahtu Private Lands
EBA Data Acquisition Limit
Existing Borrow Source
Primary Borrow Source (Mackenzie Gas Project)
Secondary Borrow Source (Mackenzie Gas Project)

**PKFN Main Traditional Activity Site**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
Spiritual and Cultural Sites
Water Proximity Concern
Traditional Hunting Ground

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
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*- LiDAR EBA.*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

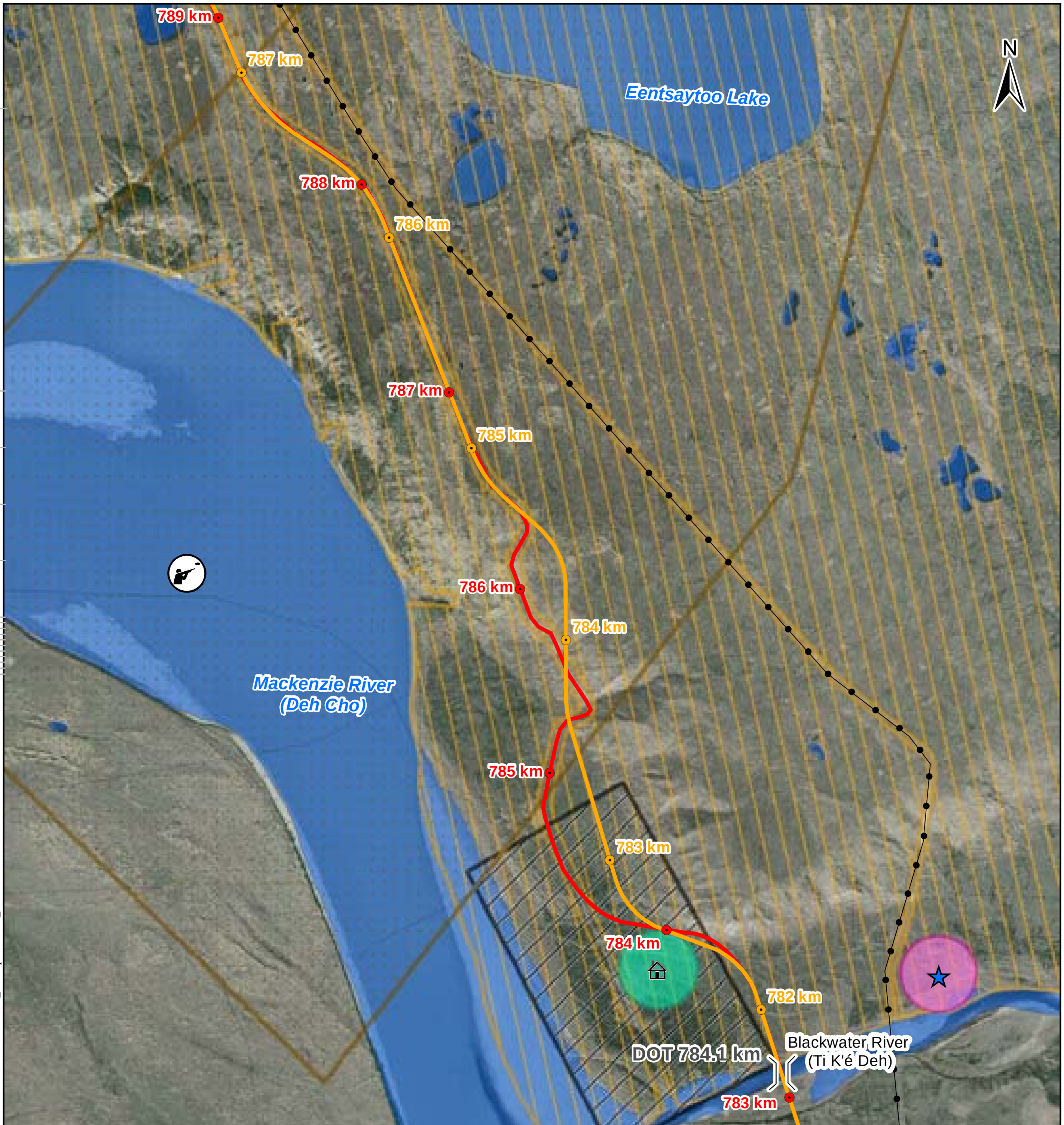
**Winter Road and Optimized Alignment**
**Sheet 17-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km
Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\v5_cad\GO\01-MXD\068-P037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd




| | |
|---|---|
| Optimized Alignment - KM Marker | Rare Plant Location |
| Winter Road - KM Marker | Ungulate Observations |
| Optimized Alignment | Sahtu Private Lands |
| Optimized Alignment Alternative | Existing Borrow Source |
| Winter Road | Primary Borrow Source (MacKenzie Gaz Project) |
| Other Road | Secondary Borrow Source (MacKenzie Gaz Project) |
| Gas Pipeline | |
| Settlement Boundary | |
| Existing bridge | |
| Bridge to be built or re-built | |
| PKFN trails | |

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
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*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 18-P**

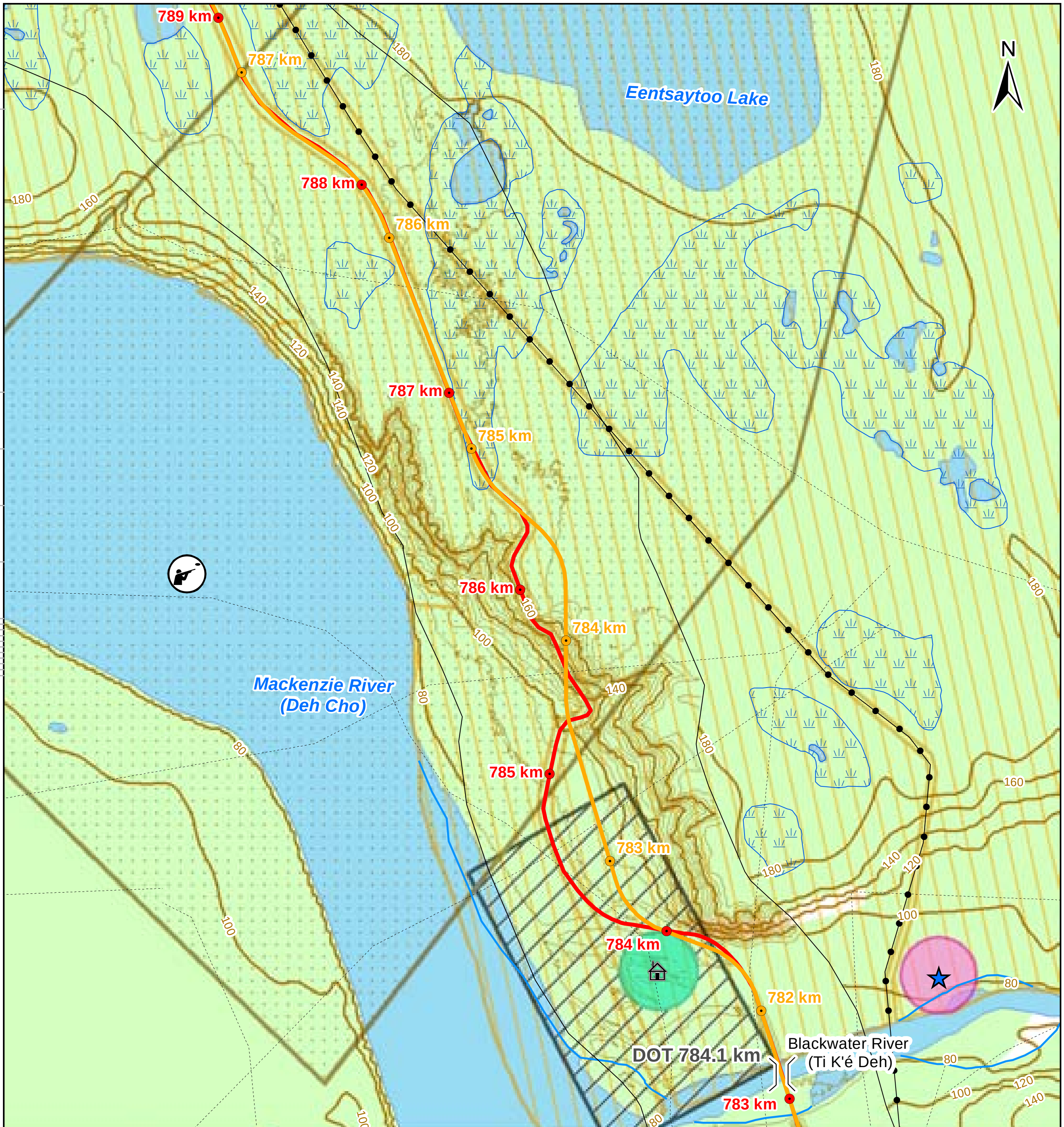
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\ENV\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C115-00_TransportPhoto_20120227.mxd




| Legend | | |
|---|---|---|
| Optimized Alignment - KM Marker | Sand | Burial Area |
| Winter Road - KM Marker | Wetland | Hunting Cabins and Traplines |
| Optimized Alignment | River | Moose Pasture Area |
| Optimized Alignment Alternative | Waterbody | Spiritual and Cultural Sites |
| Winter Road | Wooded Area | Water Proximity Concern |
| Other Road | Rare Plant Location | Traditional Hunting Ground |
| Gas Pipeline | Ungulate Observations | |
| Settlement Boundary | Sahtu Private Lands | |
| Existing bridge | EBA Data Acquisition Limit | |
| Bridge to be built or re-built | Existing Borrow Source | |
| Contour line (in meters) | Primary Borrow Source (Mackenzie Gas Project) | |
| Trail | Secondary Borrow Source (Mackenzie Gas Project) | |
| PKFN trails | | |

**PKFN Main Traditional Activity Site**

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
- *CanVec, Canada Government.*
- *LiDAR EBA.*
- *Mackenzie Gas Project, 2007*
- *PKFN, 2011*
- *© Deh Cho First Nations, 2004*
- *Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 18-T**

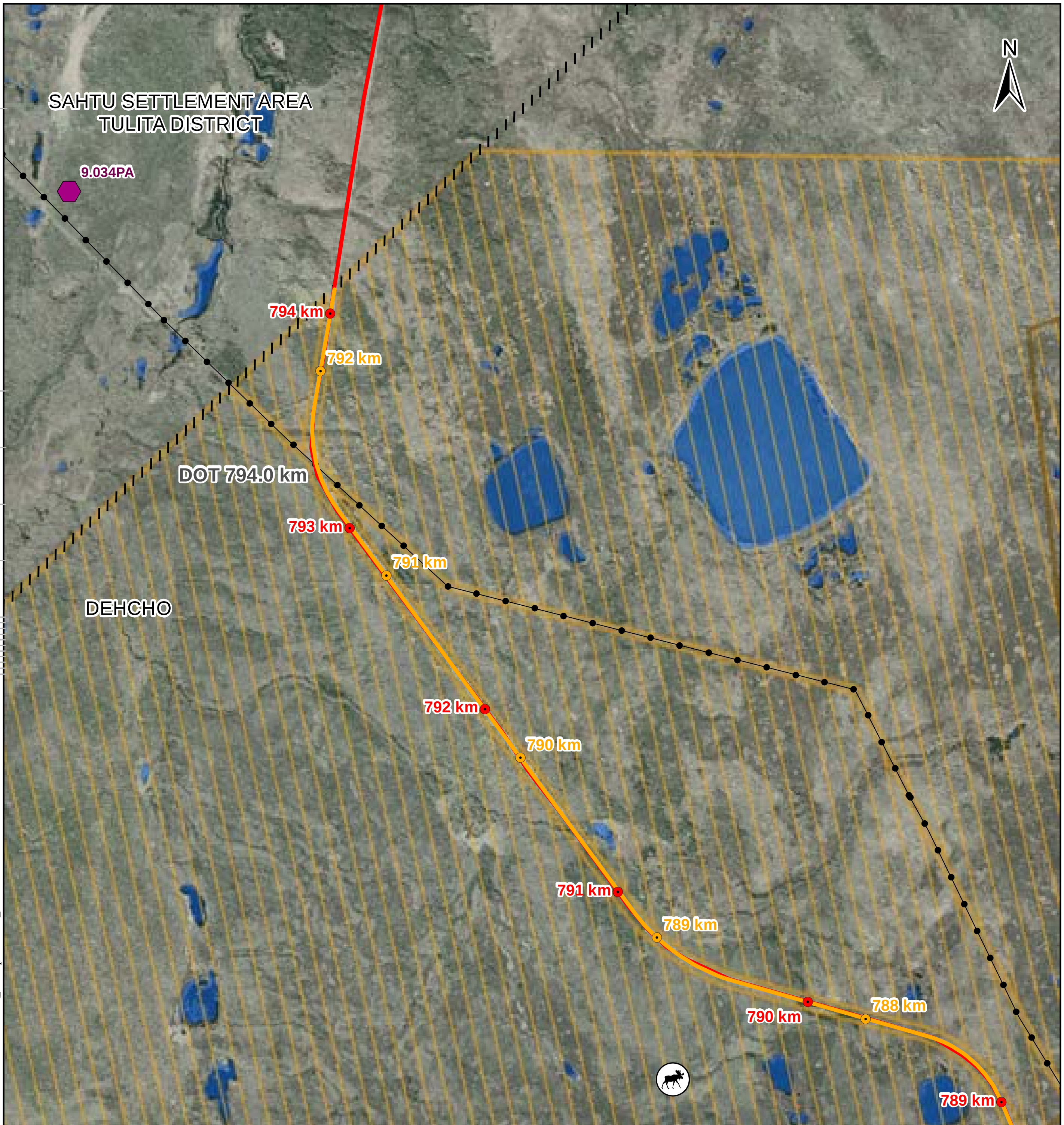
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 — 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\EN\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd




- Optimized Alignment - KM Marker
- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails

- Rare Plant Location
- Ungulate Observations
- Sahtu Private Lands
- Existing Borrow Source
- Primary Borrow Source (MacKenzie Gaz Project)
- Secondary Borrow Source (MacKenzie Gaz Project)

**PKFN MainTraditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

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*- Northwest Territories, Centre for Geomatics*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- Dessau, 2011.*

Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 19-P**

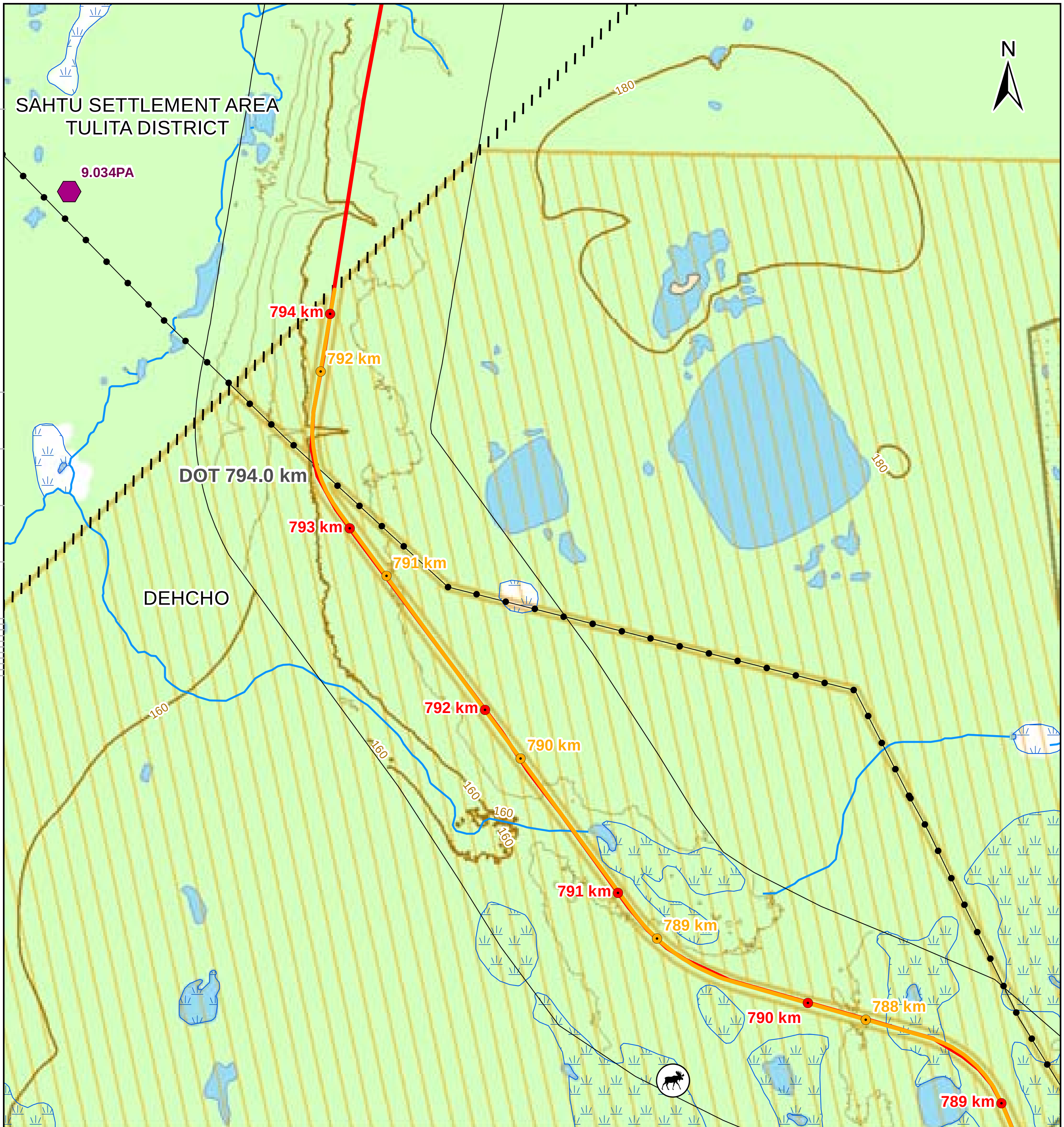
| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C115-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 — 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\ENv5_cad\GO\01-MXD\068-P037500-0202-001-GO-C115-00_TransportPhoto_20120227.mxd




| | | | | | |
|---|---|---|---|---|---|
| | Optimized Alignment - KM Marker | | Sand | | **PKFN Main Traditional Activity Site** |
| | Winter Road - KM Marker | | Wetland | | Burial Area |
| | Optimized Alignment | | River | | Hunting Cabins and Traplines |
| | Optimized Alignment Alternative | | Waterbody | | Moose Pasture Area |
| | Winter Road | | Wooded Area | | Spiritual and Cultural Sites |
| | Other Road | | Rare Plant Location | | Water Proximity Concern |
| | Gas Pipeline | | Ungulate Observations | | Traditional Hunting Ground |
| | Settlement Boundary | | | | |
| | Existing bridge | | Sahtu Private Lands | | |
| | Bridge to be built or re-built | | EBA Data Acquisition Limit | | |
| | Contour line (in meters) | | Existing Borrow Source | | |
| | Trail | | Primary Borrow Source (Mackenzie Gas Project) | | |
| | PKFN trails | | Secondary Borrow Source (Mackenzie Gas Project) | | |

*Note : Detailled contours are available only in the EBA Acquisition Limit.*

*Sources :*
*- CanVec, Canada Government.*
*- LiDAR EBA.*
*- Mackenzie Gas Project, 2007*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**Winter Road and Optimized Alignment**
**Sheet 19-T**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C116-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 8,5" x 11"
Path: C:\068\P037500-MackenzieHighway\ENV\z5_cad\GO\01-MXD\068-P037500-0202-001-GO-C116-00_TransportTopo_20120227.mxd

# Appendix 2 Geometry of the Winter Road

DESSAU

DESSAU

| Beginning of curve (m) | End of curve (m) | Curve radius (m) | Curve length (m) |
|---|---|---|---|
| 692+093 | 692+143 | 100,0 | 50,7 |
| 692+226 | 692+281 | 70,0 | 55,1 |
| 692+329 | 692+397 | 200,0 | 68,2 |
| 692+433 | 692+475 | 270,4 | 41,9 |
| 692+579 | 692+685 | 251,1 | 106,1 |
| 692+695 | 692+723 | 250,0 | 28,0 |
| 692+756 | 692+785 | 368,5 | 28,3 |
| 692+840 | 693+032 | 888,2 | 192,0 |
| 694+649 | 695+133 | 908,0 | 483,6 |
| 697+818 | 697+962 | 500,0 | 143,9 |
| 699+349 | 699+464 | 400,0 | 115,0 |
| 699+970 | 700+066 | 400,0 | 95,4 |
| 700+066 | 700+105 | 100,0 | 39,0 |
| 700+164 | 700+248 | 500,0 | 83,5 |
| 700+399 | 700+429 | 1500,0 | 29,3 |
| 700+890 | 700+967 | 497,6 | 77,3 |
| 701+066 | 701+097 | 500,0 | 30,2 |
| 703+135 | 703+243 | 1000,0 | 108,2 |
| 703+366 | 703+461 | 400,0 | 95,0 |
| 707+078 | 707+170 | 400,0 | 92,1 |
| 707+601 | 707+737 | 400,0 | 135,7 |
| 708+370 | 708+438 | 300,0 | 67,9 |
| 709+479 | 709+554 | 100,0 | 75,1 |
| 709+641 | 709+712 | 200,0 | 70,8 |
| 709+762 | 709+865 | 200,0 | 102,2 |
| 709+894 | 710+071 | 900,0 | 177,1 |
| 713+134 | 713+208 | 300,0 | 74,1 |
| 713+256 | 713+303 | 100,0 | 47,2 |
| 713+329 | 713+442 | 500,0 | 112,8 |
| 714+415 | 714+454 | 200,0 | 38,8 |
| 714+464 | 714+517 | 150,0 | 53,8 |
| 714+557 | 714+594 | 100,0 | 36,8 |
| 714+666 | 714+733 | 200,0 | 67,1 |
| 714+854 | 714+933 | 600,0 | 79,1 |
| 719+111 | 719+271 | 640,5 | 160,0 |
| 720+206 | 720+324 | 110,0 | 118,2 |
| 720+382 | 720+444 | 45,0 | 61,6 |
| 720+591 | 720+652 | 500,0 | 61,1 |
| 720+725 | 720+778 | 130,0 | 53,5 |
| 720+826 | 720+896 | 125,0 | 70,4 |
| 721+728 | 721+994 | 155,0 | 266,3 |
| 722+041 | 722+085 | 500,0 | 44,7 |
| 722+168 | 722+324 | 110,0 | 155,7 |
| 722+523 | 722+621 | 110,0 | 98,3 |
| 722+703 | 722+869 | 140,0 | 166,0 |
| 723+006 | 723+085 | 400,0 | 79,3 |
| 724+376 | 724+522 | 800,0 | 146,0 |
| 725+291 | 725+704 | 950,0 | 413,6 |
| 727+512 | 727+580 | 1200,0 | 68,2 |
| 727+633 | 727+748 | 1500,0 | 114,2 |

DESSAU

| Beginning of curve (m) | End of curve (m) | Curve radius (m) | Curve length (m) |
|---|---|---|---|
| 728+066 | 728+504 | 850,0 | 437,8 |
| 730+831 | 731+296 | 800,0 | 465,7 |
| 732+442 | 732+588 | 1000,0 | 146,0 |
| 732+782 | 732+874 | 700,0 | 92,4 |
| 733+541 | 733+612 | 150,0 | 71,4 |
| 733+696 | 733+721 | 75,0 | 25,3 |
| 733+745 | 733+769 | 75,0 | 23,9 |
| 733+848 | 733+917 | 150,0 | 68,6 |
| 734+071 | 734+109 | 400,0 | 38,0 |
| 734+128 | 734+215 | 200,0 | 87,0 |
| 734+241 | 734+295 | 200,0 | 53,2 |
| 734+340 | 734+502 | 250,0 | 161,6 |
| 734+584 | 734+657 | 150,0 | 73,9 |
| 738+309 | 738+460 | 350,0 | 151,0 |
| 738+888 | 739+017 | 400,0 | 129,3 |
| 742+860 | 742+948 | 500,0 | 88,2 |
| 744+867 | 745+015 | 115,0 | 148,8 |
| 745+203 | 745+326 | 150,0 | 123,0 |
| 745+378 | 745+527 | 150,0 | 149,4 |
| 745+650 | 745+704 | 75,0 | 54,3 |
| 745+768 | 745+828 | 100,0 | 59,9 |
| 745+878 | 745+976 | 100,0 | 98,4 |
| 745+978 | 746+057 | 100,0 | 78,8 |
| 746+219 | 746+318 | 150,0 | 99,2 |
| 747+944 | 748+266 | 1500,0 | 322,5 |
| 748+605 | 748+661 | 200,0 | 55,9 |
| 748+683 | 748+792 | 300,0 | 109,4 |
| 749+269 | 749+354 | 150,0 | 85,6 |
| 749+373 | 749+416 | 100,0 | 42,8 |
| 749+733 | 749+800 | 300,0 | 67,8 |
| 749+811 | 749+897 | 300,0 | 86,6 |
| 751+823 | 751+875 | 800,0 | 51,9 |
| 752+099 | 752+168 | 800,0 | 68,9 |
| 752+427 | 752+518 | 300,0 | 90,7 |
| 759+308 | 759+473 | 400,0 | 164,4 |
| 759+634 | 759+726 | 200,0 | 91,1 |
| 759+748 | 759+829 | 500,0 | 81,3 |
| 760+012 | 760+161 | 500,0 | 149,1 |
| 760+177 | 760+231 | 200,0 | 54,2 |
| 760+283 | 760+341 | 125,0 | 58,0 |
| 760+373 | 760+417 | 125,0 | 44,2 |
| 760+463 | 760+541 | 74,9 | 77,1 |
| 760+801 | 761+034 | 600,0 | 233,6 |
| 761+249 | 761+342 | 500,0 | 93,4 |
| 761+436 | 761+527 | 100,0 | 90,5 |
| 762+412 | 762+554 | 1500,0 | 141,2 |
| 762+621 | 762+661 | 75,0 | 40,7 |
| 765+688 | 766+090 | 1000,0 | 402,3 |
| 767+728 | 767+890 | 350,0 | 162,0 |
| 768+031 | 768+139 | 200,0 | 108,7 |

DESSAU

| Beginning of curve (m) | End of curve (m) | Curve radius (m) | Curve length (m) |
|---|---|---|---|
| 768+139 | 768+309 | 150,0 | 169,8 |
| 768+309 | 768+397 | 150,0 | 88,2 |
| 771+606 | 771+749 | 700,0 | 142,3 |
| 771+758 | 771+888 | 700,0 | 130,7 |
| 774+274 | 774+584 | 1200,0 | 310,1 |
| 775+283 | 775+345 | 500,0 | 61,9 |
| 776+396 | 776+857 | 1447,7 | 460,9 |
| 777+501 | 777+888 | 1350,6 | 386,6 |
| 781+554 | 781+816 | 691,8 | 262,0 |
| 783+352 | 783+793 | 405,0 | 440,7 |
| 784+029 | 784+393 | 384,2 | 364,7 |
| 784+500 | 784+544 | 300,0 | 43,9 |
| 784+688 | 784+739 | 100,0 | 51,2 |
| 785+038 | 785+164 | 100,6 | 125,7 |
| 785+191 | 785+266 | 36,3 | 75,2 |
| 785+400 | 785+512 | 264,5 | 112,0 |
| 785+512 | 785+552 | 100,0 | 40,6 |
| 785+552 | 785+605 | 279,5 | 53,1 |
| 785+605 | 785+645 | 50,0 | 39,6 |
| 785+645 | 785+766 | 139,7 | 120,6 |
| 785+956 | 786+060 | 112,1 | 103,9 |
| 786+123 | 786+249 | 87,7 | 125,7 |
| 786+358 | 786+503 | 387,0 | 145,4 |
| 787+677 | 788+131 | 634,1 | 454,4 |
| 788+131 | 788+729 | 779,2 | 597,9 |
| 788+729 | 789+063 | 800,0 | 333,6 |
| 789+107 | 789+206 | 250,0 | 99,6 |
| 789+256 | 789+350 | 600,0 | 94,5 |
| 790+210 | 790+765 | 840,7 | 554,4 |
| 792+963 | 793+444 | 598,5 | 481,0 |
| 795+436 | 796+104 | 584,9 | 667,9 |

# Appendix 3 Geometry of the Optimized Alignment

DESSAU

DESSAU

| Beginning of curve (km) | End of curve (km) | Curve radius (m) | Curve length (m) |
|---|---|---|---|
| 692+006 | 692+232 | 150,0 | 226,7 |
| 692+365 | 692+472 | 340,0 | 106,8 |
| 692+620 | 692+950 | 500,0 | 329,3 |
| 694+620 | 695+152 | 1000,0 | 532,6 |
| 697+812 | 697+921 | 500,0 | 108,5 |
| 699+323 | 699+497 | 400,0 | 174,0 |
| 700+042 | 700+165 | 500,0 | 123,0 |
| 701+025 | 701+347 | 750,0 | 322,7 |
| 703+181 | 703+527 | 1000,0 | 345,7 |
| 707+087 | 707+180 | 400,0 | 92,5 |
| 708+813 | 709+428 | 750,0 | 615,7 |
| 719+114 | 719+702 | 1200,0 | 587,4 |
| 720+570 | 720+943 | 1000,0 | 372,5 |
| 722+414 | 722+515 | 500,0 | 101,1 |
| 722+613 | 722+849 | 340,0 | 235,6 |
| 723+961 | 724+107 | 800,0 | 146,0 |
| 724+875 | 725+289 | 950,0 | 413,6 |
| 727+668 | 728+089 | 850,0 | 421,0 |
| 728+790 | 729+104 | 1000,0 | 313,8 |
| 730+433 | 730+671 | 1000,0 | 237,9 |
| 731+497 | 731+672 | 340,0 | 174,5 |
| 732+711 | 732+840 | 1000,0 | 129,2 |
| 733+403 | 733+525 | 340,0 | 121,7 |
| 737+756 | 737+903 | 340,0 | 146,3 |
| 738+300 | 738+494 | 600,0 | 194,0 |
| 742+289 | 742+418 | 750,0 | 129,1 |
| 747+021 | 747+344 | 1500,0 | 322,5 |
| 748+864 | 748+982 | 340,0 | 118,0 |
| 749+750 | 750+621 | 1500,0 | 872,0 |
| 751+365 | 751+582 | 340,0 | 216,9 |
| 758+573 | 758+770 | 500,0 | 197,0 |
| 759+408 | 759+755 | 750,0 | 346,9 |
| 761+009 | 761+142 | 750,0 | 133,5 |
| 764+357 | 764+759 | 1000,0 | 402,3 |
| 765+472 | 765+682 | 1000,0 | 209,5 |
| 766+256 | 766+532 | 340,0 | 275,7 |
| 767+124 | 767+263 | 1000,0 | 138,5 |
| 771+811 | 772+176 | 1000,0 | 365,0 |
| 772+996 | 773+306 | 1200,0 | 310,1 |
| 775+109 | 775+586 | 1500,0 | 477,5 |
| 776+215 | 776+616 | 1400,0 | 400,7 |
| 780+273 | 780+539 | 700,0 | 265,1 |
| 782+066 | 782+371 | 340,0 | 304,5 |
| 782+600 | 782+913 | 340,0 | 313,2 |
| 783+610 | 783+752 | 500,0 | 142,0 |
| 784+240 | 784+526 | 340,0 | 285,3 |
| 784+742 | 784+978 | 500,0 | 235,9 |
| 786+075 | 786+446 | 600,0 | 371,7 |
| 786+626 | 787+044 | 700,0 | 417,8 |
| 787+265 | 787+715 | 500,0 | 449,7 |
| 788+601 | 789+161 | 850,0 | 560,5 |
| 791+356 | 791+838 | 600,0 | 482,3 |
| 793+819 | 794+505 | 600,0 | 685,6 |

# Appendix 4 PKFN Public Consultation Inputs (July 7th, 2011)

DESSAU


- Winter Road - KM Marker
- Winter Road
- Other Road
- PKFN Realignment Proposals
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Sahtu Private Lands
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Island

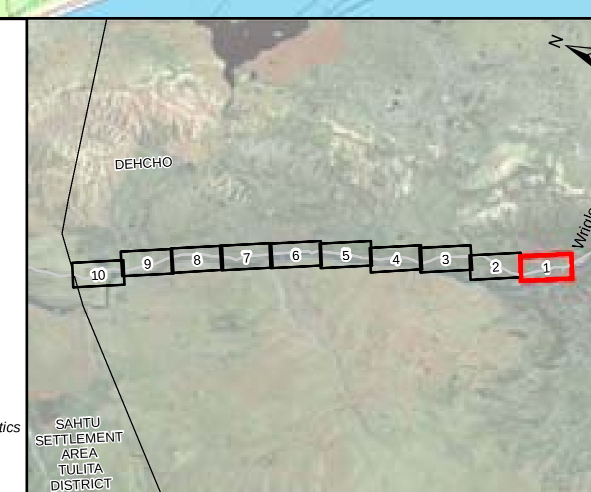
**PKFN Main Traditional Activity Site**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

**Moose sensitive area**

Comments expressed during public consultation

Sources :
- CanVec, Canada Government.
- LiDAR EBA.
- Northwest Territories, Centre for Geomatics
- PKFN, 2011
- © Deh Cho First Nations, 2004
- © Bing Maps, 2006-2009
- Dessau, 2011.




Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 1**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C114-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 11" x 17"
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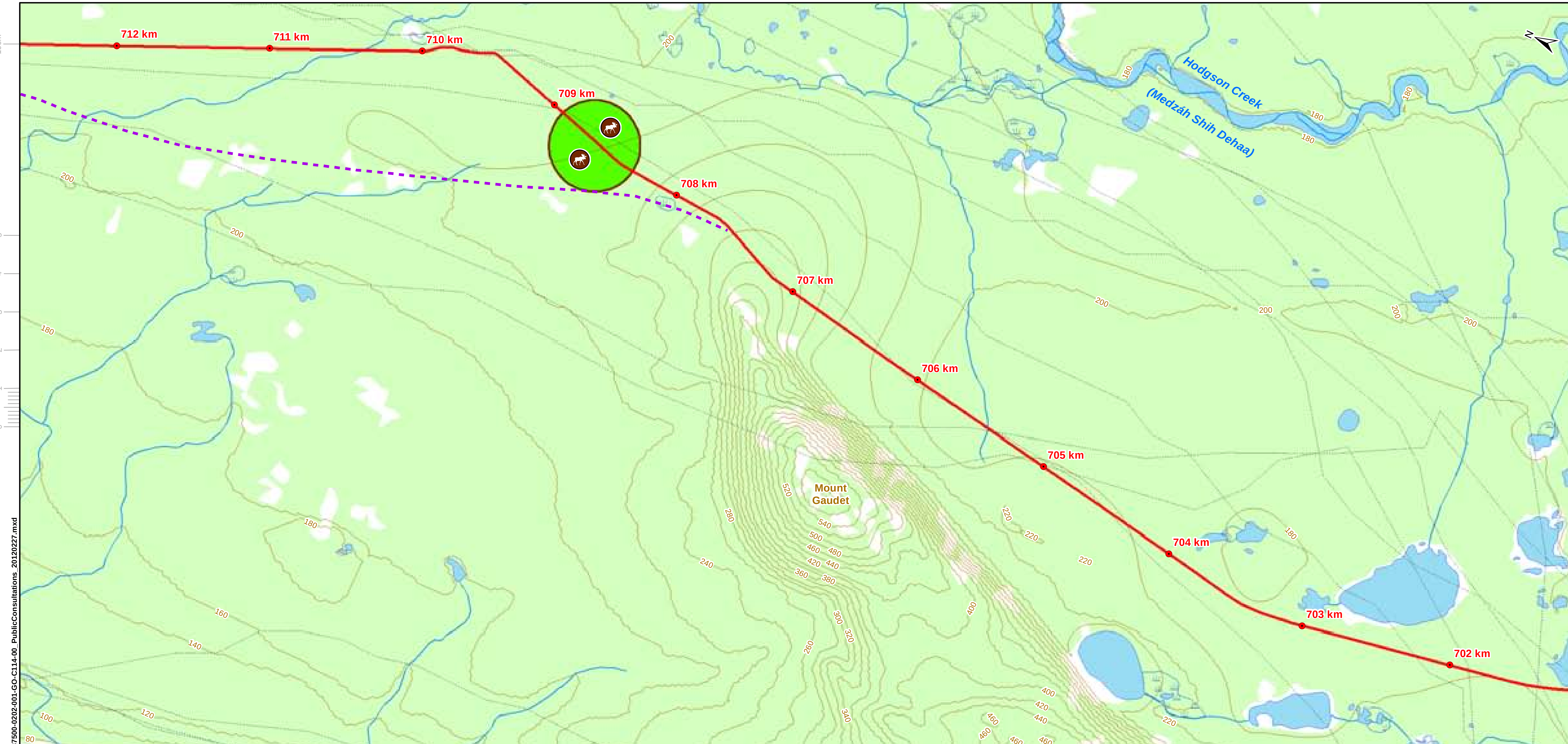


Winter Road - KM Marker
Winter Road
Other Road
PKFN Realignment Proposals
Gas Pipeline
Settlement Boundary
Existing bridge
Bridge to be built or re-built
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PKFN trails
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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 2**

| | | | |
|---|---|---|---|
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Winter Road - KM Marker

Winter Road

Other Road

PKFN Realignment Proposals

Gas Pipeline

Settlement Boundary

Existing bridge

Bridge to be built or re-built

Sahtu Private Lands

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PKFN trails

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River

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Burial Area

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 3**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C114-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 000 m

Projection UTM zone 10N, WGS84

DESSAU

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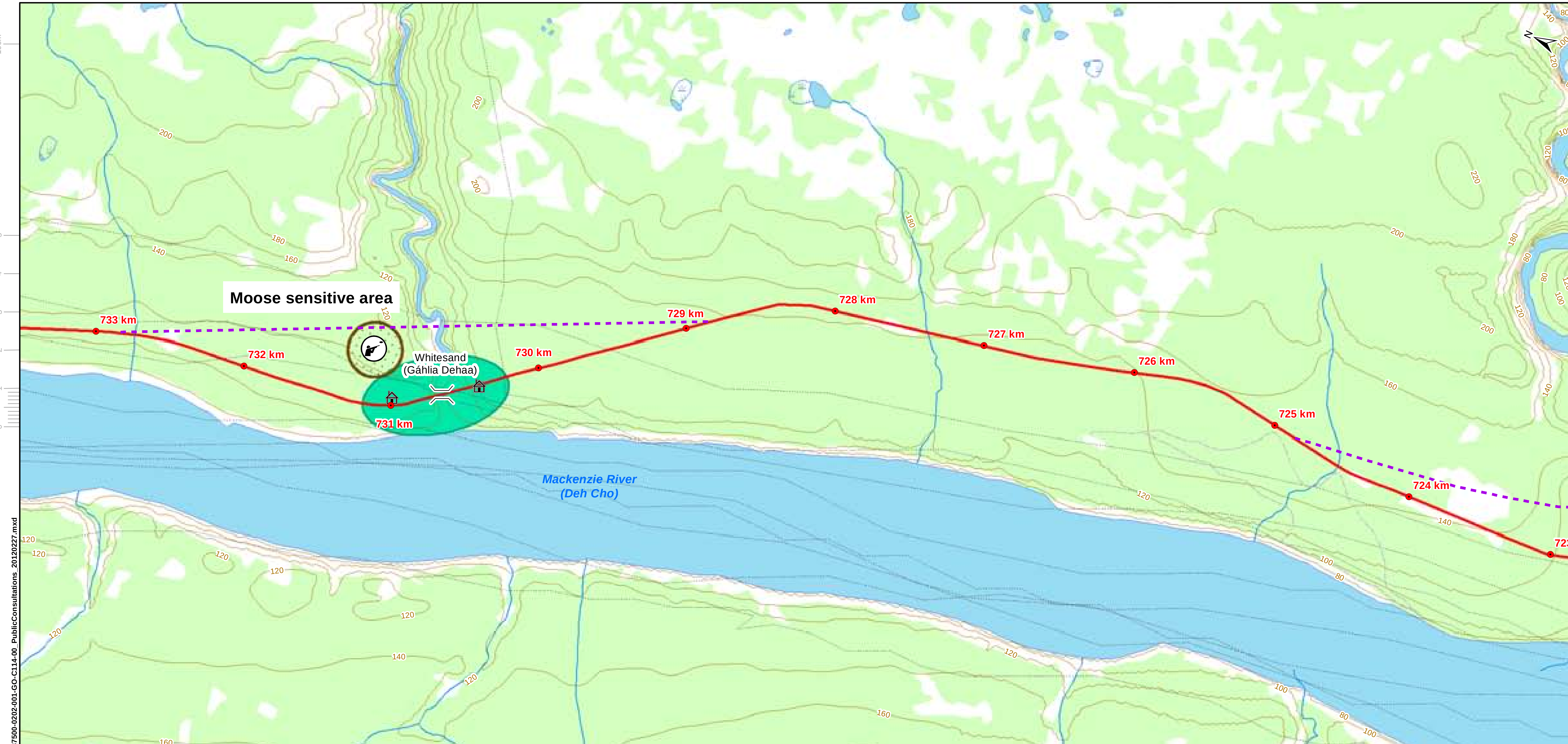


Winter Road - KM Marker
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PKFN Realignment Proposals
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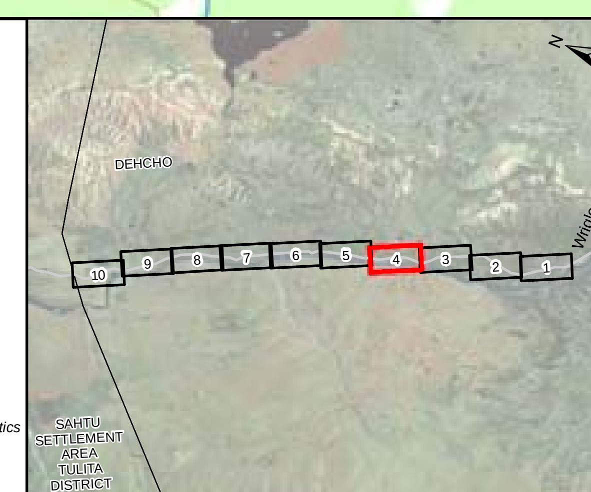


Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 4**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : D. Aubin

No : 068-P0037500-202-001-GO-C114-00
Scale : 1:25 000
Date : February 27, 2012

0 1 000 m
Projection UTM zone 10N, WGS84

DESSAU

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Winter Road - KM Marker
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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 5**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : D. Aubin

No : 068-P0037500-202-001-GO-C114-00
Scale : 1:25 000
Date : February 27, 2012

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Projection UTM zone 10N, WGS84

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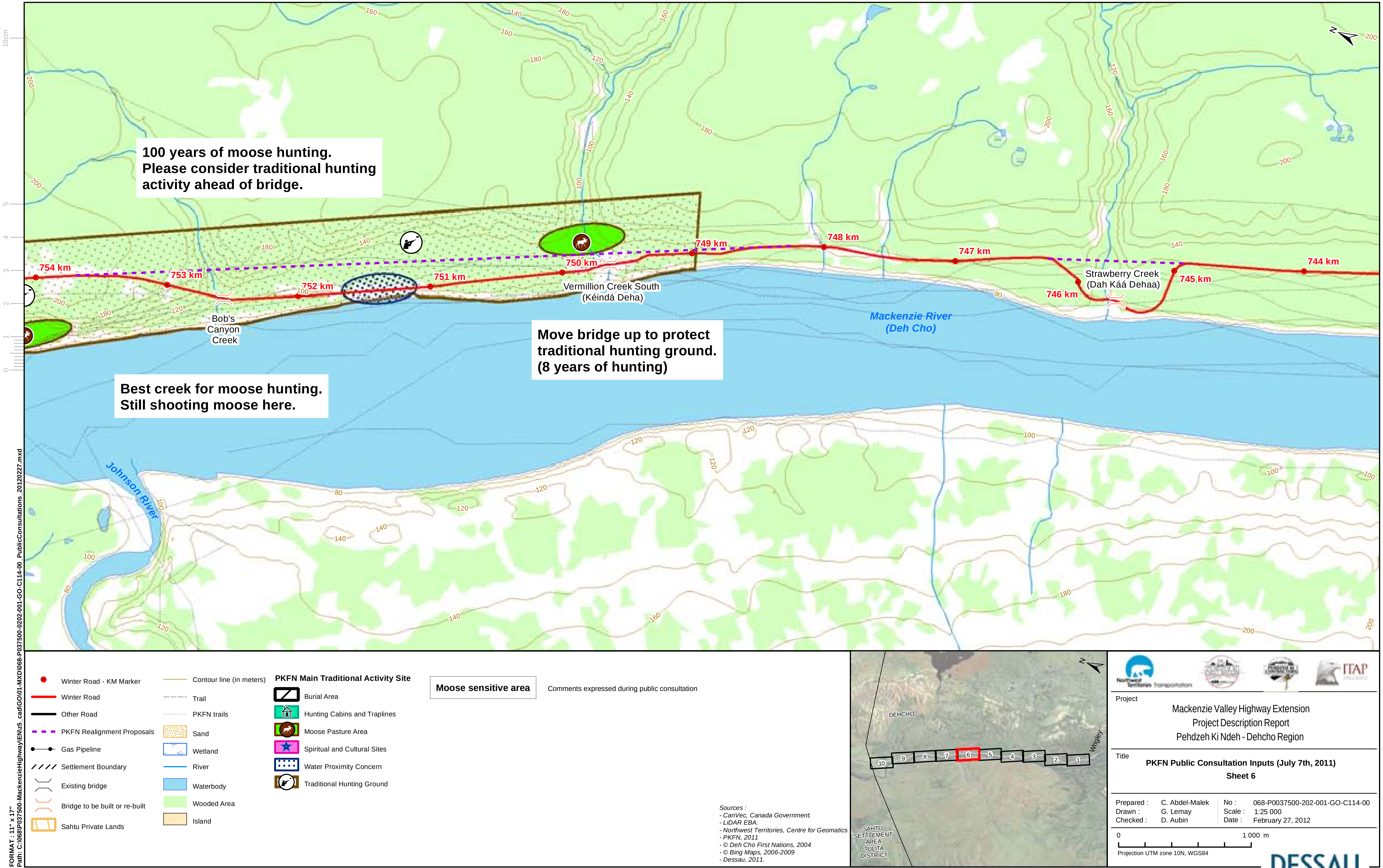
100 years of moose hunting.
Please consider traditional hunting activity ahead of bridge.
Best creek for moose hunting.
Still shooting moose here.
Move bridge up to protect traditional hunting ground. (8 years of hunting)
754 km
753 km
752 km
751 km
750 km
749 km
748 km
747 km
746 km
745 km
744 km
Bob's Canyon Creek
Vermillion Creek South (Kéindá Deha)
Strawberry Creek (Dah Káá Dehaa)
Mackenzie River (Deh Cho)
Johnson River
Winter Road - KM Marker
Winter Road
Other Road
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DEHCHO
Wrigley
SAHTU SETTLEMENT AREA TULITA DISTRICT
Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region
Title
PKFN Public Consultation Inputs (July 7th, 2011)
Sheet 6
Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : D. Aubin
No : 068-P0037500-202-001-GO-C114-00
Scale : 1:25 000
Date : February 27, 2012
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Projection UTM zone 10N, WGS84
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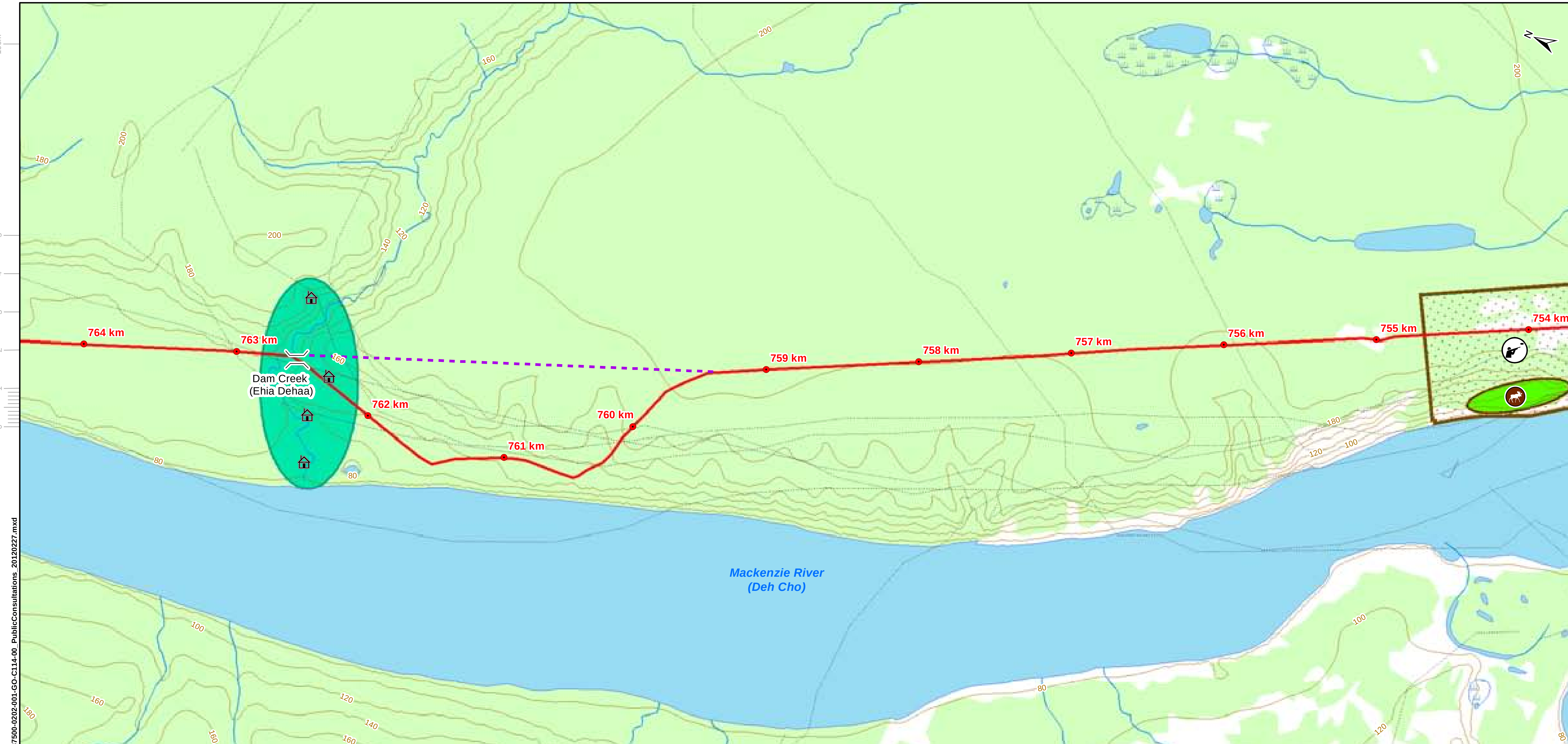


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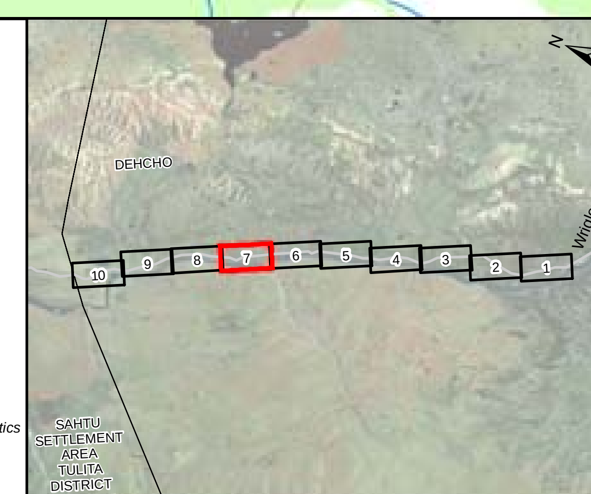


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 7**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C114-00 |
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| Checked : | D. Aubin | Date : | February 27, 2012 |

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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 8**

| | | | |
|---|---|---|---|
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Projection UTM zone 10N, WGS84

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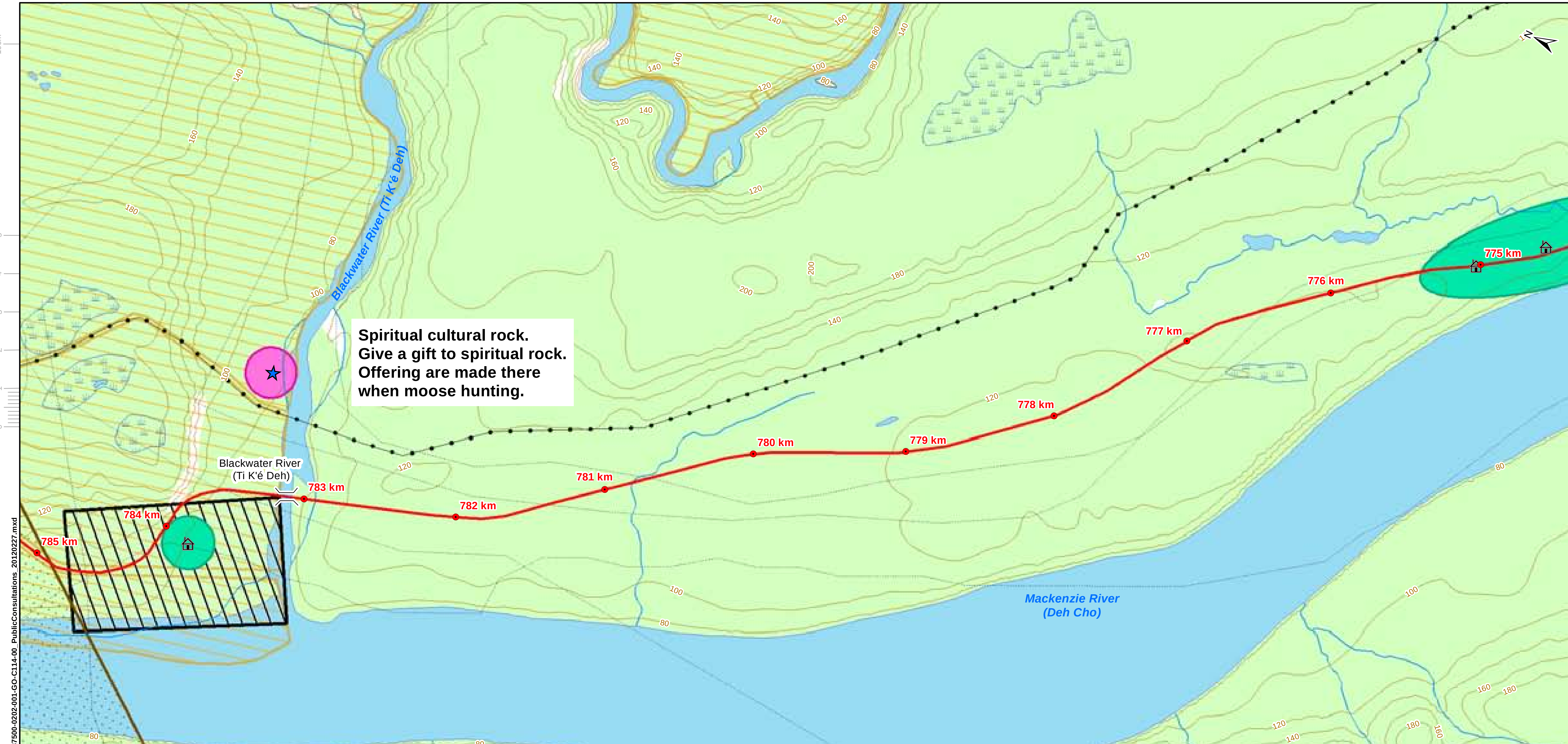


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Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 9**

| | | | |
|---|---|---|---|
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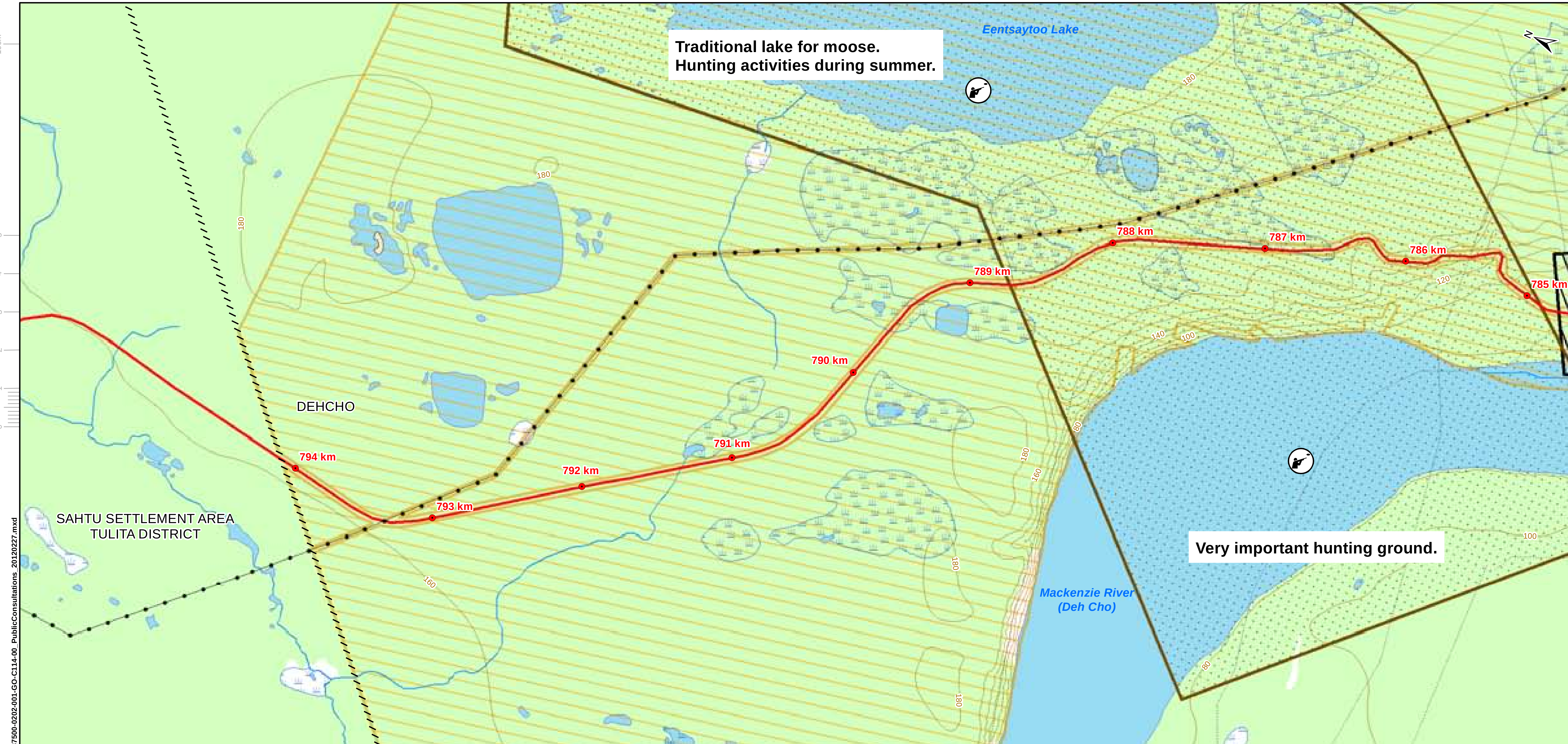


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Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (July 7th, 2011)**
**Sheet 10**

| | | | |
|---|---|---|---|
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DESSAU

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# Appendix 5 Early Consultation

DESSAU

# Annex 1 Public Consultation Notice

**Pehdzeh Ki First Nation (PKFN) &**

**Pehdzeh Ki Contractors (PKC)**

**Will be hosting a**

**Community Public Consultation**

**On the**

**Mackenzie Valley Highway Project Description Report**

**Where:** Pehdzeh Ki Community Complex Gym

**When:** Monday November 22, 2010

**Time:** 3:00pm

For those unable to travel to Wrigley for the Public Consultation, your input is important. Please provide your written comments to PKFN/PKCL concerning the Mackenzie Valley Highway. Your concerns will be brought forward at the Public Consultation.
Letters can be faxed to: 867-581-3229 or
emailed to: tannis@pehdzehkicontractors.com

**Snacks and beverages will be served throughout the consultation**
**Supper will be provided @ 6:00pm**

**Any questions or concerns please contact 867-581-3321 and ask for Tannis Cli Moses or by email. For more details go to our website: Pehdzehkicontractors.com**

Nov 5, 2010

the survey after the big

NCE

R 11

we remember the brave
have fought to protect our
home and overseas. It is because
ce, hard work and dedication
nd present, that Canada
ee, and we thank them for
and our country.

o commemorate our veterans
will you remember?

CHO

needed every five to six years to assess the bigger picture and produce more statistically reliable data, said Larter.

Peter Marcellais is one Deh Cho resident who sees the moose monitoring survey as being beneficial.

"It's good. It gives you more information," Marcellais said.

Last year Marcellais, who's from Nahanni Butte, helped

***en land, Pierre Catholique manages** to boil a cup of tea. Rene Fumoleau included this*
*: 67 of his new book, Way Down North: Dene Life – Dene Land.*



PEHDZEH KI FIRST NATION

PEHDZEH KI CONTRACTORS

Pehdzeh Ki First Nation (PKFN) &

Pehdzeh Ki Contractors (PKC)

will be hosting a

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on the

## Mackenzie Valley Highway Project Description Report

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## Annex 2 Multimedia Presentation

DESSAU

Community Consultation for

**the Mackenzie Valley Highway Extension Through the Pehdzeh Ki First Nation Traditional Territory**

# Agenda

- Opening Prayer
- Understanding of the Purpose of the Meeting
- Introductions: PKCL, HTES and Dessau
- A Look at the MVH Project
- The Project Description Report (PDR)
- The Community Consultation Process

# Opening Prayer

**Prayer**

- Elder Gabe Hardisty

# Understanding of the Purpose of the Meeting

## Overview

+ HTES First Nations relationships
+ Armin Alexis: PKCL Business Advisor
+ GNWT goal: Extend MVH from Wrigley to Tulita
+ PKFN needs an Engineer for PDR work
+ HTES previous meetings in NWT
+ MOU requirement: Community Consultation within 30 days of signing.

# Introductions

## The PDR Team Members

+ Pehdzeh Ki First Nation Chief and Council
+ PKCL
+ HTES
+ Dessau

# Introductions

## Pehdzeh Ki First Nation Chief and Council

- Chief Tim Lennie
- Councilor Elsie Hardisty
- Councilor Henry Hardisty
- Councilor Charlie Tale
- Councilor Sarah Lennie
- Councilor Mary Clillie
- Councilor Mary Alice Christopher

# Introductions

## PKCL

+ President Wesley Pellissey
+ Vice President Gabe Hardisty
+ Secretary Treasurer Sally Nayally
+ PKFN Band Council Representative Charlie Tale
+ PKFN Band Council Representative Mary Alice Christopher
+ Director Albert Moses
+ Chief Tim Lennie Ex Officio

# Introductions

## HTES

+ HTES has previously met with PKCL & GNWT DOT
+ HTES Aboriginal partnerships in AB , BC, and SK
+ HTES past projects
+ HTES capacity
+ The successful past partnership has led to a further committment for long term future works
+ HTES's past work experience with Dessau on Kicking Horse Canyon, North East Stoney Trail, and North West Anthony Henday – Total Overall Value = $2.2 Billion

# Introductions

## Dessau

- 100% Canadian Privately Owned Company
- 4,800 employees
- 391 employee shareholders
- $600M in annual sales
- Over 50 years of experience and expertise
- One of Canada's largest consulting engineering companies
- Ranked 58th among the world's top 150 engineering companies
- Over 100 awards of excellence recognizing innovation and the technical accomplishments of our experts
- ISO 9001: 2008 certified (ISO certified since 1994)

# Team Development

PEHDZEH KI FIRST NATION
CHIEF and COUNCIL

GOVERNMENT OF THE
NWT - DOT

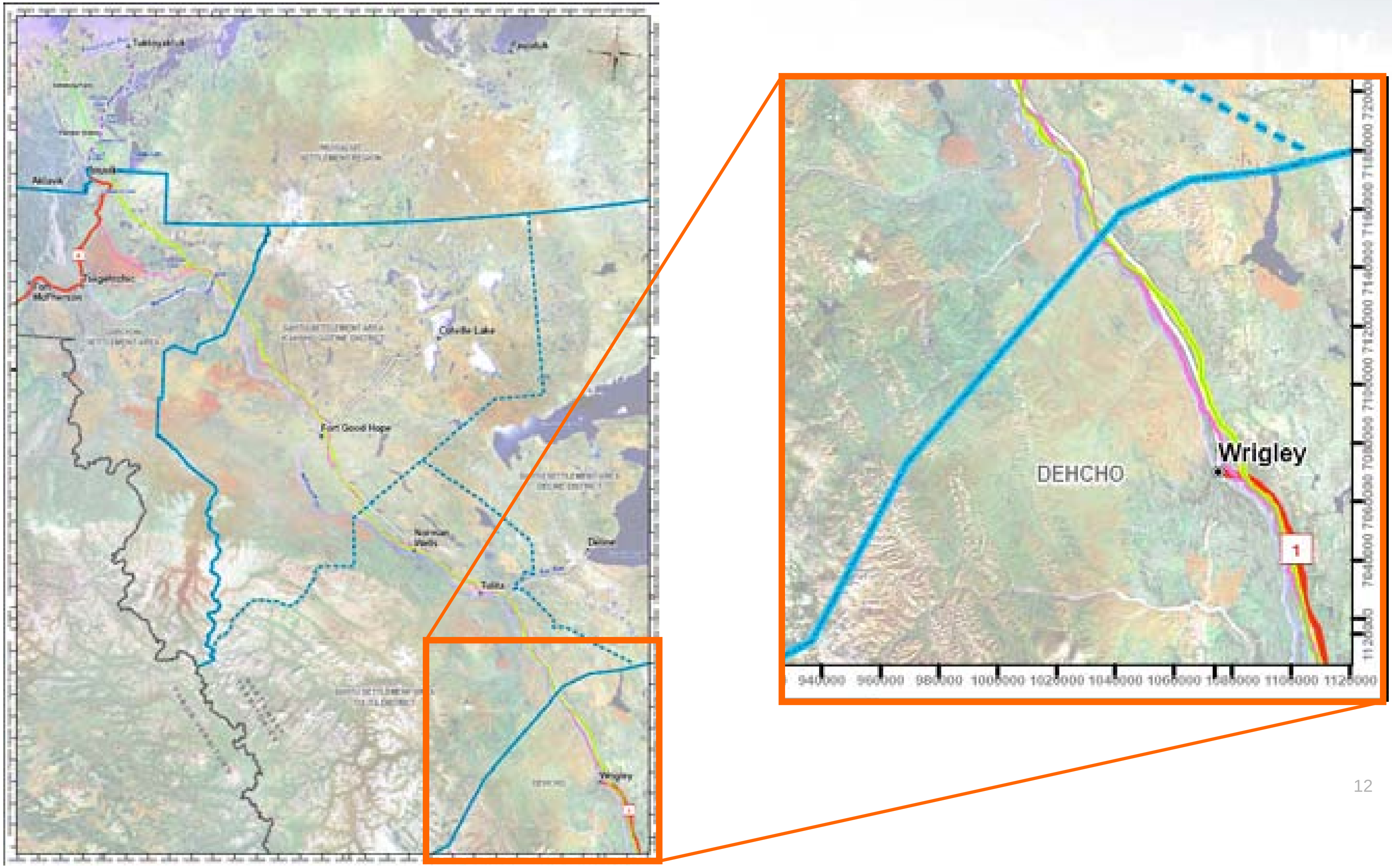
A Joint Venture Between
PKCL, HTES & Dessau

# A Look at the MVH Project

## History

+ 1957 – 58 Federal Government announced to complete the MVH to the Arctic Coast.
+ 1972 and 1976 extensive surveying, environmental-highway design and construction from Fort Simpson to Inuvik.
+ 1977 the Berger Inquiry recommended a 10-year moratorium on development.
+ 1994 the MVH was completed up to Wrigley.
+ June 8, 1998, an initial Stakeholder's Workshop was held in Norman Wells.
+ March 29, 1999, Environmental Scoping Consultation was held in Wrigley.
+ October 27, 2010, MOU was signed between GNWT – DOT and PKFN to prepare PDR.

# Proposed Highway Alignment






PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

## Objectives

- Design/Define the MVH alignment (90kms)
- Detail the construction process;
- Predict adverse and/ or significant effects on environment;
- Discuss adverse and/ or beneficial socio-economic impacts;
- Provide mitigation measures to those adverse and/ or significant effects; and

# Regulatory Agencies Involved

- Mackenzie Valley Land and Water Board (MVLWAB);
- DehCho Land Use Planning Board;
- Department of Transportation - GNWT
- Indian and Nothern Affairs Canada;
- Department of Fisheries and Oceans;
- Department of Environment and Natural Resources – GNWT;
- Prince of Wales Northern Heritage Centre; and
- Others deemed necessary by PKFN and DehCho First Nations.

# Objectives of Community Consultation Process

## 1. To Gather Information On:

- Traditional Land Uses: Camps, Cabins, Trap lines, Hunting, Fishing;
- Wildlife: In the area and migration routes;
- The Land, Water, Plants, Flowers, Berries, Trees;
- Effects of Global Warming: Erosion, Slumping, Permafrost ;
- Historical: Burial/Archeological/Heritage sites ;
- Socio-Economics: Safety, Training, Employment, Businesses, and ;
- Industries: Tourism, Mining, Oil & Gas, Roads, Bridges

## 2. To Validate the Impacts and Mitigation Measures

## 3. To Optimize the Project

# Benefits of the MVH

- Increase mobility;
- Connect Wrigley to the four communities of Tulita,
- Norman Wells, Fort Good Hope and Tsiigehtchic;
- Lower the cost of living for all communities in the MV;
- Improve the quality of life and standard of living;
- Facilitate for economic diversification;
- Promote self-reliance by expanding development in renewable and non-renewable resources; and
- Promote employment, training, education, and businesses.

# Closing

## Questions, Comments, Concerns

For additional information, please contact:

Tannis Cli-Moses at PKCL

Tel: (867) 581-3321

Fax: (867) 581-3229

Email: tannis@pehdzehkicontractors.com

Mahsi Cho for Your Attention

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Appendix 6 First Round of Public Consultation

DESSAU

# Annex 1 Factsheet

DESSAU

## Project Benefits

- Increase mobility;
- Connect Wrigley to the four communities of Tulita, Norman Wells, Fort Good Hope and Tsiigehtchic;
- Lower the cost of living for all communities in the MV;
- Improve the quality of life and standard of living;
- Facilitate economic diversification;
- Promote self-reliance by expanding development in renewable and non-renewable resources;
- Promote employment, training, education and businesses.

Source: http://www.flickr.com/photos/sahtuwildlife/382828282/

Winter Road— DehCho Region

DESSAU

Highway Technical Engineering Services

PEHDZEH KI CONTRACTORS

PEHDZEH KI FIRST NATION

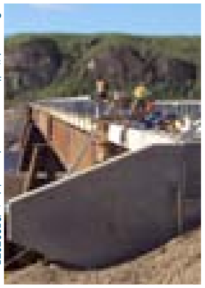
# *Mackenzie Valley Highway Project*

## *DehCho Section*

Fact Sheet
July 2011

For additional information, please contact:
Tannis Cli-Moses at PKCL
Tel: (867) 581-3321Fax: (867) 581-3229
Email: tannis@pehdzehkicontractors.com

# *Mackenzie Valley Highway Project DehCho Section*



Source: http://www.panoramio.com/photo/35897975

As part of the federal governments long standing vision to develop Canada's north, a program for the construction of an all-weather road in the western Arctic was implemented. The extension of the Mackenzie Valley Highway (DehCho region) from Wrigley to the southern boundary of the Sahtu settlement, 93 km north is yet another step towards linking the southern and eastern populations of Canada to the arctic region. Such an endeavour in the valley of the longest river in the country requires an assessment to evaluate biophysical and human impacts as do all projects potentially impacting the environment.

This proposed section of the highway will offer substantial benefits locally, regionally and nationally as it eventually joins the Inuvik-Tuktoyaktuk section at the northern part of the Mackenzie Valley.

## DehCho Section Alignment

## DehCho Section Highway Project Details

- From Wrigley to Blackwater River Bridge;
- All season highway;
- 93 km long;
- 9 meters wide;
- Maximum speed of 80km/h;
- 2 lanes / 2 ways highway;
- Preferred alignment : winter road
- 8 crossing points

## Mackenzie Valley DehCho Section Project Steps

Environmental Impact Screening

↓

(If Required)
Environmental Impact Study (EIA)

↓

Highway Construction

The Mackenzie highway project is currently under its Environmental Impact Screening phase. During this process, data on regulatory framework, engineering details, environmental overview, anticipated effects, mitigation measures are collected and will be analyzed.

Communities and stakeholders are consulted and invited to participate in the environmental impact screening process because their knowledge and quality of life is essential to the success of this project.

## Mackenzie Valley DehCho Section Project Consultation Activities:

- Winter 2010
- Summer 2011
- Fall 2011

# Annex 2 Public Consultation Notice

DESSAU

**Pehdzeh Ki First Nation (PKFN) &**

**Pehdzeh Ki Contractors (PKC)**

Will be hosting a

**Community Public Consultation on**

**The Mackenzie Valley Highway Project**

**DehCho Region Progress Report and Highway Alignment**

**Where:** Pehdzeh Ki Community Complex Gym

**When:** Thursday, July 7, 2011

**Time:** 1h30pm

For those unable to travel to Wrigley for the Public Consultation, your input is important. Please provide your written comments to PKFN/PKCL concerning the Mackenzie Valley Highway. Your concerns will be brought forward at the Public Consultation.

Comments and letters can be faxed to: **867-581-3229** or emailed to: tannis@pehdzehkicontractors.com

**Lunch will be provided at 11h30 am**

**Snacks and beverages will be served throughout the consultation**

**Any questions or concerns please contact 867-581-3321 and ask for Tannis Cli Moses or by email at** tannis@pehdzehkicontractors.com

**Pehdzeh Ki First Nation (PKFN) and**
**Pehdzeh Ki Contractors (PKC)**

*will be hosting a*

COMMUNITY PUBLIC CONSULTATION ON

# The Mackenzie Valley Highway Project DehCho Region Progress Report and Highway Alignment

## Thursday, July 7, 2011

**1:30pm, at the Pehdzeh Ki Community Complex Gym**

For those unable to travel to Wrigley for the Public Consultation, your input is important. Please provide your written comments to PKFN/PKCL concerning the Mackenzie Valley Highway. Your concerns will be brought forward at the Public Consultation.

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*Snacks and beverages will be served throughout the consultation.*

*Any questions or concerns please contact Tannis Cli Moses at 867-581-3321 or by email at tannis@pehdzehkicontractors.com*

# Annex 3 Multimedia Consultation

DESSAU

# Community Consultation for the Mackenzie Valley Highway - DEHCHO SECTION

# Agenda

- Opening Prayer
- Introduction
- Our Starting Point
- Mackenzie Valley Highway Project and Progress
- The Community Consultation Process
- Questions, Comments and Suggestions

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Opening Prayer

**Elder Gabe Hardisty**

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Introduction

**Purpose of the Meeting**

- To Present the Progress Report of DehCho Section of the Mackenzie Valley Highway Project;

- To Receive Comments, Views, Concerns and Questions from the Community.

# Introduction

## Mackenzie Valley DehCho Section Highway Team

PEHDZEH KI FIRST NATION
CHIEF and COUNCIL

GOVERNMENT OF THE
NWT - DOT

A joint venture between
PKCL, HTES & DESSAU

# Our Starting Point

## History of the Mackenzie Valley Highway Project

- 1957–58 Federal Government announced to complete the MVH to the Arctic Coast;
- 1972 and 1976 extensive surveying, environmental-highway design and construction from Fort Simpson to Inuvik;
- 1977 the Berger Inquiry recommended a 10-year moratorium on development;
- 1994 the MVH was completed up to Wrigley;
- June 8, 1998, an initial Stakeholder's Workshop was held in Norman Wells;
- March 29, 1999, Environmental Scoping Consultation was held in Wrigley;
- October 27, 2010, MOU was signed between GNWT – DOT and PKFN to prepare PDR.

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Our Starting Point

## Mackenzie Valley DEHCHO Section Project Steps

Environmental Impact Screening

↓

(If Required)
Environmental Impact Study (EIA)

↓

Highway Construction

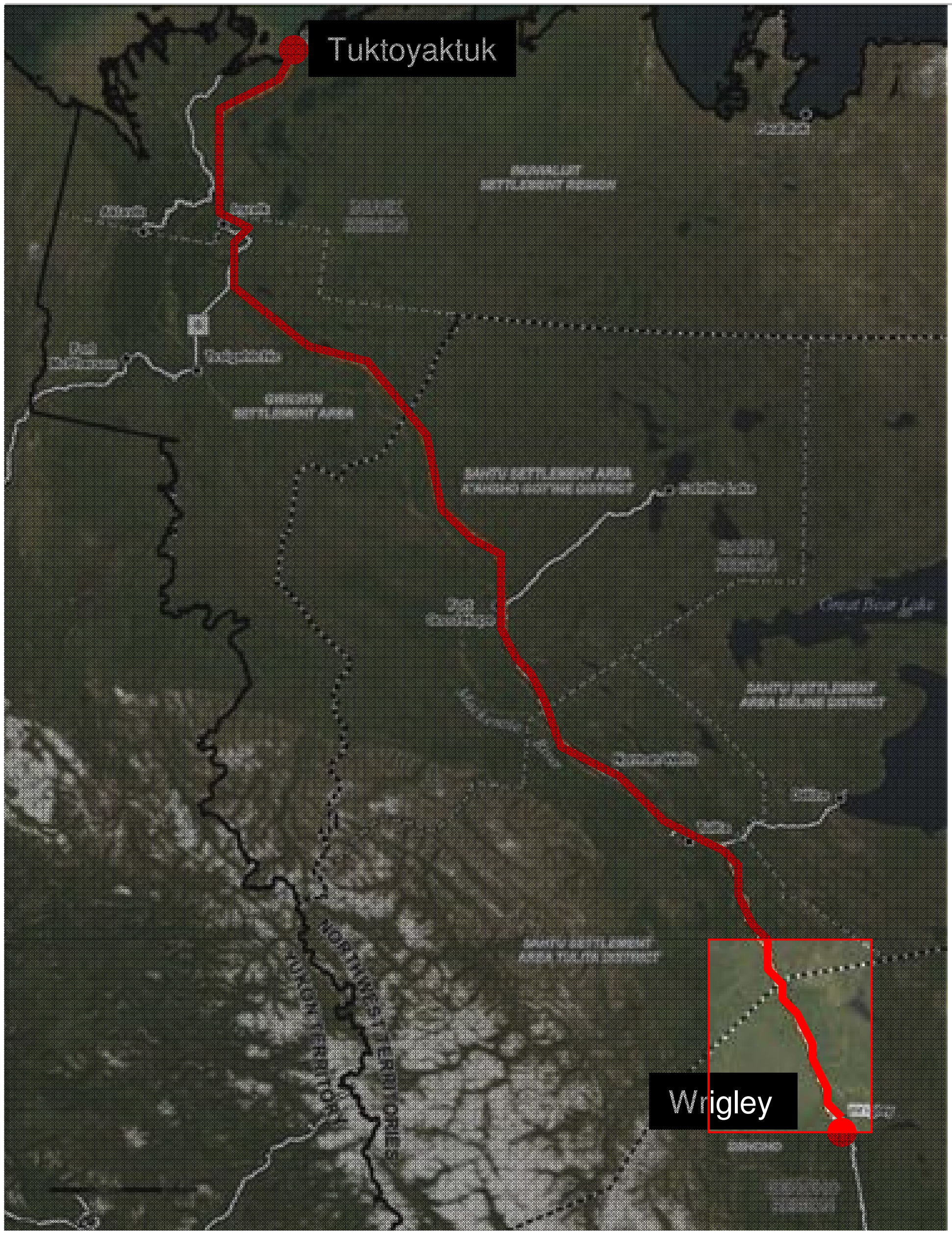
# Our Starting Point

## Mackenzie Valley DEHCHO Section Project Steps

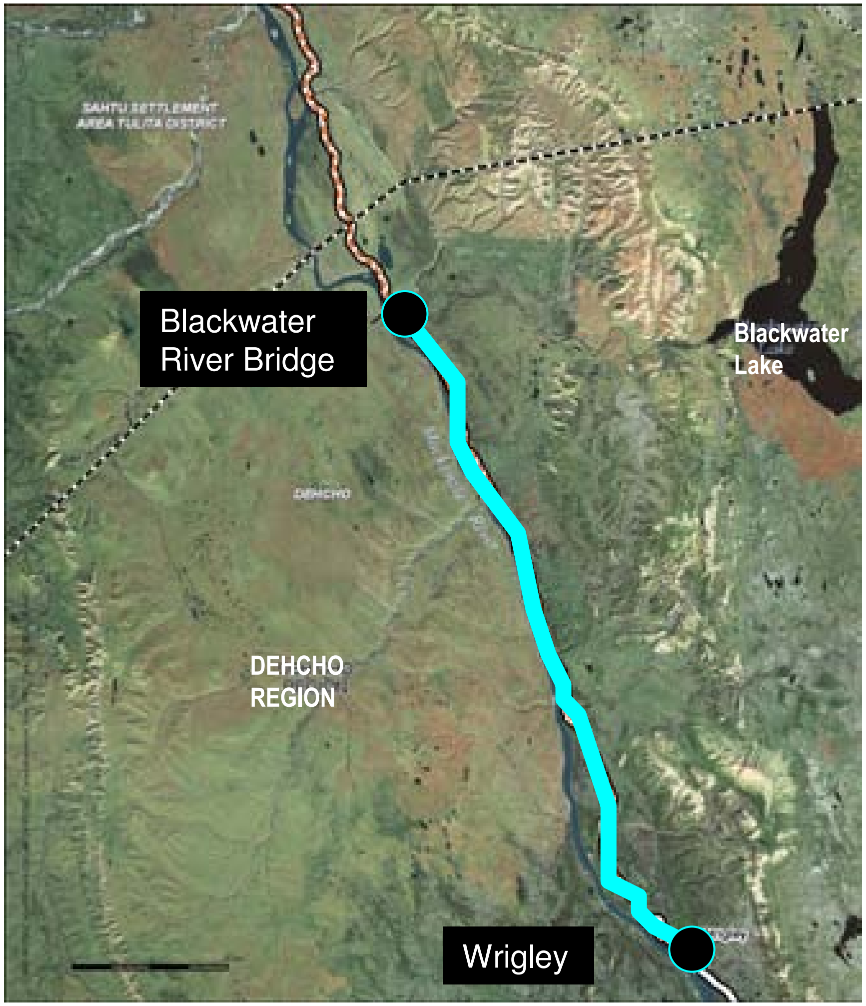
**Environmental Impact Screening**

- Regulatory Review
- Project Description / Engineering
- Environmental Overview
- Community Consultation
- Anticipated Efffects and Proposed Mitigation
- Environmental Management Plan

# Mackenzie Valley Highway Project and Progress




## MVHighway/DehCho Section



# Mackenzie Valley Highway Project and Progress


## DehCho Section Highway Details

- From Wrigley to Blackwater River Bridge;
- 4 season highway;
- 93 km long;
- 9 meters wide;
- Maximum speed of 80km/h;
- 2 lanes / 2 way highway;
- Preferred alignment: winter road
- 8 crossing points.

Source: http://www.panoramio.com/photo/35897975

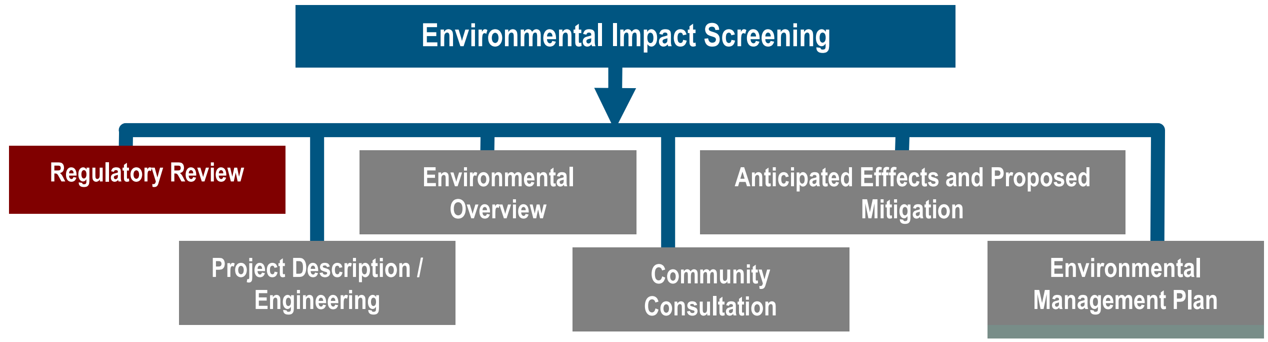
# Mackenzie Valley Highway Project and Progress

## Benefits of the Project

- Increase mobility;
- Connect Wrigley to the four communities of Tulita,
- Norman Wells, Fort Good Hope and Tsiigehtchic;
- Lower the cost of living for all communities in the MV;
- Improve the quality of life and standard of living;
- Facilitate for economic diversification;
- Promote self-reliance by expanding development in renewable and non-renewable resources;
- Promote employment, training, education, and businesses.

# Mackenzie Valley Highway Project and Progress

## Regulatory Review




## Regulatory Agencies Involved

- Mackenzie Valley Land and Water Board (MVLWAB);
- DehCho Land Use Planning Board;
- Department of Transportation – GNWT;
- Indian and Northern Affairs Canada;
- Department of Fisheries and Oceans;
- Department of Environment and Natural Resources – GNWT;
- Prince of Wales Northern Heritage Centre;
- Others deemed necessary by PKFN and DehCho First Nations.

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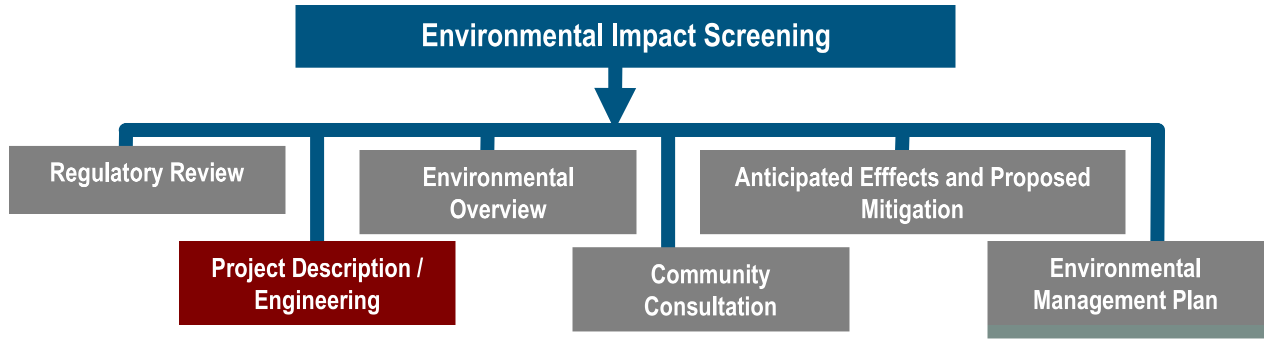
# Mackenzie Valley Highway Project and Progress

## Project Description and Engineering




### Update

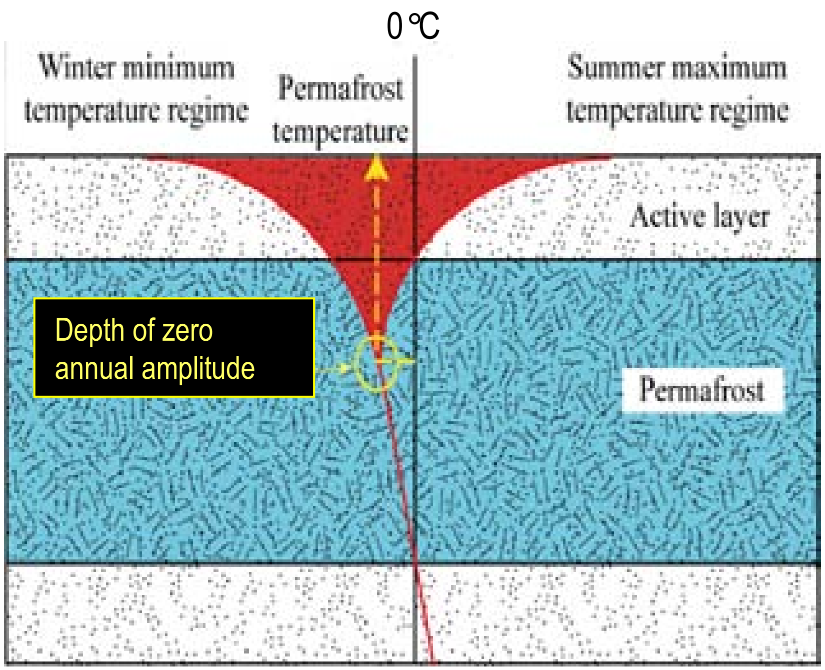
+ Design parameters (embankment, geometry and drainage structure);
+ Borrow sources;
+ Key highway geotechnical

### Next steps

+ Alternative Alignment Analysis;
+ Identification of preferred alignment;
+ Analysis of permafrost sensitive area and geotechnical zone;
+ Terrain conditions survey;
+ Quantity and economic evaluations;
+ Construction.

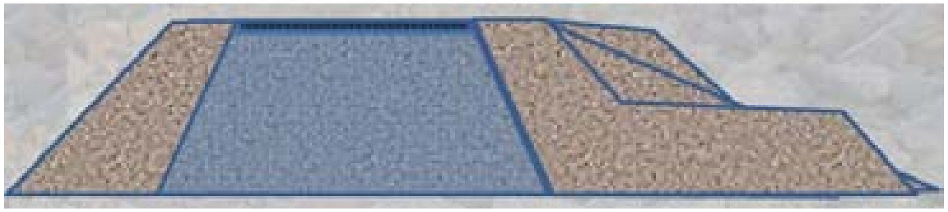
PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Mackenzie Valley Highway Project and Progress




## Challenge of building on Permafrost

- Preliminary studies;
- Site investigation;
- Embankment design (geometry and thickness);
- Mitigation methods:
  - Reduction of heat intake during summer;
  - Activation of heat extraction during winter;
- Cost/Benefit analysis.

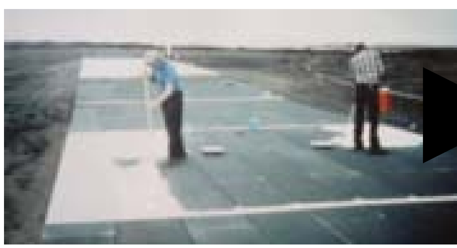


# Mackenzie Valley Highway Project and Progress

## New road building techniques on Permafrost

### Reduction of heat intake during summer

Thermal Insulation

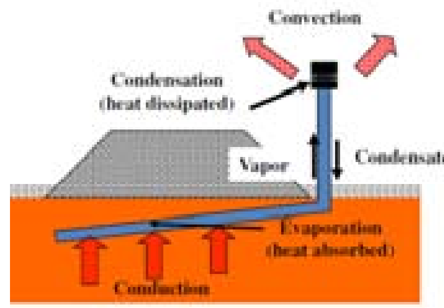


High albedo surfacing materials

Sun Shed

### Activation of heat extraction during winter

Thermosyphons



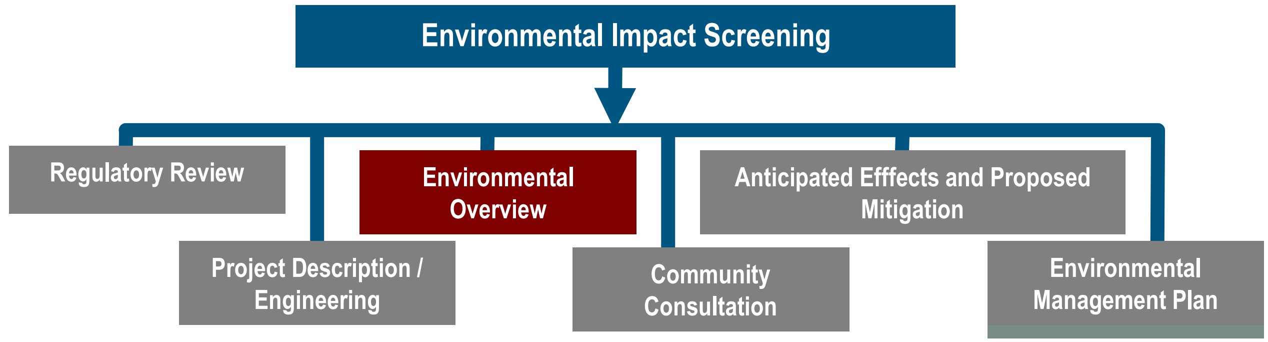

Air convection embankments

Heat drain

Air ducts

# Mackenzie Valley Highway Project and Progress

## Environmental Overview




## Update

- Define study area;
- Initiated  research for Environmental baseline and potentially impacted components;
- Investigated new road construction techniques on permafrost and how it affects the chosen alignment and environmental study;
- Initiated lidar based analysis : land use, geo hazards, alternate routes, archaeological potential;
- Initiated work plan for GIS production;
- Defined and tested appropriate scales of GIS for each environmental component.

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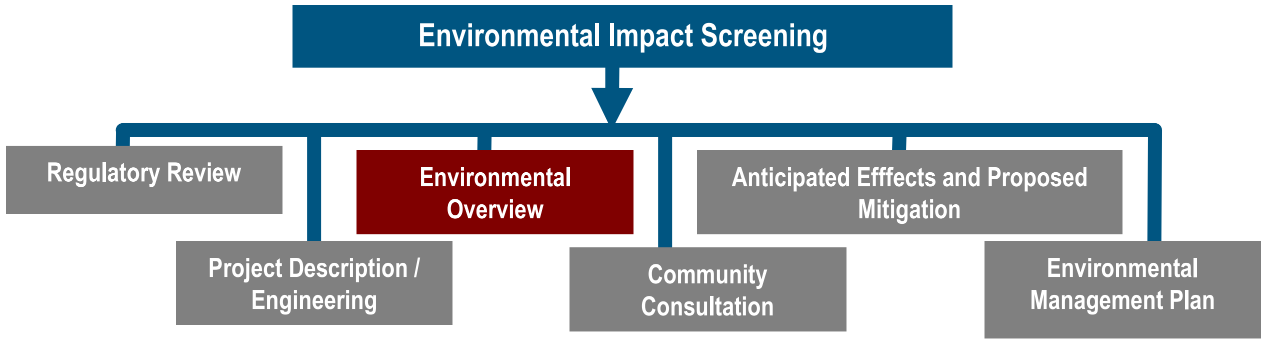
# Mackenzie Valley Highway Project and Progress

## Environmental Overview




## Next Steps

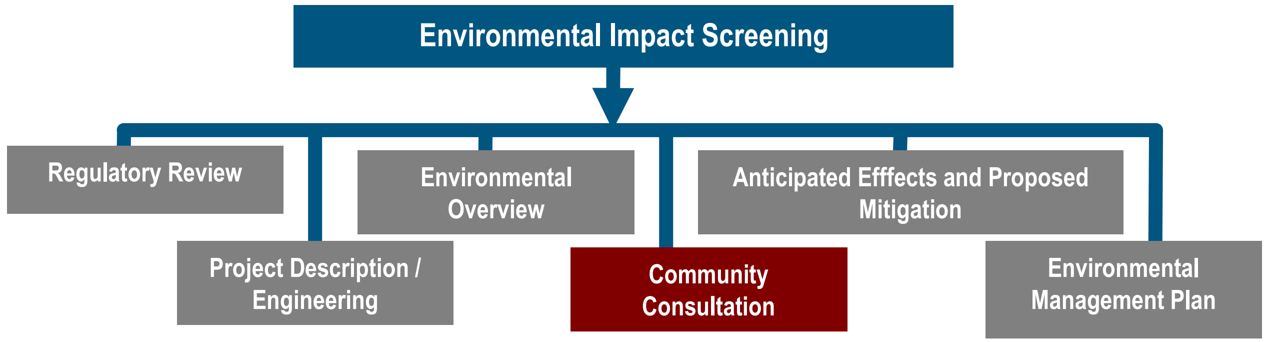
- On site visit;
- Environmental overview data collection;
- Identification of land use and archaeological components;
- Integration of Traditional Knowledge in highway project.


Source: http://www.flickr.com/photos/sahtuwildlife/382828282/

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Mackenzie Valley Highway Project and Progress

## Community Consultation




## Update

Winter 2010

+ First informative meeting in November 2010

## Next steps

Summer 2011

+ Community consultation on proposed alignment (winter road) and possible effects of the new highway

Fall 2011

+ Community consultation on preferred alignment and mitigation measures

# The Community Consultation Process

## Objectives

### 1. Gather Information

- Traditional land uses: camps, cabins, trap lines, hunting, fishing;
- Wildlife and migration routes;
- Land, vegetation, streams, lakes, berries, trees;
- Traditional sites: burial, archeological, heritage sites.

### 2. Integrate Concerns and Opportunities

- Climate change: Permafrost, erosion, slumping;
- Economic benefits;
- Social Impacts.

### 3. To Validate Alignment and Optimize Project

- Integrate concerns & opportunities;
- Validate preferred alignment;
- Optimize opportunities and benefits in project planning

# The Community Consultation Process

## Concerns and opportunities

### 1. Land Use and Access

- Camps, cabins, trap lines, hunting, fishing;
- Burial, valued landscape and cultural sites;
- Wildlife and migration routes.

### 2. Economic

- Employment, education;
- Economic activities, tourism;
- Industries: mining, oil & gas, roads, bridges.

### 3. Social

- Traditional culture, beliefs and activities;
- Age groups;
- Social structure, demographic groups.

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

# Questions, Comments, Suggestions

For additional information, please contact:

Tannis Cli-Moses at PKCL

Tel: (867) 581-3321

Fax: (867) 581-3229

Email: tannis@pehdzehkicontractors.com

PEHDZEH KI FIRST NATION | PEHDZEH KI CONTRACTORS | DESSAU | Highway Technical Engineering Services

Mahsi Cho for your attention

# Annex 4 Attendance Sheet

DESSAU

DESSAU

Highway Technical Engineering Services

## COMMUNITY CONSULTATION FOR THE MACKENZIE VALLEY HIGHWAY PROJECT – DEHCHO SECTION

## CONTACT INFORMATION

| Meeting Date and Time : 7 July 2011 – 1h30pm | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 1 | Stanley Sanguez | Chief | Jean Marie River First Nation | S_Sanguez58@hotmail.com |
| 2 | [illegible] | Elder | PKFN. | Wrigley N.T. |
| 3 | Charles H [illegible] | | PFN | WRIGLEY N.T |
| 4 | Brendan Moses | Student | PKFN | Wrigley NT |
| 5 | Alice Hardisty | Councillor | PKFN | " " |
| 6 | Henry Hardisty | " | PKFN | " " |
| 7 | ROLAND [illegible] | " | PKFN | WRIGLEY NT |
| 8 | ALBERT Moses | " | PKC | Wrigley |
| 9 | Mary Alice Christopher | Councillor | PKFN | Wrigley |
| 10 | Margaret Moses | elder | PKFN | Wrigley |

| Title | CONTACT INFORMATION | | |
|---|---|---|---|
| | | | Page 1/6 |

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 11 | Sarah Lennie | Council | PKFN | Wrigley, N.T. |
| 12 | Charlotte Canadien | member | PKFN | Wrigley, NT. |
| 13 | Stanley Sanguez | chief | Sach Mow Ake | |
| 14 | D'Arcy MOSES | member | | |
| 15 | LEO MOSES | ELDER | PKFN | Wrigley N.T. |
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# Annex 5 Comment Sheets

DESSAU

COMMUNITY CONSULTATION FOR THE MACKENZIE VALLEY HIGHWAY PROJECT – DEHCHO SECTION

## QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 7 July 2011 – 1h30pm | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

Protect all our Rivers, Creeks and our forest for ~~the~~ our future generations. The community members are very concerns about protecting our land, moose, caribou and fish along with our Timbers.
Blackwater Area is very important traditional place. There is old grave places that has being over grown with willows these should be portected.

Mahsi!
Mary Alice Christopher 867-581-3093

DESSAU

Highway Technical Engineering Services

**COMMUNITY CONSULTATION FOR THE MACKENZIE VALLEY HIGHWAY PROJECT – DEHCHO SECTION**

# QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 7 July 2011 – 1h30pm | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

We have lots of dropouts, therefore, we need adult Education in the community. Training packages for the young people that have finish grade 12 to further their education or go back to school to train for careers.
Evening mtg would of been good.
People around here eat and run, so next time have a mtg first, then eat. Also previous Chief & councillors paid people to attend mtgs, so it is really hard to get members to attend. Door prizes ~~mostly~~ is really good, too.
Berry Patch along the way
It would be good ~~for~~ if you can come into the school and do a presentation to the higher grades. It's their future.

867
Sarah Lennie – 581-3831 (h).

## Appendix 7 Door-to-Door Survey

DESSAU

DESSAU | Highway Technical Engineering Services | PEHDZEH KI CONTRACTORS

**PROPOSED MACKENZIE RIVER VALLEY HIGHWAY EXTENSION**
**SURVEY OF PEHDZEH KI FIRST NATION PEOPLES**
**PERCEPTION AND OPINION**

## Introduction

The proposed extension of the Mackenzie River Valley Highway from Wrigley to the Blackwater River Bridge, (approximately 93 km north of Wrigley) is yet another step towards directly linking by land the Pehdzeh Ki First Nations peoples with their neighbours to the north, as well as the rest of Canadians all the way to the Arctic Ocean. Such an endeavour in the valley of the longest river in the country requires an assessment to evaluate both biophysical and human impacts.

Chief Tim Lennie has expressed the need to get the overall perceptions and opinions of the Pehdzeh Ki First Nation community on this proposed project and of the role of the community's leadership.

This survey seeks to identify the points of view of the community members in order to guide the leadership towards a productive and representative role in this proposed project.

## Questionnaire

Male: ____________

Female: ____________

Age: ____________

- **What positive aspects do you expect the Mackenzie River Valley Highway project will bring to the Pehdzeh Ki First Nation community?**

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

- **What negative aspects do you expect the Mackenzie River Valley Highway project will bring to Pehdzeh Ki First Nation community?**

- **How do you think that a new four season highway will affect or change your personal life?**

- **How do you think that a new four season highway will affect or change your family's life?**

- How do you think that a new four season highway will affect or change your community's life?

- What position do you think the Council should adopt regarding the highway project? (Should they be for or against it. Should they require conditions and if so what conditions?)

- Are their measures, precautions or conditions you think should be taken prior to, while and after the highway is built?

- **What activities do you think will be affected by the new all season highway, (hunting, berry picking, fishing, spiritual and ancestry sites)?**

- **Are you for or against this project?**

# PROPOSED MACKENZIE RIVER VALLEY HIGHWAY EXTENSION
# SURVEY OF PEHDZEH KI FIRST NATION PEOPLES
# BASELINE INFORMATION

This survey seeks to describe and understand the community members way of life in order to elaborate the community baseline, evaluate potential benefits and/or impact of the project as well as developed mitigation measures.

- **Please list up to 10 important resources (for example, caribou, fish species, waterfowl, etc) for you in order of priority? Please identify them on the map where possible.**

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

**Comments:** ______________________________

______________________________

______________________________

- **Which streams have fish in them within 200m upstream or downstream of the existing crossings of the winter road? Please identify them on the attached map where possible.**

______________________________

______________________________

---

- **Are there important heritage or archaeological resources that must be avoided and where are they? Please identify them on a map.**

---

---

---

- **Which parts of the highway in your territory most interact with each of these resources (Please identify them on the attached map where possible)**

- **List up to 10 tourism resources and locations that will be important for you (Please identify on the attached map where possible)?**

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

**Comments:** ______________________________

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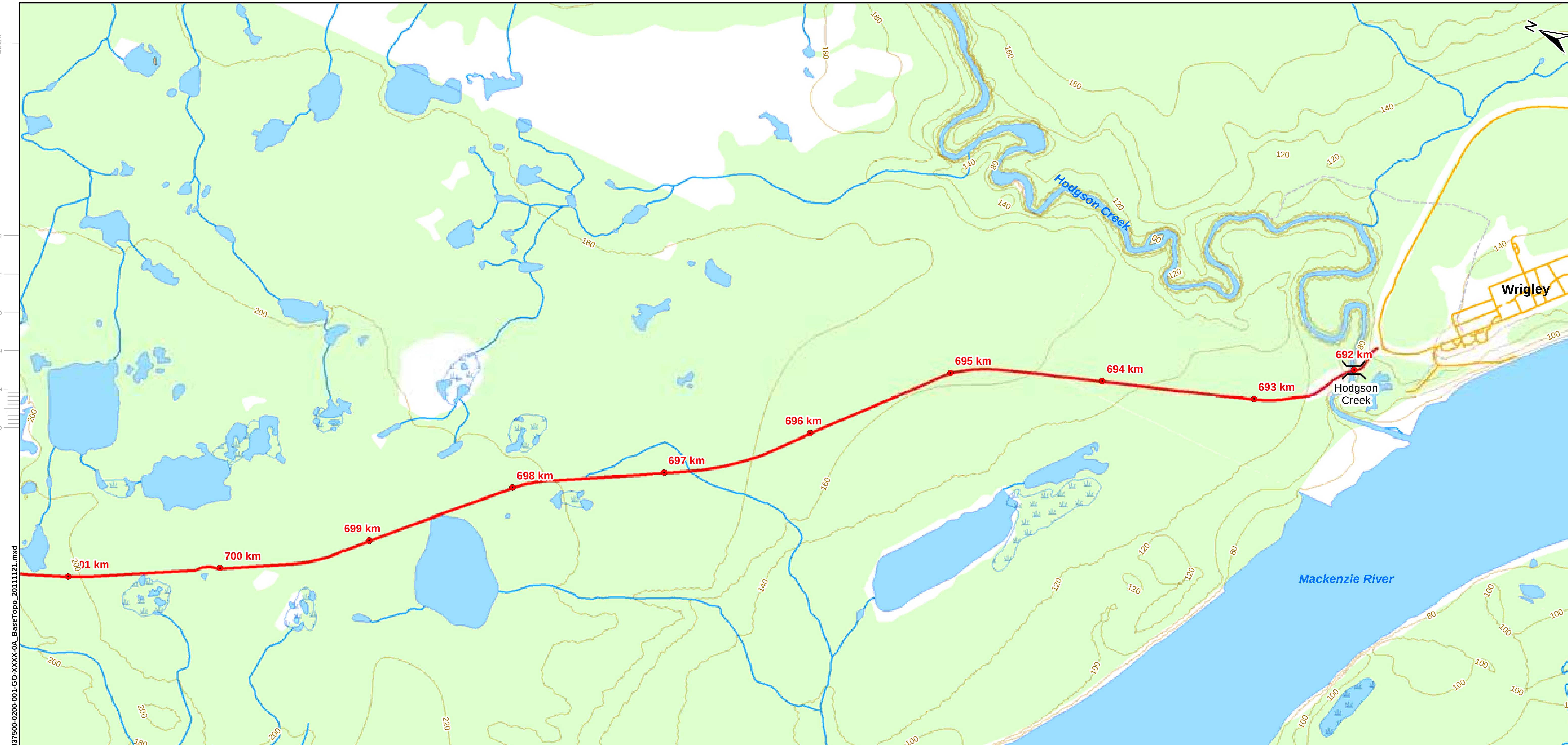
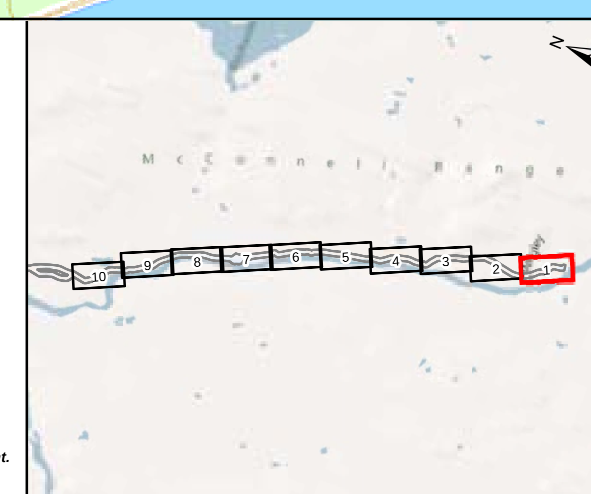



- Actual Winter Road - KM Marker
- Actual Winter Road
- Other Roads
- Pipeline
- Boundary Community
- Existing bridge
- Bridge to be built or re-built
- Sahtu Private Lands
- Contour line (in meters)
- Trail
- Sand
- River
- Wetland
- Waterbody
- Wooded Area
- Island

DRAFT MAP

Sources :
- CanVec, Canada Government.
- LiDAR EBA.
- Dessau, 2011.




Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 1**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : F. Faustin

No : 068-P0037500-200-001-GO-XXXX-0A
Scale : 1:25 000
Date : November 21, 2011

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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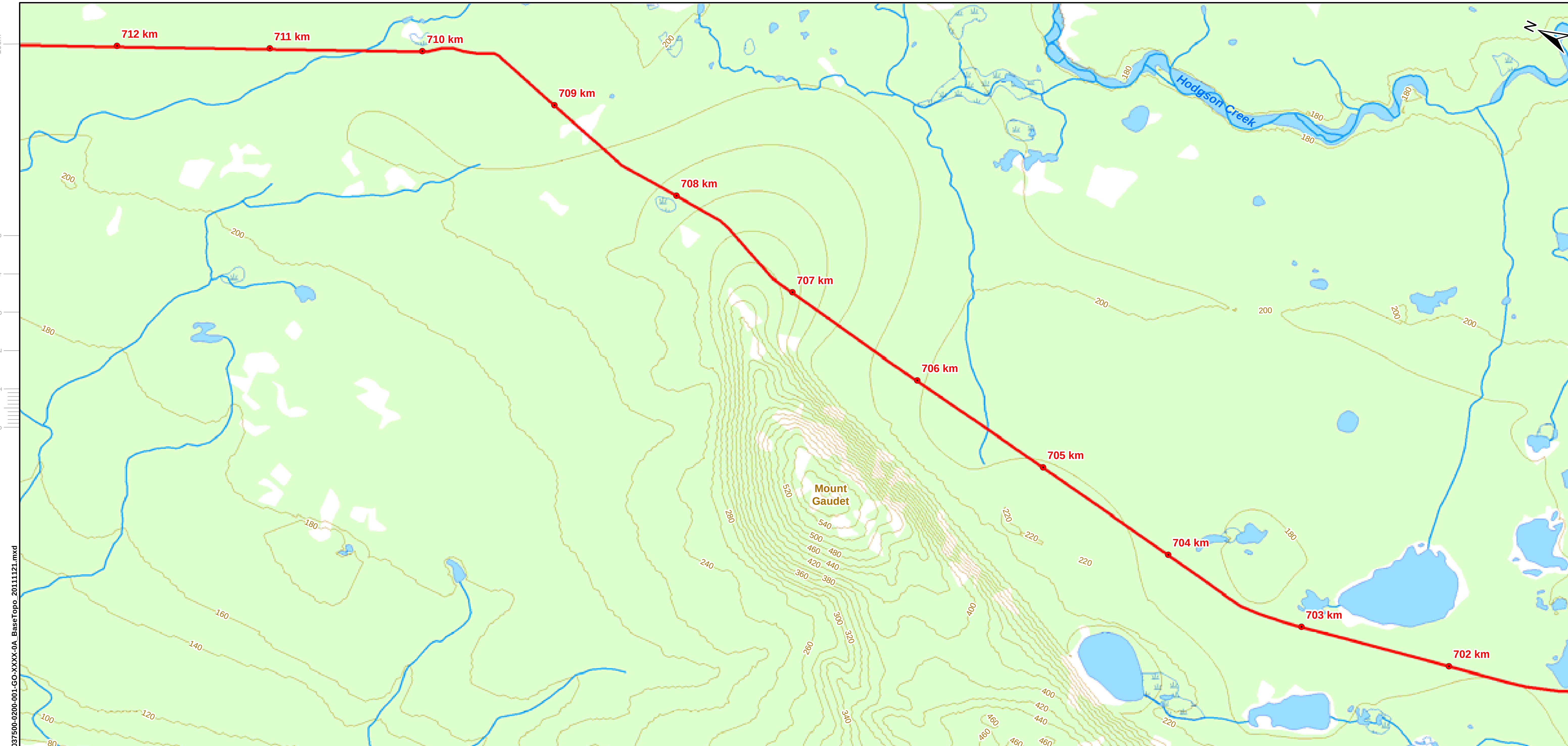


Actual Winter Road - KM Marker
Actual Winter Road
Other Roads
Pipeline
Boundary Community
Existing bridge
Bridge to be built or re-built
Sahtu Private Lands
Contour line (in meters)
Trail
Sand
River
Wetland
Waterbody
Wooded Area
Island

DRAFT MAP

Sources :
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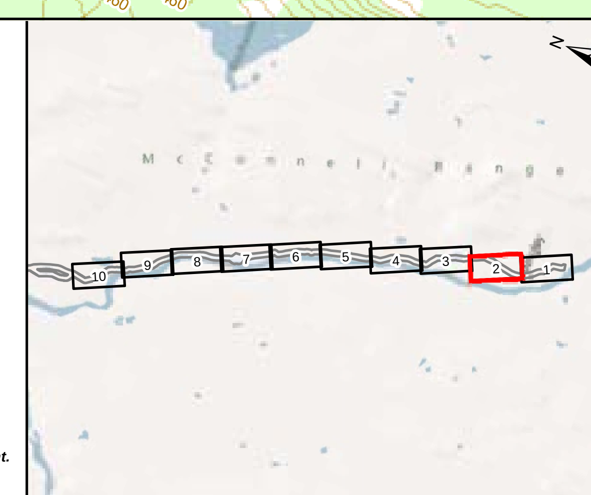
- LiDAR EBA.
- Dessau, 2011.




Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 2**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : F. Faustin

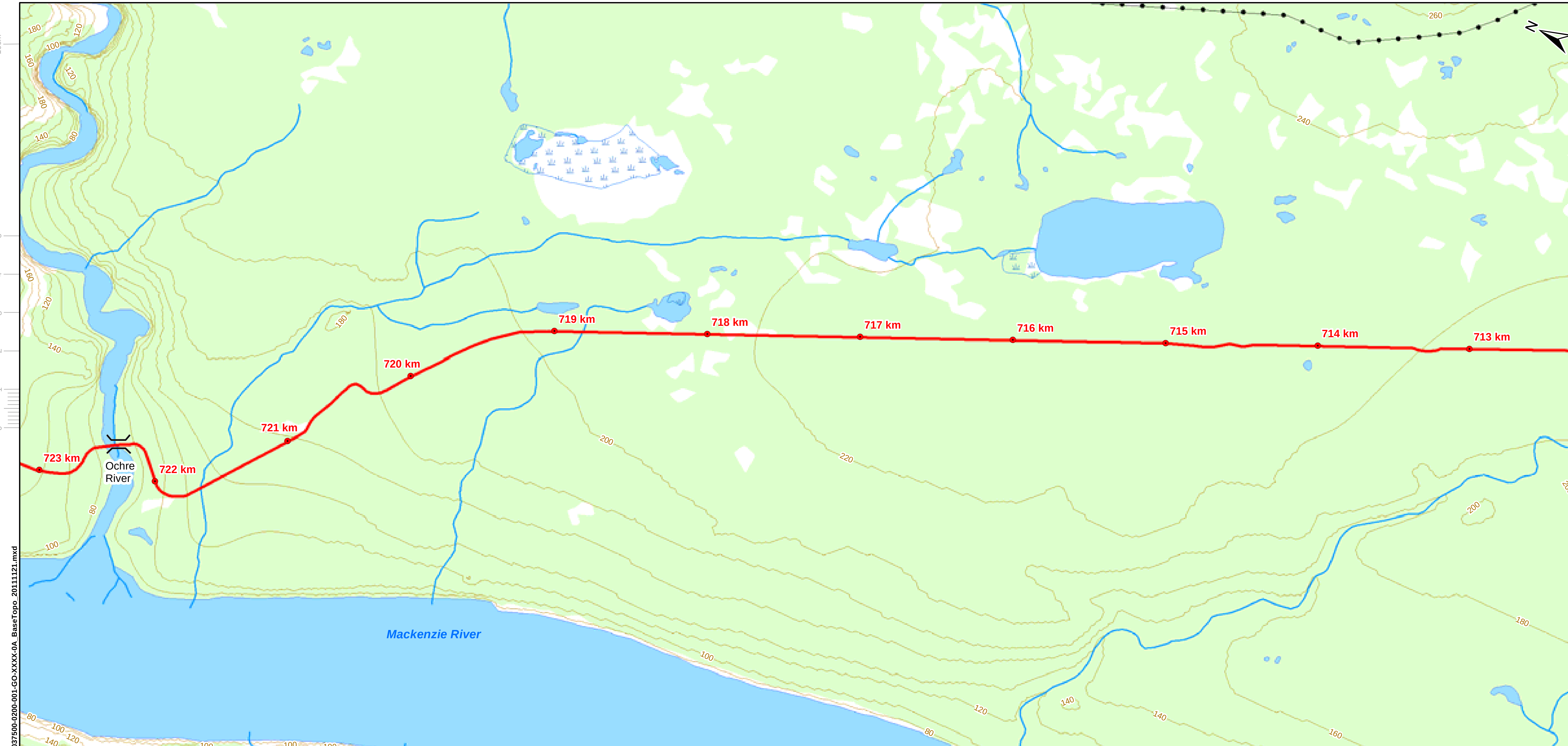
No : 068-P0037500-200-001-GO-XXXX-0A
Scale : 1:25 000
Date : November 21, 2011

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
Path: G:\068\P037500-MacKenzieHighway\ENI\z5_CAD\GO\01-MXD\068-P037500-0200-001-GO-XXXX-0A_BaseTopo_20111121.mxd




- Actual Winter Road - KM Marker
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DRAFT MAP

*Sources :*
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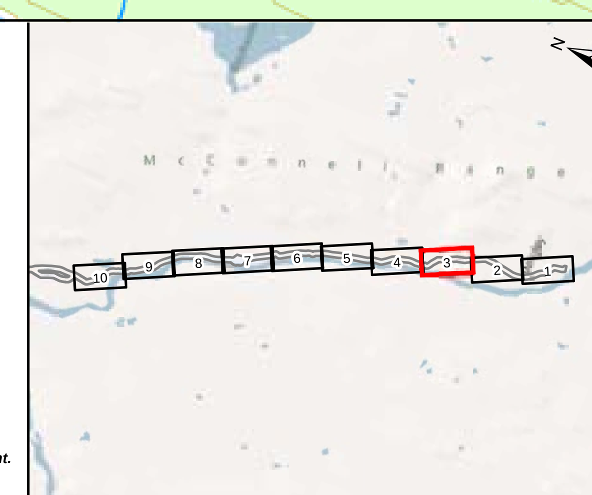


Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 3**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-200-001-GO-XXXX-0A |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | F. Faustin | Date : | November 21, 2011 |

0 750 m
Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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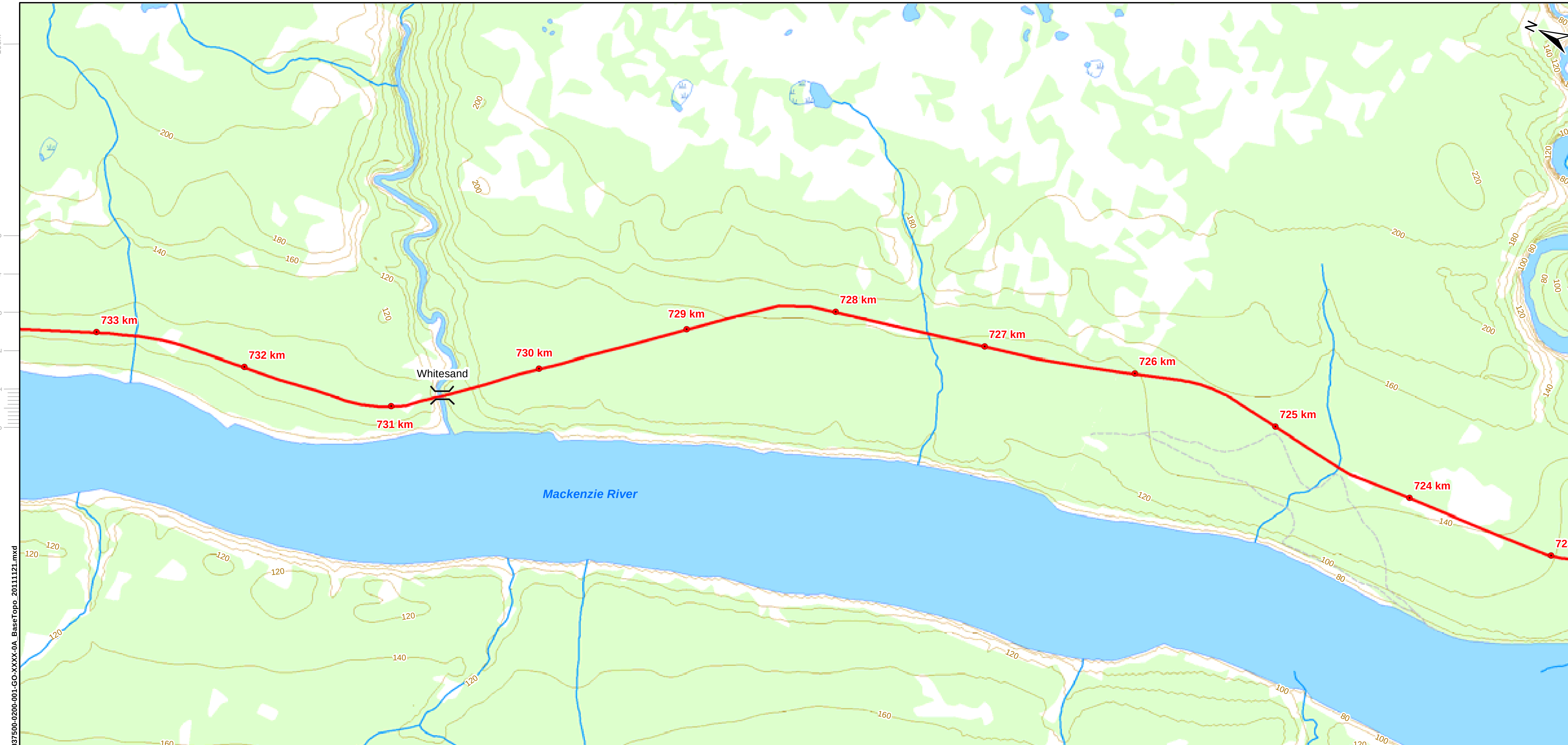


Actual Winter Road - KM Marker
Actual Winter Road
Other Roads
Pipeline
Boundary Community
Existing bridge
Bridge to be built or re-built
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DRAFT MAP

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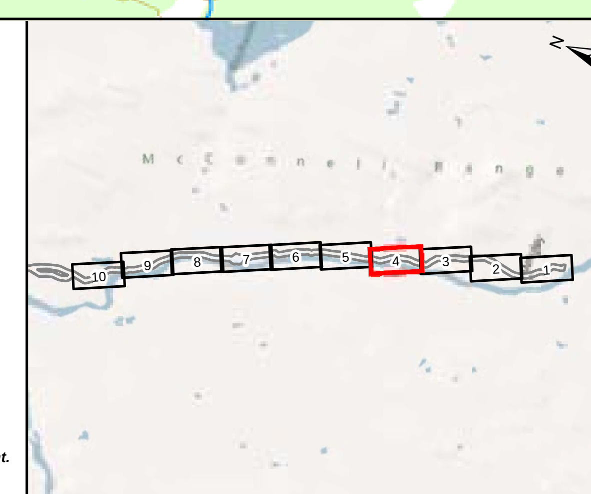


Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 4**

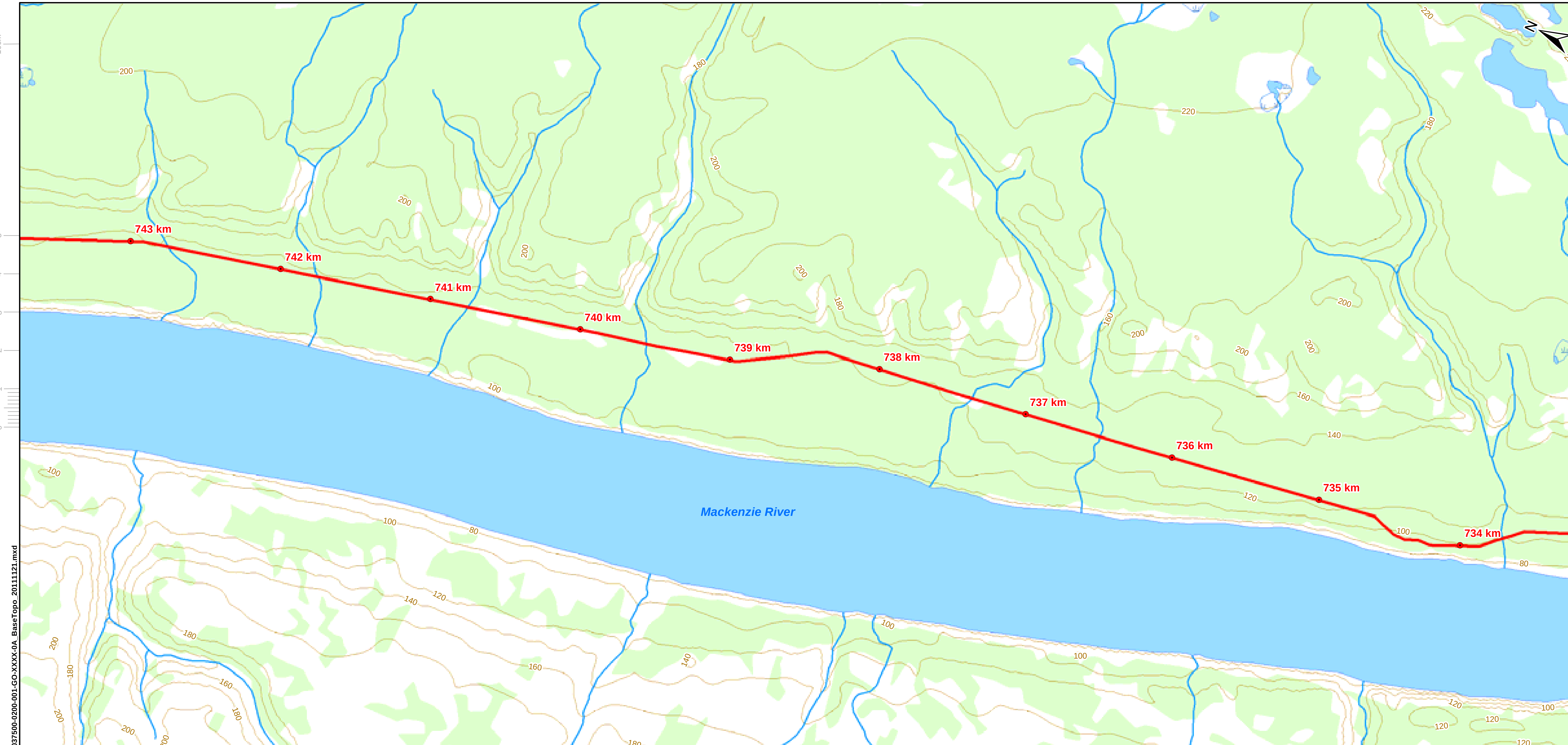
| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-200-001-GO-XXXX-0A |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | F. Faustin | Date : | November 21, 2011 |

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
Path: G:\068\P037500-MacKenzieHighway\ENI\z5_CAD\GO\01-MXD\068-P037500-0200-001-GO-XXXX-0A_BaseTopo_20111121.mxd




- Actual Winter Road - KM Marker
- Actual Winter Road
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- Pipeline
- Boundary Community
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*Sources :*
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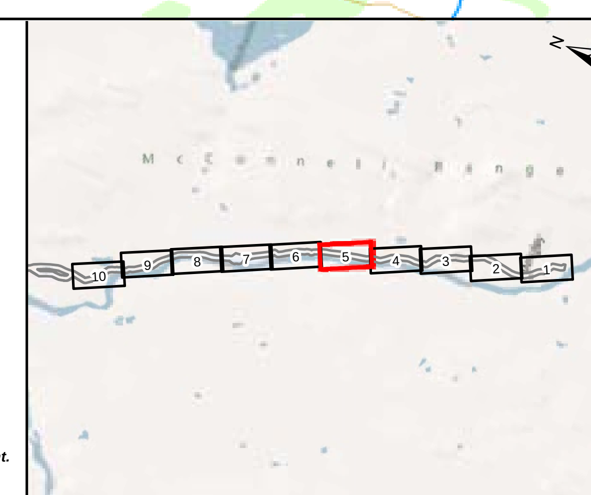

Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 5**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-200-001-GO-XXXX-0A |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | F. Faustin | Date : | November 21, 2011 |

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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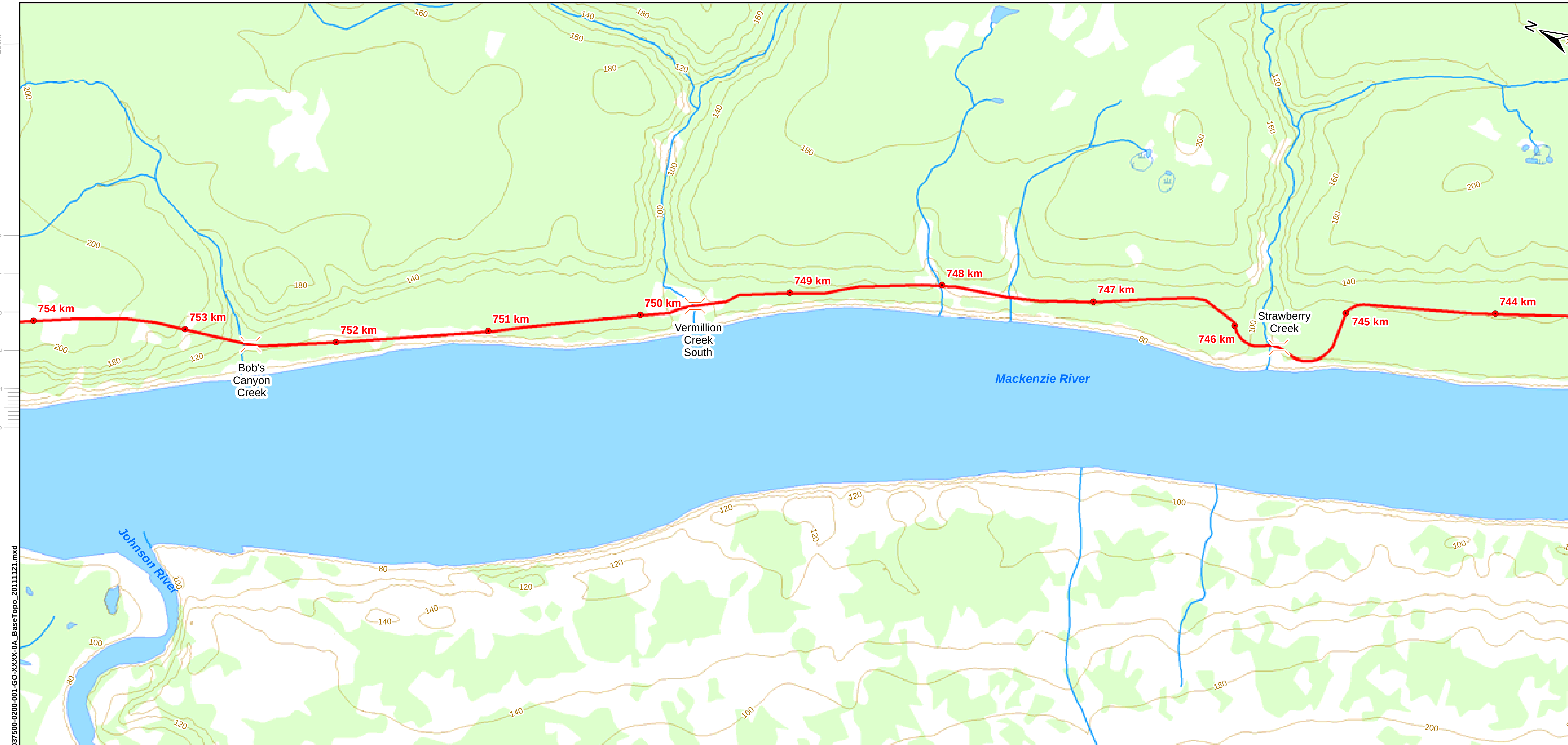


Actual Winter Road - KM Marker
Actual Winter Road
Other Roads
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Existing bridge
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Sahtu Private Lands
Contour line (in meters)
Trail
Sand
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Sources :
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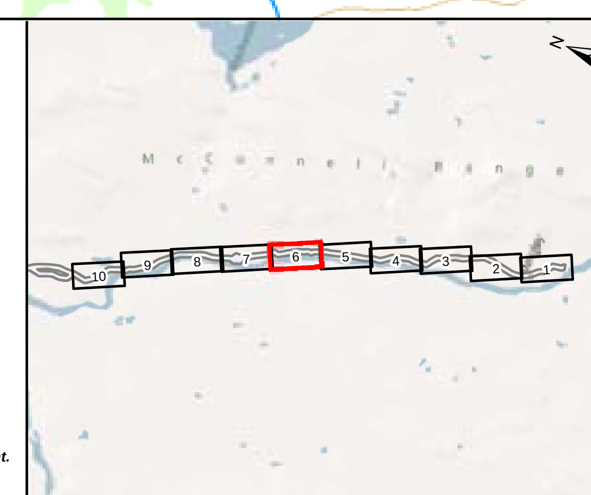
- LiDAR EBA.
- Dessau, 2011.




Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 6**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : F. Faustin

No : 068-P0037500-200-001-GO-XXXX-0A
Scale : 1:25 000
Date : November 21, 2011

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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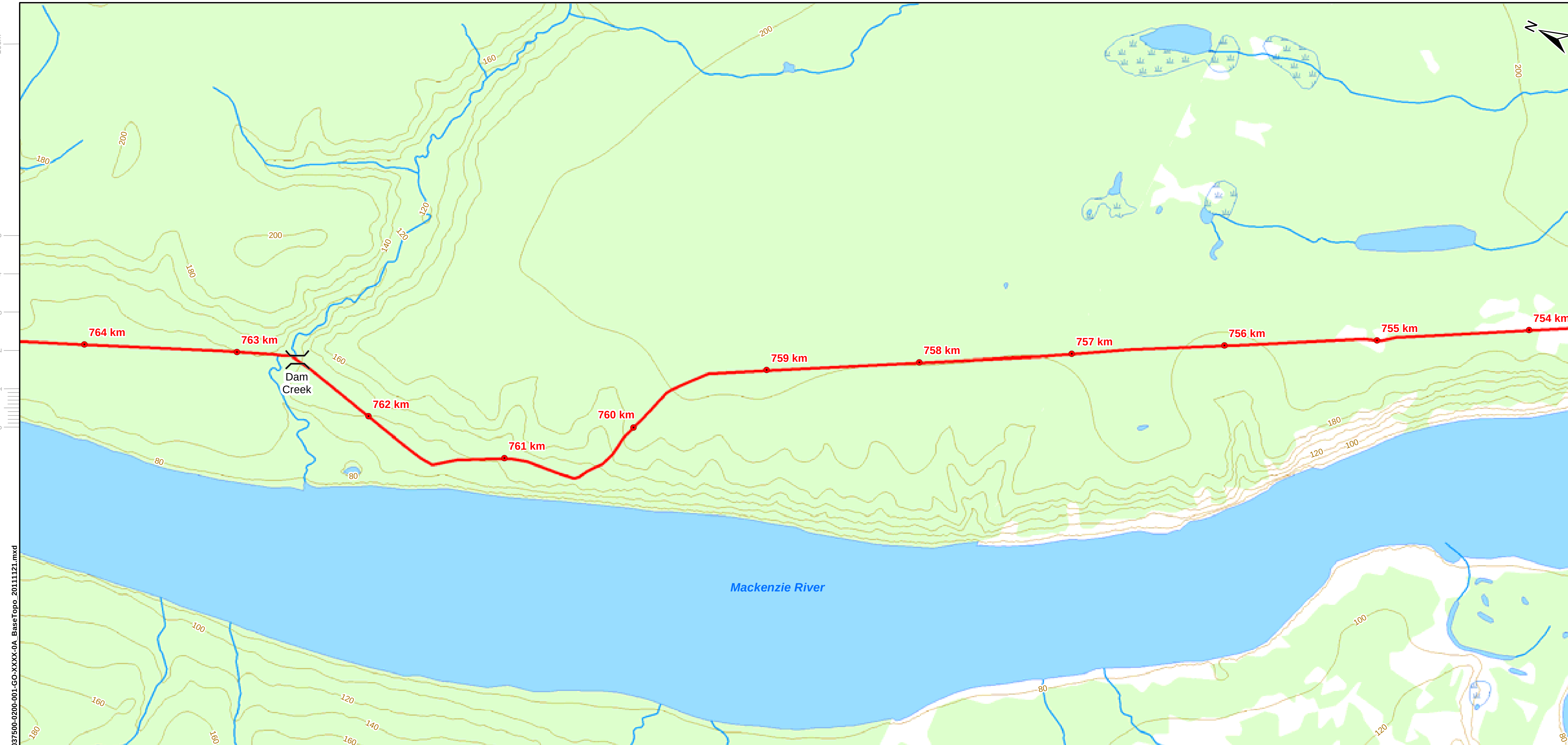


Actual Winter Road - KM Marker

Actual Winter Road

Other Roads

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Boundary Community

Existing bridge

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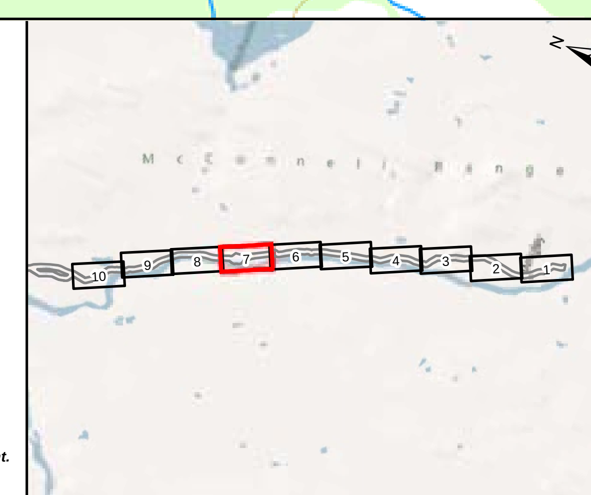


Client

Pehdzeh Ki First Nation

Project

Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title

**Topographic Base Map**
**Sheet 7**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : F. Faustin

No : 068-P0037500-200-001-GO-XXXX-0A
Scale : 1:25 000
Date : November 21, 2011

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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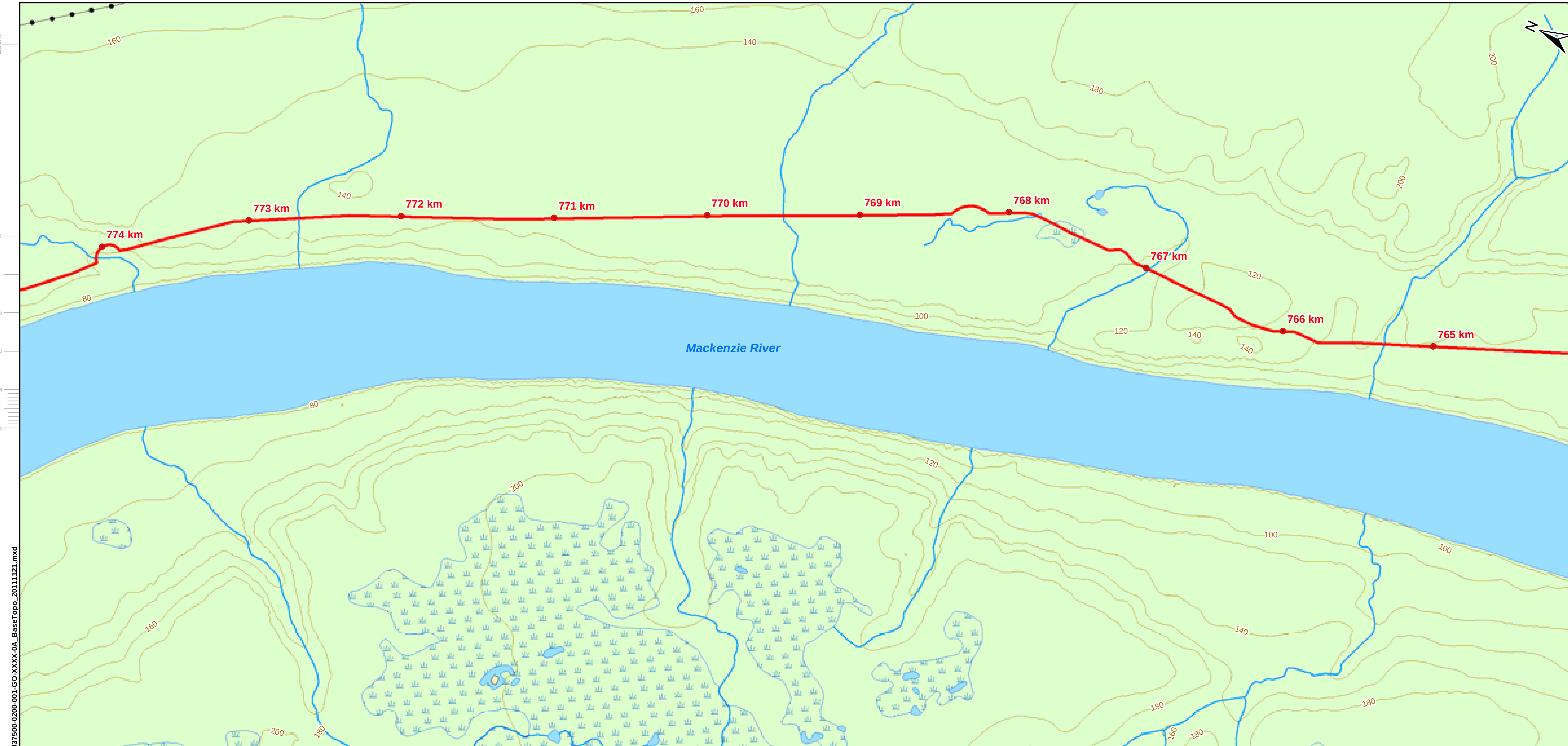


Actual Winter Road - KM Marker
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*Sources :*
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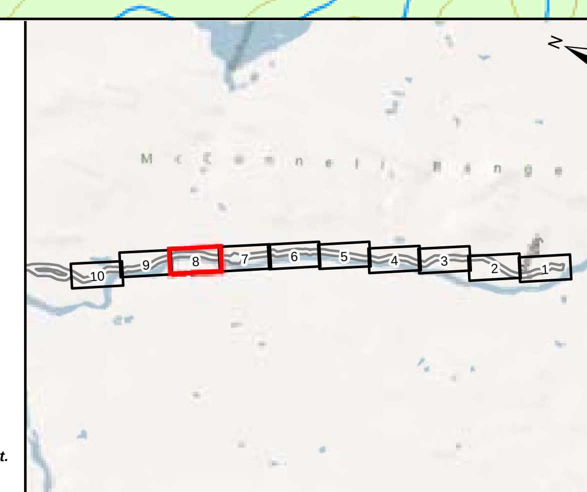


Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 8**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-200-001-GO-XXXX-0A |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | F. Faustin | Date : | November 21, 2011 |

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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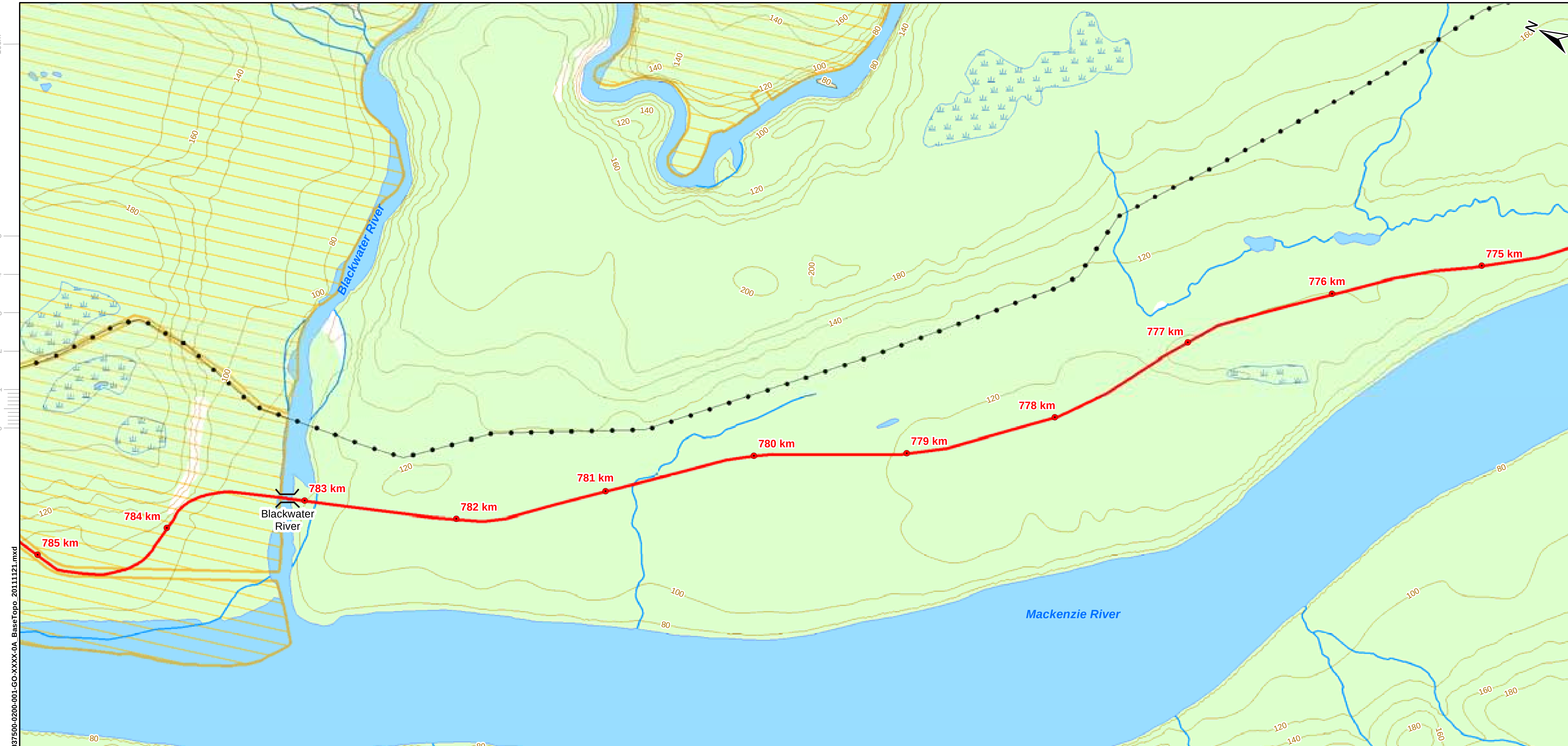


Actual Winter Road - KM Marker
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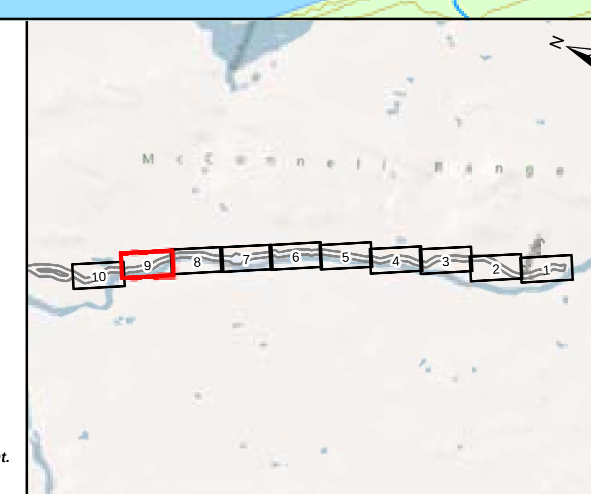


Client
Pehdzeh Ki First Nation

Project
Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title
**Topographic Base Map**
**Sheet 9**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : F. Faustin

No : 068-P0037500-200-001-GO-XXXX-0A
Scale : 1:25 000
Date : November 21, 2011

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
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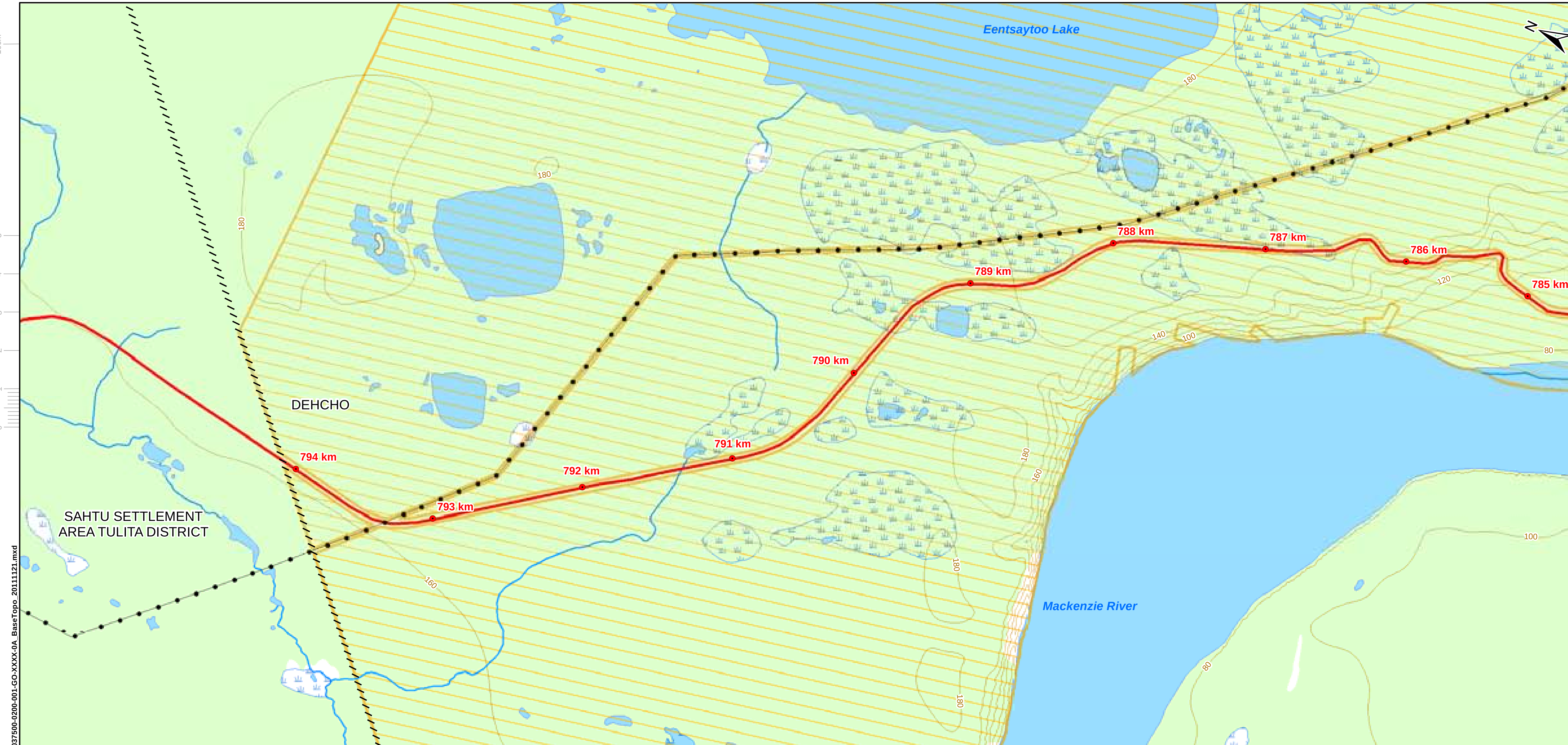


- Actual Winter Road - KM Marker
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DRAFT MAP

**Sources :**
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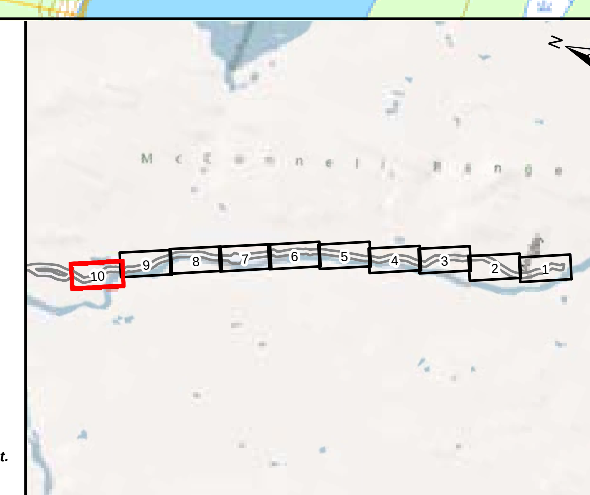



Client

Pehdzeh Ki First Nation

Project

Mackenzie Valley Highway Extension
Project Description Report
Dehcho Region

Title

**Topographic Base Map**
**Sheet 10**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-200-001-GO-XXXX-0A |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | F. Faustin | Date : | November 21, 2011 |

0 750 m

Projection UTM zone 10N, WGS84

DESSAU

FORMAT ORIGINAL : 11" x 17"
Path: G:\068\P037500-MacKenzieHighway\ENI\5_CAD\GO\01-MXD\068-P037500-0200-001-GO-XXXX-0A_BaseTopo_20111121.mxd

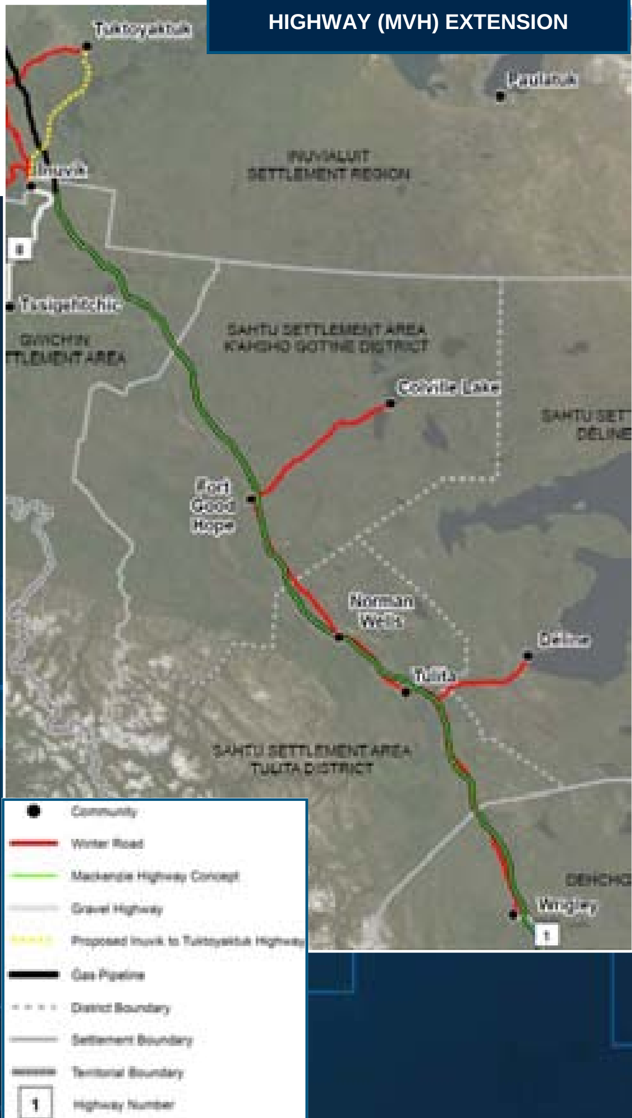
# Appendix 8 Second Round of Public Consultation

DESSAU

## Annex 1 Factsheet

DESSAU

**PROPOSED MACKENZIE VALLEY HIGHWAY (MVH) EXTENSION**




## CONSTRUCTION METHODOLOGY

- Use winter construction techniques
- In the design of embankments in sensitive permafrost areas, use mitigation techniques such as Thermosyphons, Air Convection Embankment, Heat Drains and Geotextile Installation to protect the permafrost

**The Project Description Report (PDR) has been supervised by Pehdzeh Ki First Nation (PKFN) according to a Memorandum of Understanding (MOU) signed in October 2010 between PKFN and the Government of Northwest Territories as represented by the Department of Transportation.**

**The PDR has been realized according to a participative approach that included three consultation activities with the PKFN community members in Wrigley:**

- **November 2010**
- **July 2011**
- **January 2012**

**A focus has been given to Traditional Knowledge and Land Use based on information given by PFKN.**

**For additional information, please contact:**
**Tannis Cli-Moses at PKCL**
**Tel: (867) 581-3321 Fax: (867) 581-3229**
**Email: tannis@pehdzehkicontractors.com**

# Mackenzie Valley Highway (MVH) Extension Project - Dehcho Section -

## PROJECT DESCRIPTION REPORT

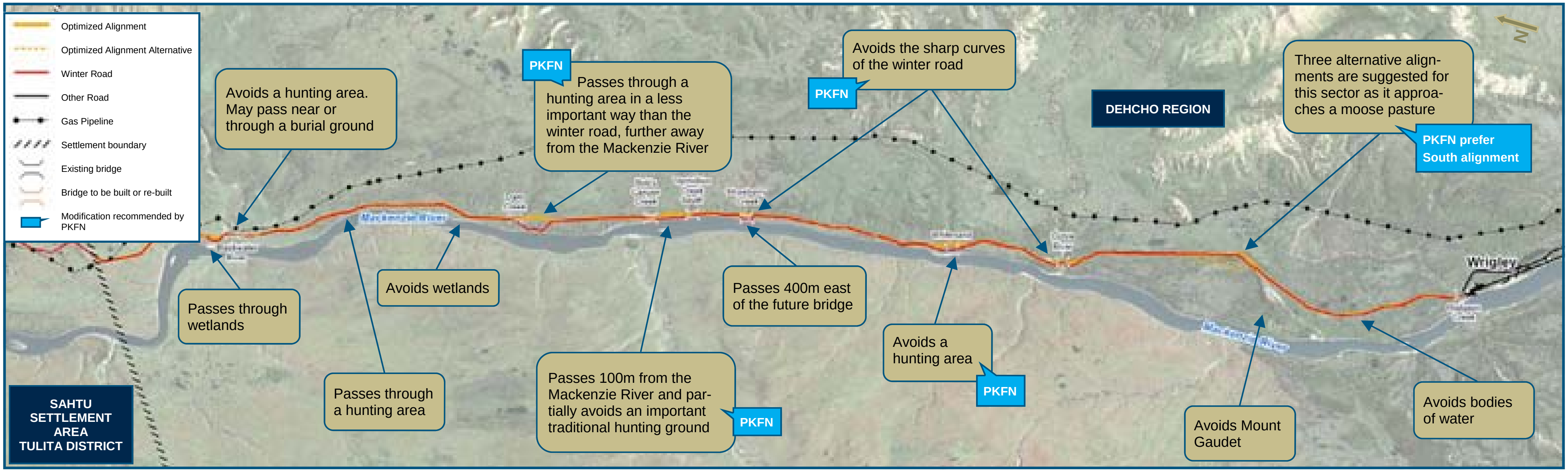
Source: NWT-DOT Website - Winter and Ice Roads Information

Factsheet

January 2012

Preliminary Screening Phase

# ALL WEATHER HIGHWAY—DEHCHO REGION

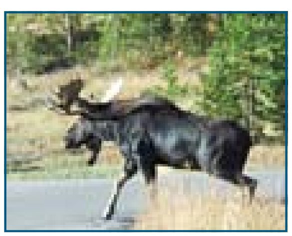



## BENEFITS OF THE PROJECT

- **Reduced cost of living**
- **New business opportunities associated with the construction and operation of the Highway**
- **Increase in tourism and related business opportunities**
- **Easier access to improved quality of healthcare, recreation and education resources**
- **Increase in cultural, community, and family interactions**
- **Increased year-round access to areas adjacent to the Mackenzie Valley for Pehdzeh Ki First Nation members**

## GUIDING PRINCIPLES FOR THE DESIGN OF THE OPTIMIZED ALIGNMENT

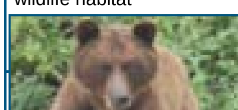
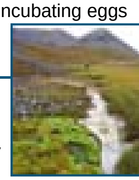
- Areas used for traditional and cultural activities should be avoided to the extent possible
- Sensitive natural areas, such as wetlands and wildlife habitat, should be avoided to the extent possible
- Highway should run at least 50m away from all bodies of water
- A minimum radius of 340m is desired for all curves

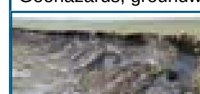


Source:http://www.cbc.ca/news/pointofview/2010/

- Existing and proposed (future) bridges should be used
- Road safety measures should be incorporated into the design of the highway
- Recommendations of the local community should be integrated as much as possible

## MITIGATION MEASURES FOR LESS DESIRABLE IMPACTS

| POTENTIAL IMPACTS | MITIGATION MEASURES |
|---|---|
| **TRADITIONAL AND OTHER LAND USES** | |
| Reduced availability of wildlife resources | ▪ Regulate non-traditional hunting and fishing activities<br>▪ Avoid sensitive areas |
| Potential disturbance to cultural, ceremonial, historical, archaeological or traditional activities sites | ▪ Analyze or undertake in-depth investigative studies to identify all sites<br>▪ Implement protection measures for known sites and avoid identified locations<br>▪ Stop all activities in the event that unanticipated cultural finds are encountered |
| **VEGETATION, WILDLIFE, FISH AND FISH HABITAT** | |
| Loss and disturbance of vegetation, rare plants and wetlands | ▪ Minimize project footprint<br>▪ Attempt to translocate plants and monitor growth |
| Loss and fragmentation of wildlife habitat  Source: http://www.visitterrace.com/ | ▪ Establish buffer areas around habitat and implement minimum setbacks for seasonally important habitat<br>▪ Incorporate timing considerations for construction |
| Fish habitat loss and mortality of fish or incubating eggs | ▪ Follow all pertinent Fisheries and Oceans Canada Guidelines<br>▪ Avoid critical habitat, minimize disturbance to riparian areas and limit the duration of instream activities<br>▪ Monitor culverts for subsidence or lifting that could create barriers to fish movement |
| Impacts on water quality  Source: http://www.nrcan.gc.ca/com/elements/issues/47/images/image-1a.jpg | ▪ Promptly revegetate exposed soils<br>▪ Ensure runoff containing suspended sediment does not enter watercourses<br>▪ Establish spill prevention and response protocols |

| Summary of Potential Impacts continued | Proposed Mitigation Measures continued |
|---|---|
| **PHYSICAL ENVIRONMENT** | |
| Geohazards, groundwater changes  Source: http://www.calgaryherald.com/technology/5791328.bin?size=620x400s | ▪ Map out seepage zones, permafrost and sediments sensitive to erosion<br>▪ Use construction techniques (i.e. thermosyphons in embankments) to minimize impacts |
| Contamination due to accident or malfunction | ▪ Implement an Environmental Management Plan<br>▪ Designate safe refuelling and vehicle maintenance sites |
| **DEMOGRAPHY AND SOCIOECONOMIC CONDITIONS** | |
| Loss of land and possible new patterns of development | ▪ Ensure that residents have access to traditional territories and resources and that they have input into the development of the region |
| Migration (outward* and inward), which may impact local culture<br>**PKFN mention possible outward migration of women in particular* | ▪ Encourage development of programs for women (training, etc)<br>▪ Ensure local language education continues in school and support efforts to maintain cultural activities |
| **INDIVIDUAL, FAMILY AND COMMUNITY WELLNESS** | |
| Possible increase in social problems in local communities | ▪ Support preventative education and social and health programs |
| Possible increase in number and severity of traffic accidents | ▪ Ensure clear signage and proper maintenance of the road<br>▪ Prepare a traffic management plan |
| **COMMUNITY INFRASTRUCTURE AND UTILITIES** | |
| Impacts on services and utilities | ▪ Identify locations of existing utilities lines and establish buffer areas<br>▪ Monitor drinking water quality |

## Annex 2 Public Consultation Notice

DESSAU

**Pehdzeh Ki First Nation (PKFN) &**

**Pehdzeh Ki Contractors Ltd. (PKCL)**

Will be hosting a

## Community Public Consultation on

## The Mackenzie Valley Highway Extension Project
## - Dehcho Region -
## Optimized Alignment and Potential Impact Analysis

**Where:** Pehdzeh Ki Community Complex Gym
**When:** Thursday, January 26th, 2012
**Time:** 3h30pm

For those unable to travel to Wrigley for the Public Consultation, your input is important. Please provide your written comments to PKFN/PKCL concerning the Mackenzie Valley Highway. Your concerns will be brought forward at the Public Consultation.

**Supper will be provided at 5h00pm**

**Snacks and beverages will be served throughout the consultation**

# NORTHERN STUDENTS AND GRADUATES, HERE'S YOUR OPPORTUNITY...

## SUMMER EMPLOYMENT

The Summer Student Employment Program will help you gain valuable work experience in your field of study.

Summer Student Employment Program
Applications accepted beginning December 1, 2011.

Northern Graduate Employment Program
Application deadline January 31, 2012.

## NORTHERN GRADUATE EMPLOYMENT PROGRAM

For students graduating in 2012, the Northern Graduate Employment Program is an opportunity to apply what you learned during your studies in a work environment.

**For information** about these programs contact Helen Minoza, our Student and Youth Recruitment Officer at helen_minoza@gov.nt.ca or by phone at (867) 873-7953.

**To apply** send your resume, cover letter and references to: Corporate Human Resources
Email: casuals@gov.nt.ca
Fax: (867) 873-0445

www.hr.gov.nt.ca/employment

Northwest Territories

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Northwest Territories Transportation

PEHDZEH KI FIRST NATION

PEHDZEH KI CONTRACTORS

DESSAU

**Pehdzeh Ki First Nation (PKFN) and**
**Pehdzeh Ki Contractors (PKCL)**

*will be hosting a*

# COMMUNITY PUBLIC CONSULTATION

*on*

## The Mackenzie Valley Highway Extension Project
## - DehCho Region -
## Optimized Alignment and Potential Impact Analysis

## Pehdzeh Ki Community Complex Gym, Wrigley, NT
## Thursday, January 26, 2012
## 3:30 pm

For those unable to travel to Wrigley for the Public Consultation, your input is important. Please provide your written comments to PKFN/PKCL concerning the Mackenzie Valley Highway. Your concerns will be brought forward at the Public Consultation.

Comments and letters can be faxed to: **867-581-3229**
Or emailed to: tannis@pehdzehkicontractors.com

**Supper will be provided at 5:00 pm**
**Snacks and beverages will be served throughout the consultation.**

***Any questions or concerns please contact Tannis Cli-Moses at 867-581-3321 or by email at tannis@pehdzehkicontractors.com***

# Annex 3 Multimedia Consultation

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# Community Consultation for the Mackenzie Valley Highway - DEHCHO REGION

January 26th, 2012

# Presentation Team

**Gina Potts-Alexis : Presentation and Community Activity Facilitator**

**Daniel Aubin : Project Director / Transportation Engineer**

**Frederic Faustin : Environmental Specialist**

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# Agenda

- Opening Prayer
- Purpose of the Meeting
- MVH Project Steps for the Dehcho Region
- Mackenzie Valley Highway Project Location
- Winter Road and Optimized Alignments
- Potential Impacts and Mitigation / Optimization Measures
- Community Activity

# + Opening Prayer

**Elder Gabe Hardisty**

# + Purpose of the Meeting

- Present the Optimized Alignment for the Mackenzie Valley Highway Extension within the Dehcho Region and included in the Project Description Report (PDR)
- Validate Information on Traditional Land Use Collected during the Public Consultation of July 2011 in Wrigley
- Discuss the Potential Impacts of the Project and Propose Mitigation / Optimization Measures
- Receive Comments, Views, Concerns and Questions from the Community

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# MVH Project Steps for the Dehcho Region

Broad focus

Does not involve in-depth study

**Preliminary Environmental Screening**

Determine whether or not a development might cause significant impact on the environment or public concern

Detailed and Rigorous Analysis

Involves in-depth study

**(If Required) Environmental Impact Assessment (EIA)**

Evaluate potential impacts in order to make good decisions about whether or not a project should proceed, and if so, under what conditions

**Regulatory Phase (License and Permit Application Procedures)**

**Highway Construction**

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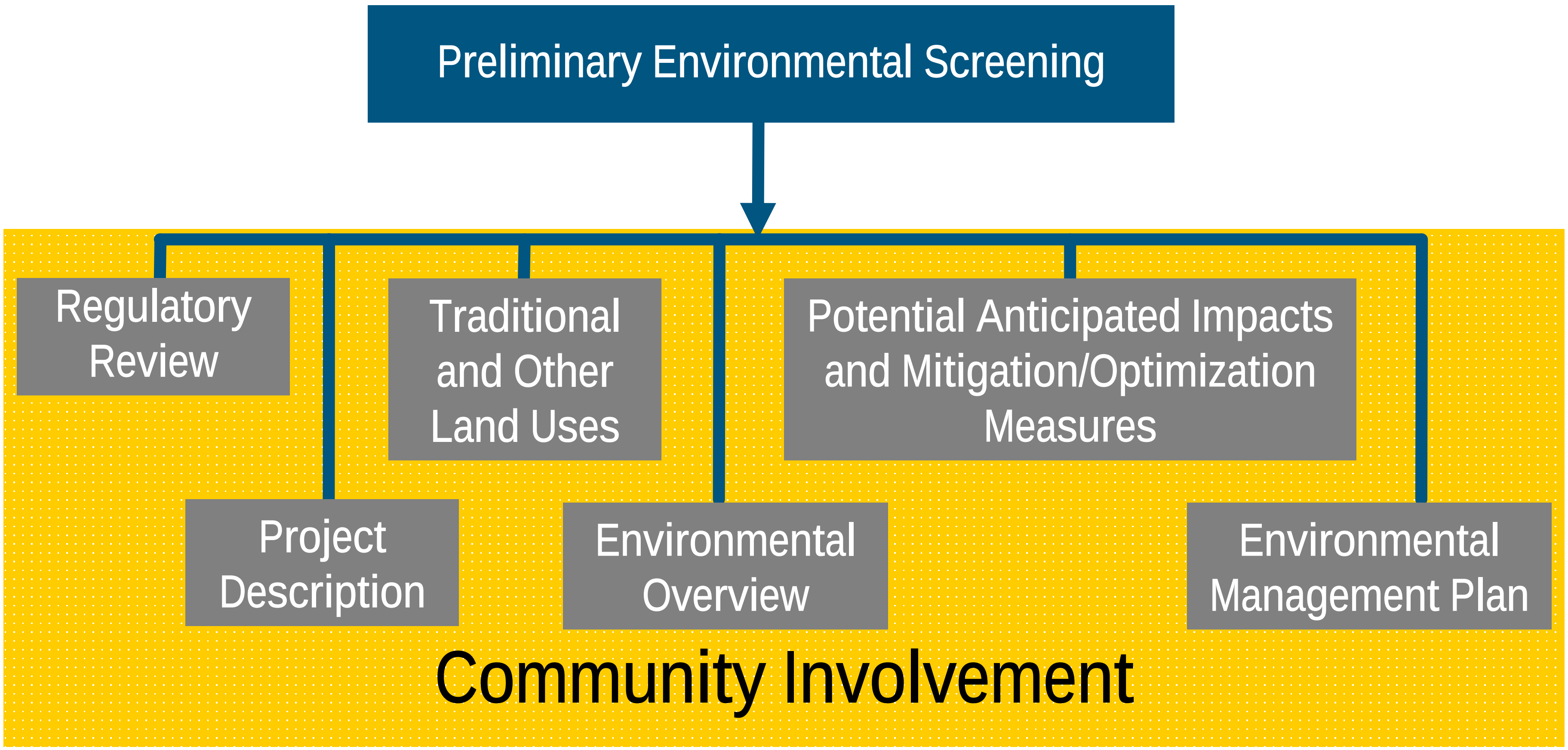
# MVH Project Steps for the Dehcho Region

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# MVH Project Steps for the Dehcho Region

## Community Involvement

**Three meetings**

**Early Community Engagement**

**November 22nd, 2010**

- Inform the community about the proposed Project
- Obtain feedback and questions from the population

**Public Involvement Throughout the Preliminary Environmental Screening (PES)**

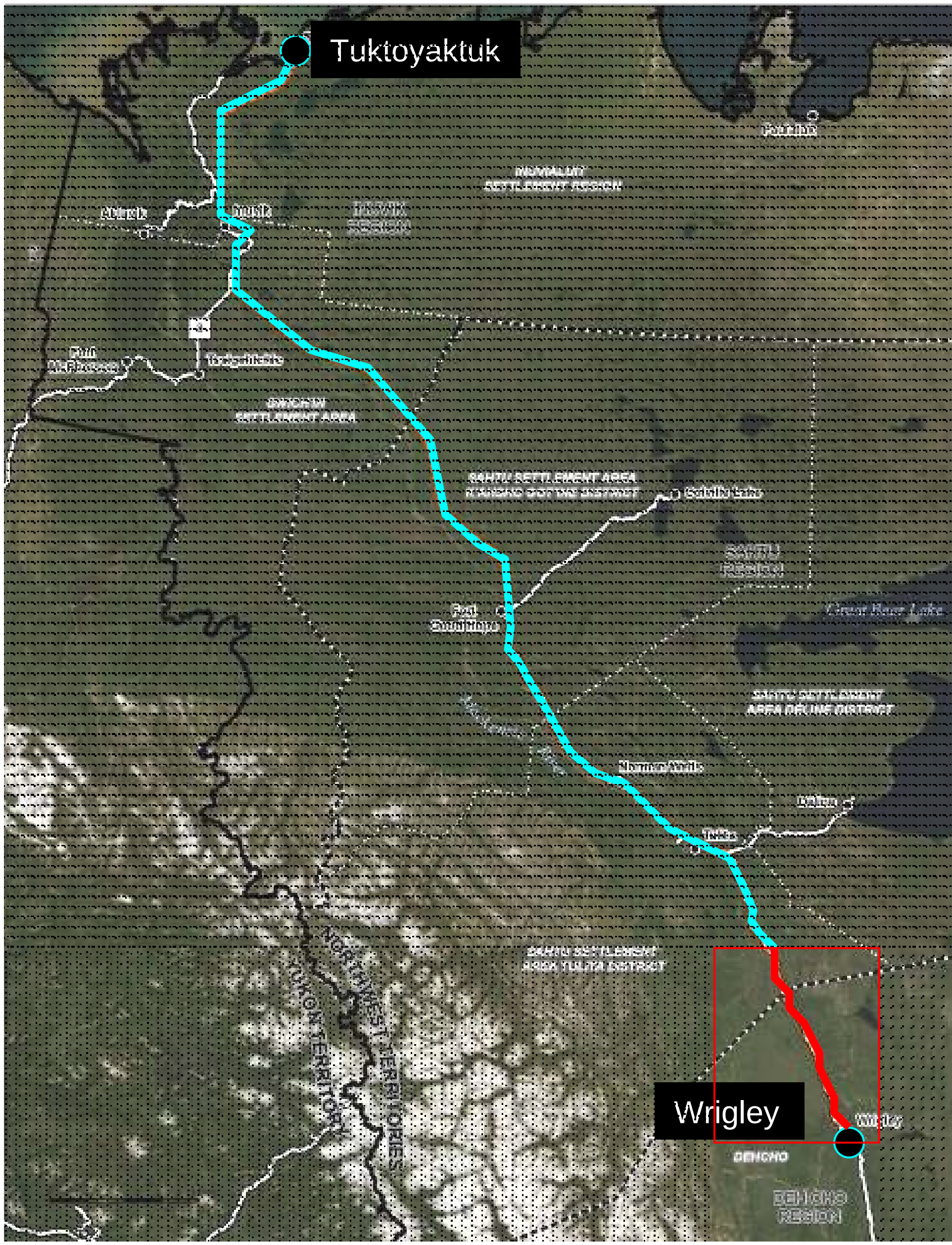
**1st Round:**
**July 7th, 2011**

- Present the Project
- Obtain feedback and comments in order to minimize or mitigate the negative impacts identified and/or maximize the possible benefits

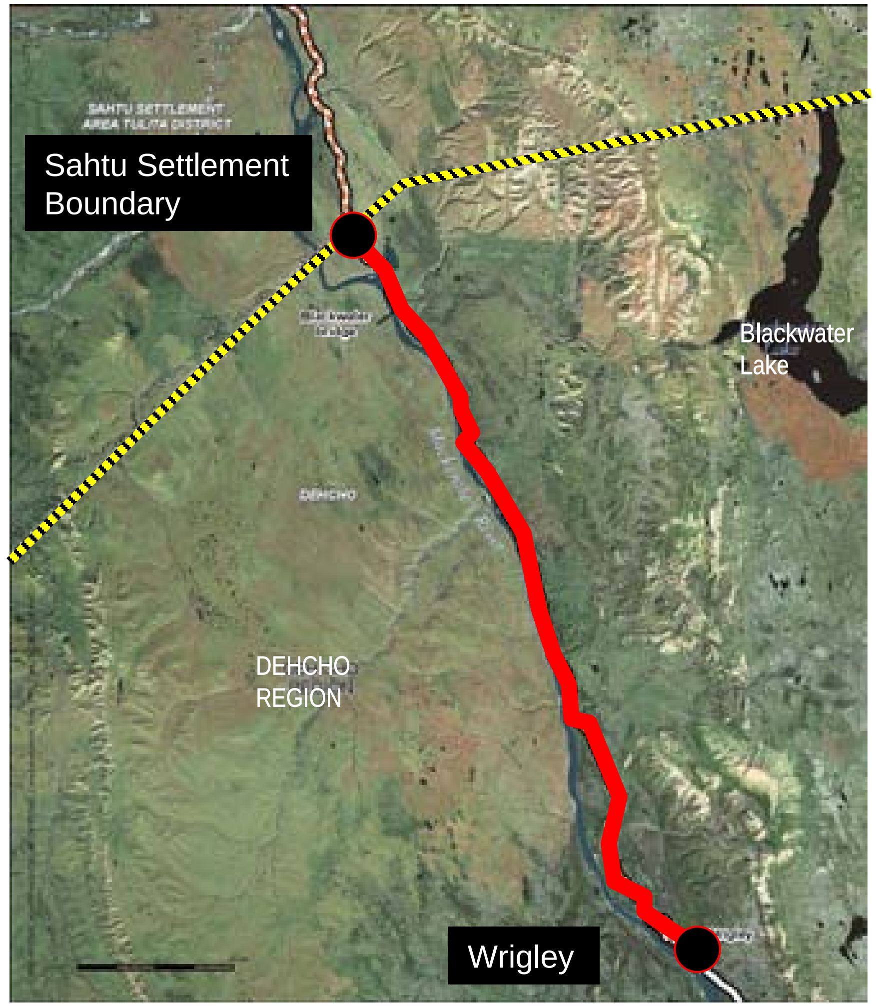
**2nd Round:**
**January 26th, 2012**

- Communicate the results of the PES
- Validate Data
- Collect final comments

# Mackenzie Valley Highway Project Location




## MVH - Dehcho Region



# Winter Road and Optimized Alignments

## Design considerations

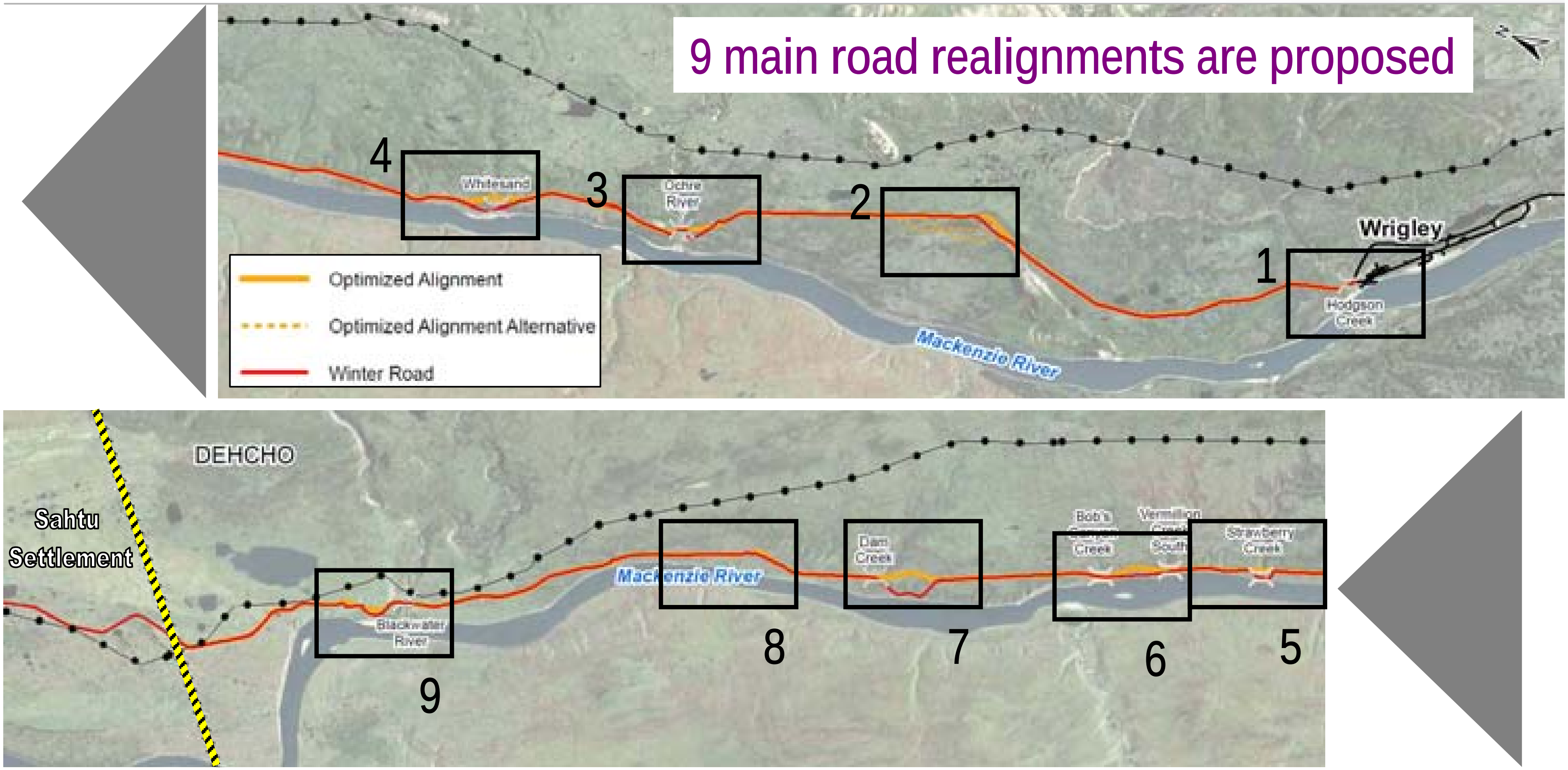
1. Avoiding bodies of water
2. Avoiding sensitive areas
3. Passing over existing bridges
4. Improving general safety
5. Avoiding sensitive soil areas
6. Respecting design parameters

+ Wild Animal Concentration
+ Pasture areas
+ Wildlife Corridor and Travel Route
+ Hunting Ground
+ Traplines and Cabins
+ Spiritual and Cultural Ground
+ Traditional Activity Sites
+ Archaeological Sites
+ Rare Plants

**Data sources:**

+ Existing Studies
+ Public Consultation Inputs (PKFN)

# Winter Road and Optimized Alignments




- All weather highway
- Maximum speed of 80km/h
- 2 lanes / 2 ways gravel highway
- From Wrigley to  the Sahtu Settlement Boundary
- 8 crossing points
- 100 km long
- 9 meters wide

# + Winter Road and Optimized Alignments



Optimized Alignment

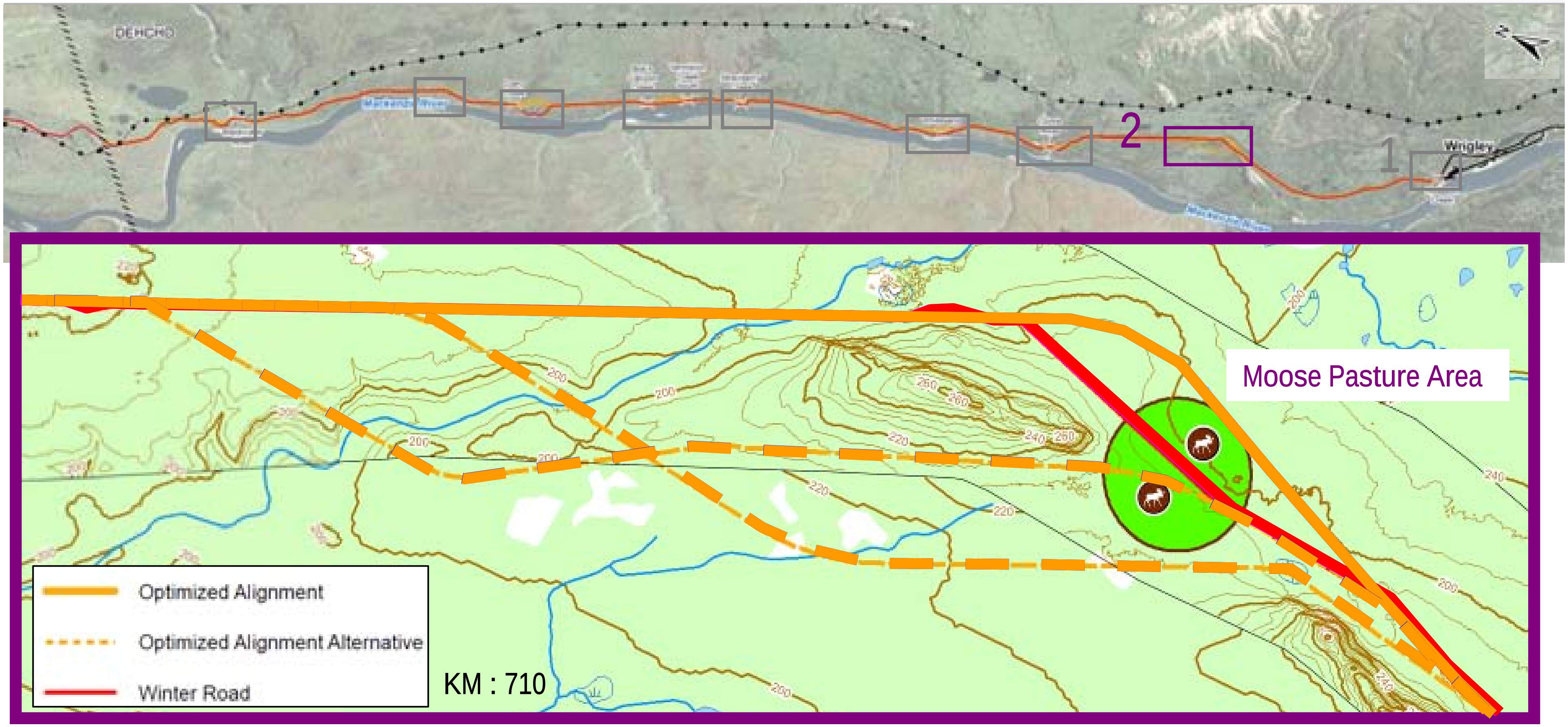
Optimized Alignment Alternative

Winter Road

- + Smoother curves
- + Increased safety
- + More rectilinear approach to the bridge

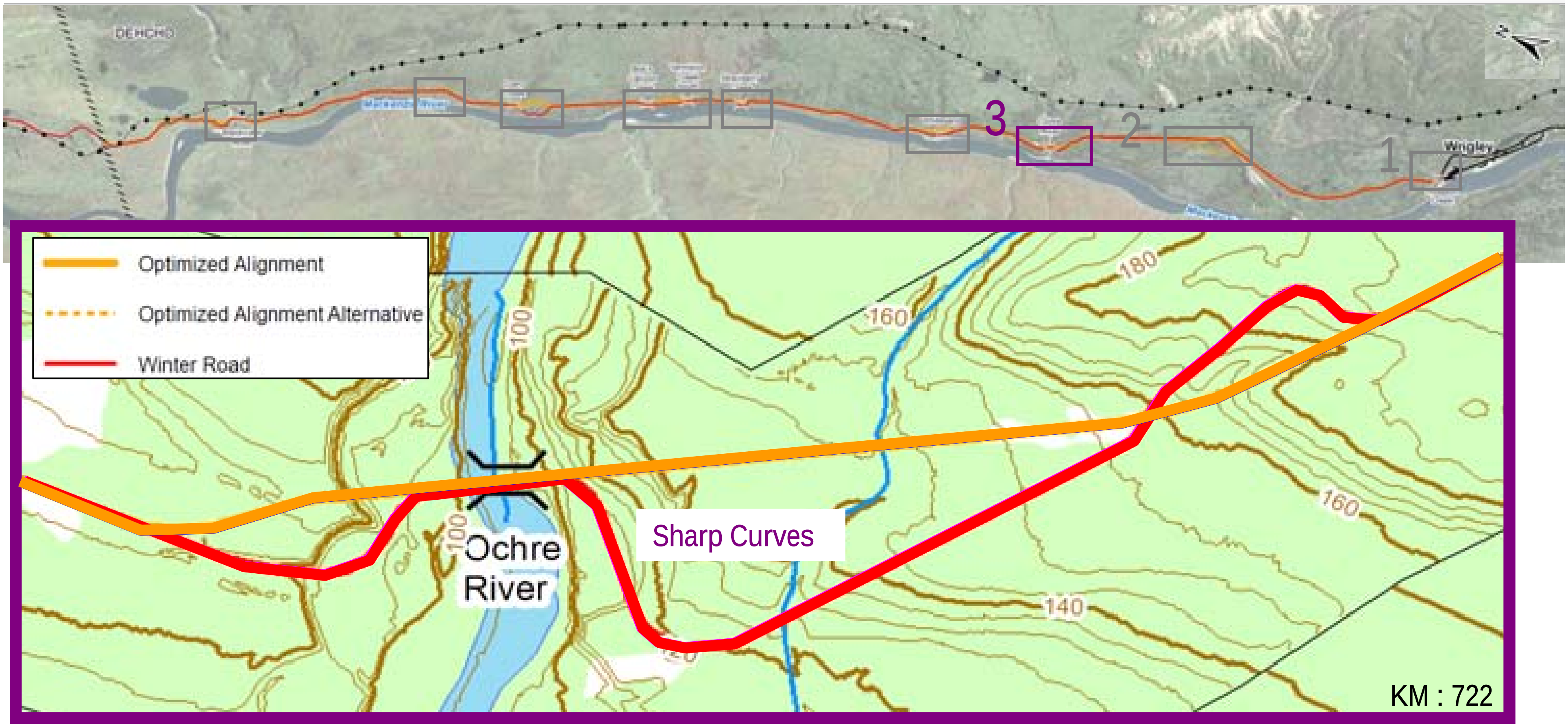
Hogson Creek Bridge (July 2011)

# + Winter Road and Optimized Alignments




- Avoids Mount Gaudet
- Three alternative alignments are suggested for this sector due to the presence of a moose pasture
  - PKFN prefers the South Alignment

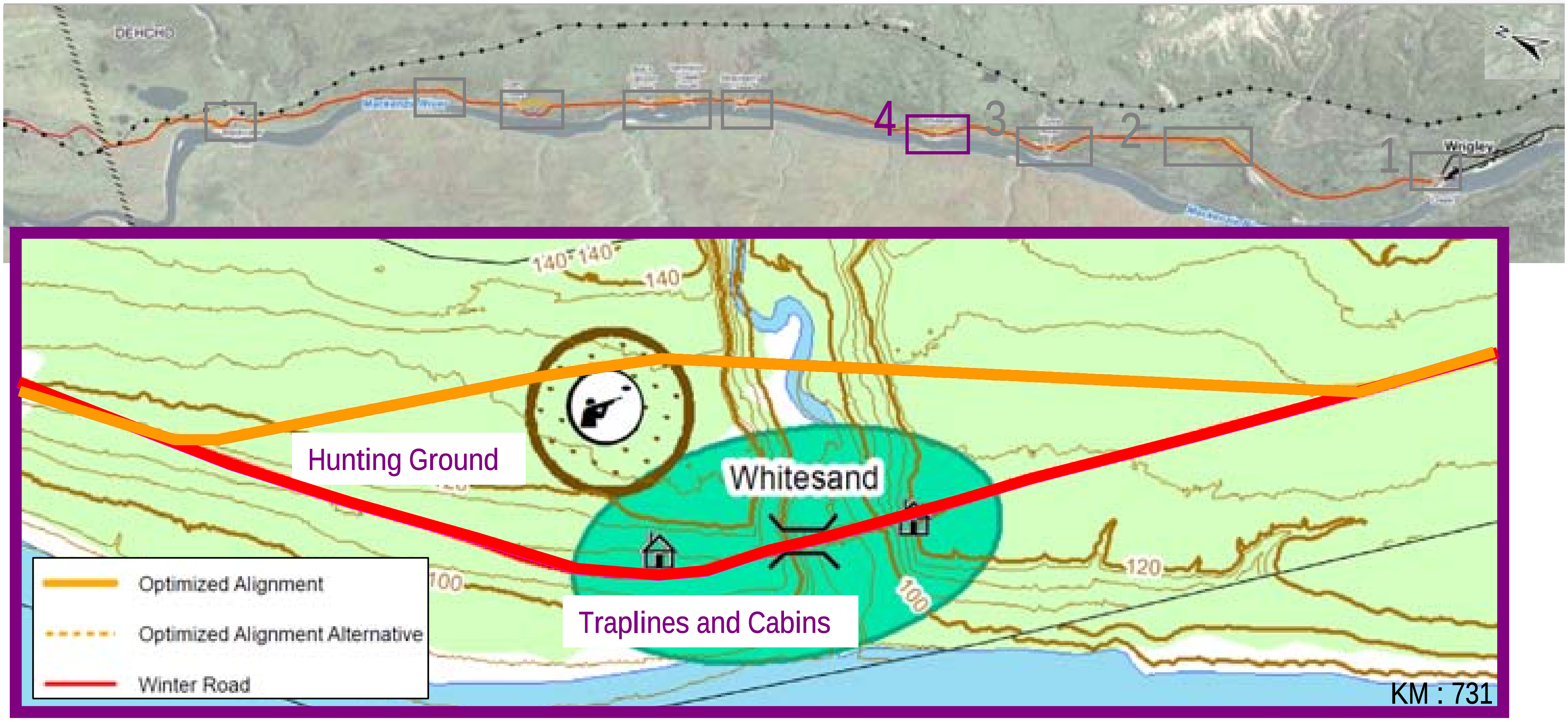
# + Winter Road and Optimized Alignments




- + Smoother curves
- + Increased safety
- + More rectilinear approach to the bridge

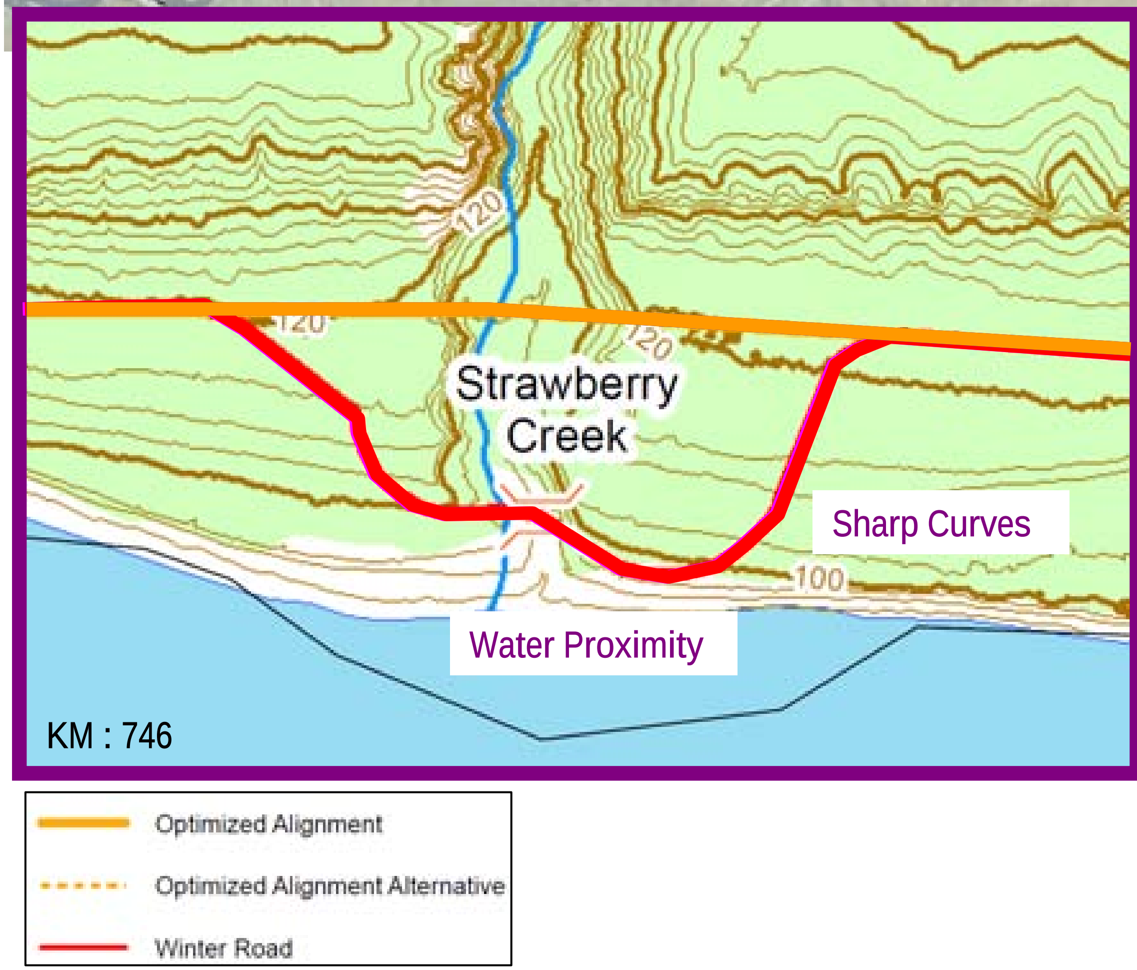

Ochre River Bridge (July 2011)

# Winter Road and Optimized Alignments



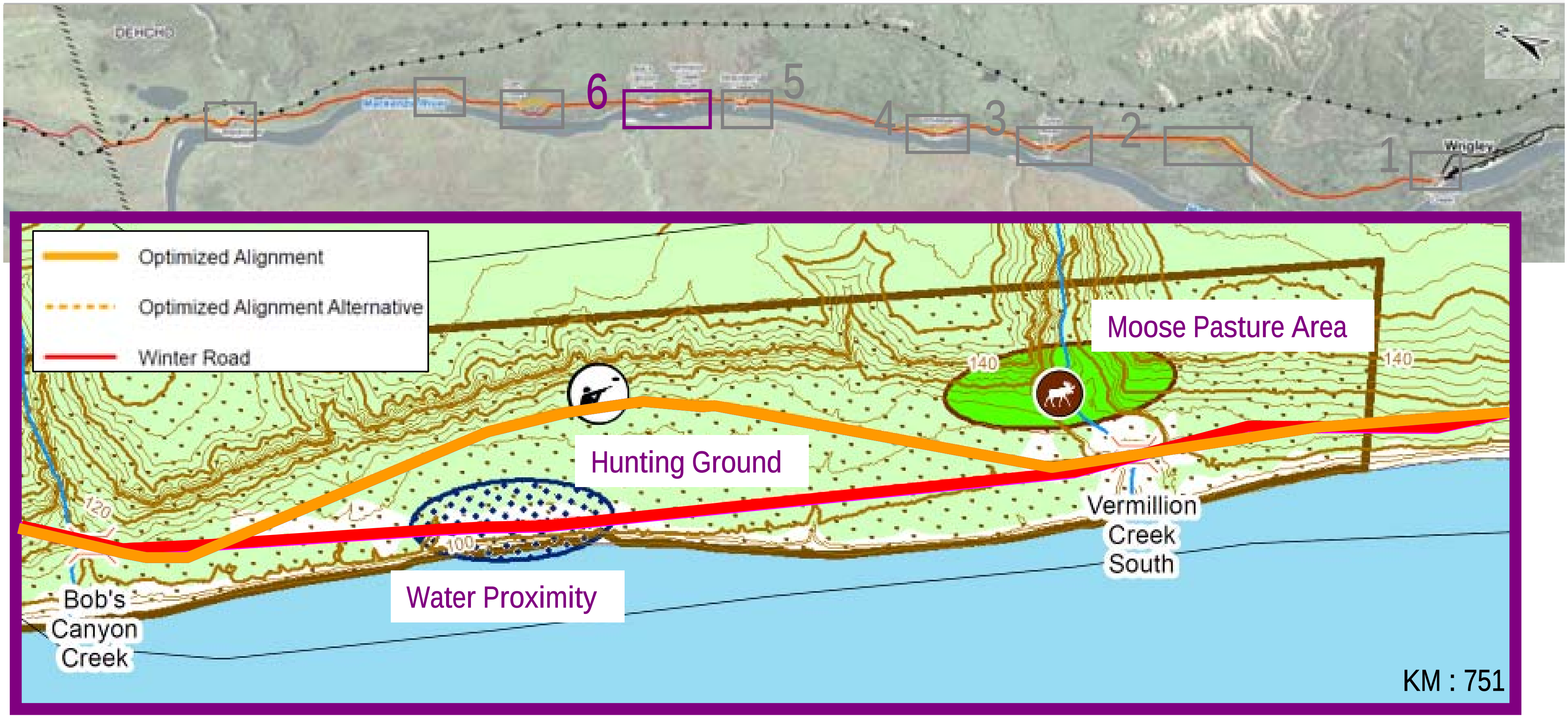

+ Avoids a hunting area where cabins and traplines are located
+ Straighter alignment
+ Increased distance from the Mackenzie River
+ Modification recommended by PKFN

# + Winter Road and Optimized Alignments


- Avoids sharp curves and follows a linear trajectory
- Increased safety
- Increased distance from the Mackenzie River
- Passes 400m east of the future bridge
  - Strongly recommended to re-evaluate the location of the proposed bridge

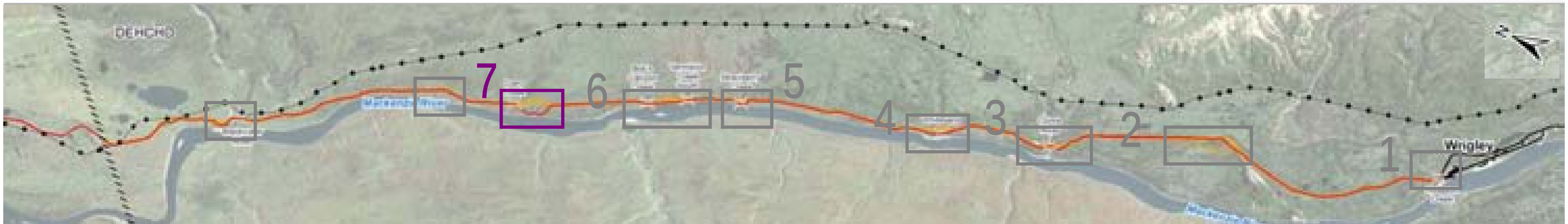
# Winter Road and Optimized Alignments

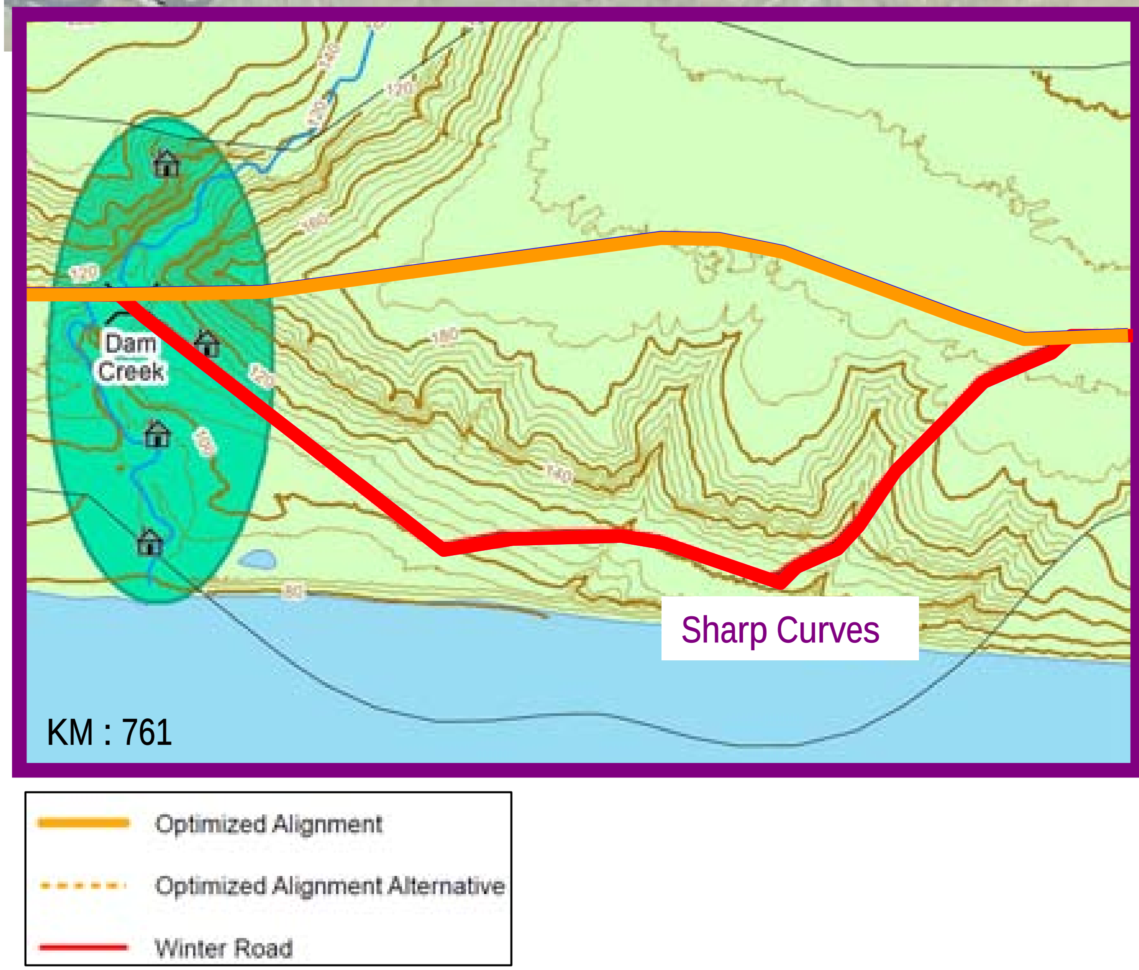



- Increased distance from the Mackenzie River
- Avoids a Moose Pasture
- Crosses a hunting ground in a less important way than the winter road


Between Vermillion Creek South and Bob's Canyon (July 2011)

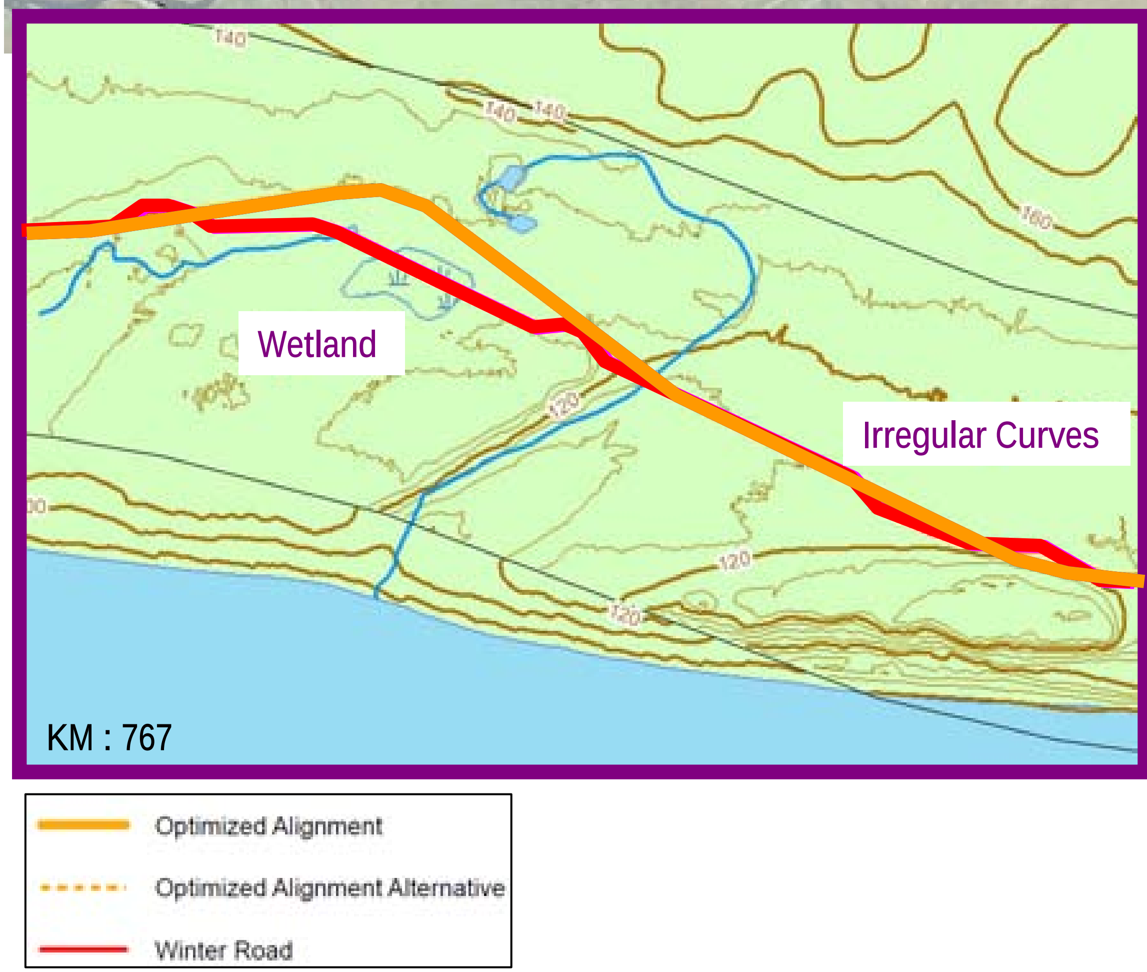
# + Winter Road and Optimized Alignments



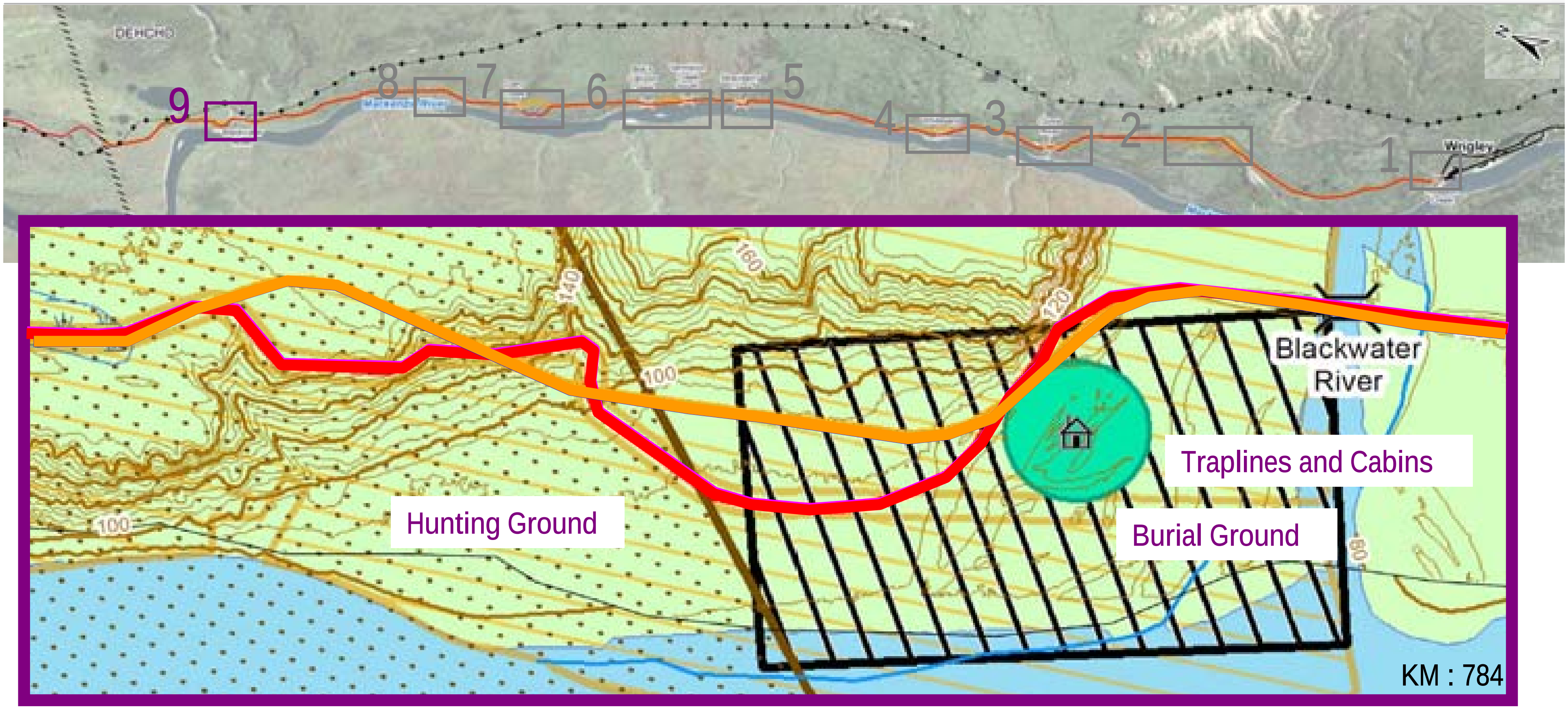

- Smoother curves
- More linear trajectory
- Passes through a hunting ground in a less important way
  - Some relocations of cabins may be required

# + Winter Road and Optimized Alignments


- Smoother curves
- Increased safety
- Avoids wetlands

# Winter Road and Optimized Alignments

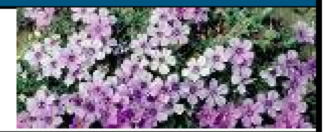



- Passes through a small part of a large hunting area
- Passes through a wetland area
- Smoother curves
- Avoids a hunting area with cabins and traplines
- May passes near or partially through a burial ground (Exact boundaries to be confirmed)

# Potential Impacts and Mitigation/Optimization Measures

## Traditional and Other Land Uses

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Reduced availability of wildlife resources | + Regulate non-traditional hunting and fishing<br>+ Protect wildlife and vegetation species  |
| Potential disturbance to cultural, ceremonial, historical archaeological, or traditional activities sites | + Analyse or undertake in-depth investigative studies to identify all sites<br>+ Avoid sensitive areas and ensure a buffer area is maintained around sites<br>+ Recover artefacts from potentially impacted sites<br>+ Cease all activities in the event that unanticipated cultural finds are encountered  |
| Reduced costs related to the construction of the Mackenzie Gas Project (benefit) | + Complete construction of the MVH prior to commencing work on the MGP |
| Increased opportunities for Natural Resource Exploration and development (benefit) | + Complete the MVH extension in a timely fashion in order to provide increased access to potential exploration sites<br>+ Provide training opportunities in order to increase skills and capacity for future projects |

http://www.mun.ca/biology/delta/arcticf/images/b0880084.jpg

http://www.cleveland.com/world/index.ssf/2009/09/in_canadas_tiny_tuktoyaktuk_th.html

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# Potential Impacts and Mitigation/Optimization Measures

## Vegetation and Wildlife

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Loss of or disturbance to vegetation communities, wetlands, rare plants | + Minimize project footprint<br>+ Attempt translocation and monitor<br>+ Maintain natural hydrology of wetlands and streams<br>+ Collect and contribute voucher specimens to herbariums<br> |
| Habitat loss, fragmentation | + Minimize project footprint<br>+ Identify important habitats and establish buffers<br>+ Timing considerations<br> |
| Sensory disturbance (auditory, visual or olfactory) | + Implement minimum setbacks from seasonally important habitats<br>• Prohibit clearing and construction activity within a 1 km radial buffer from September 1 to May 1 (carnivore denning season)<br>+ Increase staff awareness of ways to minimize interaction with and habituation of wildlife<br>+ Prohibit recreational off-road vehicle use year round, wherever it is enforceable |

http://www.nwtpas.ca/science-focalspecies.asp

http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_wildlife_bio diversity.aspx

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# + Potential Impacts and Mitigation/Optimization Measures

## Fish and Fish Habitat

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Habitat loss | + Follow all pertinent Fisheries and Oceans Canada (DFO) Guidelines<br>+ Avoid critical habitat, minimize disturbance to riparian areas and limit the duration of instream activities<br>+ Monitor culverts for subsidence or lifting that could create barriers to fish movement |
| Impacts to water quality | + Promptly revegetate exposed soils<br>+ Ensure runoff containing suspended sediment does not enter watercourses<br>+ Establish spill prevention and response protocols |
| Mortality of fish or incubating eggs | + Minimize the duration of instream activities<br>+ Follow pertinent DFO guidelines<br>+ Require the presence of an independent Environmental Monitor during all instream works |

ttp://inuvikphotos.ca/2007/12/31/fish-of-the-arctic/

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# + Potential Impacts and Mitigation/Optimization Measures

## Physical Environment

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Geohazards, groundwater changes | + Map out seepage zones, permafrost and sediments sensitive to erosion<br>+ Use construction techniques (i.e. thermosyphons in embankments) to minimize impacts<br> |
| Contamination due to fuel spills, accidents and malfunctions | + Designate safe refueling and vehicle maintenance sites<br>+ Develop an Emergency Response Plan<br>+ Ensure that vehicles used to haul hazardous materials on the road meet standards for the environmental conditions on the highway<br>+ Provide for storage of equipment and materials to support spill cleanup<br>+ Train personnel in local communities to support spill cleanup and to respond to emergencies, including knowledge of proper health and safety practices related to materials likely to be transported on the highway |

http://www.calgaryherald.com/technology/5791328.bin?size=620x400s

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# Potential Impacts and Mitigation/Optimization Measures

## Demography

Analyse or Undertake In-Depth Studies

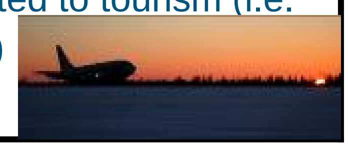
| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Acquisition of Dehcho territorial lands by outside investors, such as resource development companies | + Ensure the Dehcho people have access to traditional territories and resources<br>+ Ensure Dehcho residents are consulted and have input into the development of the region |
| The potential for the erosion of language, culture, traditional practices in the Dehcho region | + Ensure cultural and community facilities are unaffected and/or enhanced by the project<br>+ Ensure that local infrastructure has the capacity to respond to potential population growth<br>+ Ensure language and cultural education is included in school curriculums<br><br>+ Support the training and development of young people (i.e construction and engineering) in order to meet the needs of the required labour force |
| Migration (outward* and inward)<br>**PKFN mention possible outward migration of women in particular* | + Encourage development of programs for women (training, social/cultural activities, etc) |

http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_demography.aspx

# + Potential Impacts and Mitigation/Optimization Measures

## Socioeconomic Conditions

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Increased education and training opportunities and access to other facilities/services available in other communities (benefit) | + Encourage programs that support the increased connectivity between education facilities, students and teachers throughout the region, while improving local accessibility to educational resources  |
| Reduced cost of living (benefit) | + Monitor costs related to distribution of goods<br>+ Implement a reliable system of supply of consumable goods to communities along the MVH alignment |
| New business opportunities that are directly and indirectly associated with the construction and operation of the Highway (benefit) | + Promote and support business opportunities at the appropriate time<br>+ Promote training and accreditations that will provide longer term employment benefits |
| Increased tourism spending throughout the Dehcho region (benefit) | + Encourage development of businesses related to tourism (i.e. residences, restaurants, tours, gas stations) and promote new and existing businesses  |

http://pwnhc.learnnet.nt.ca/teach/heritage_fairs_guide/tg_intro.asp

http://www.dot.gov.nt.ca/_live/pages/wpPages/YZF_for_Pilots.aspx

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# Potential Impacts and Mitigation/Optimization Measures

## Individual, Family and Community Wellness

Analyse or Undertake In-Depth Studies

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| Easier access to healthcare, recreation and education resources (benefit) | + Ensure maintenance of the road at all times in order to take advantage of increased accessibility to services and facilities available in other communities  |
| Increase in wage income during MVH construction and operation may lead to social and community challenges | + Support preventive education and social and health programs<br>+ Explore wage payment options that reduce availability of 'cash-in-hand' |
| Increased traffic during construction and operation of the MVH | + Prepare a traffic management plan in consultation with GNWT DOT<br>+ Ensure the installation of clear signage along the highway (i.e. speed, presence of wildlife corridor, etc)   |
| Potential for accidents and spills | + Implement an Environmental Management Plan<br>+ Ensure that trained response team(s) are available to deal with accidents and spills |

NWT-DOT Website - Winter and Ice Roads Information

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# + Potential Impacts and Mitigation/Optimization Measures

Analyse or Undertake In-Depth Studies

## Community Infrastructure and Utilities

| Potential Impacts | Proposed Mitigation/Optimization Measures |
|---|---|
| De facto creation of a transportation and utilities corridor through the Mackenzie Valley (benefit) | + Encourage development within the common corridor to take advantage of access via the MVH extension and to minimize development footprint on the land |
| Increase in demand for community services and infrastructure | + Development of a health and safety management plan in accordance with community requirements |
| Potential impacts to community drinking water | + Monitor quality of drinking water regularly throughout construction |

http://www.keew.org/keew/kashcareer2004feb20.htm

http://www.ifimages.com/public/image/388417/view.html

http://pwnhc.learnnet.nt.ca/research/photogallery/Galleries/Government/Education%20Gallery/g-1995-001-4368.jpg

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# Community Activity

## Second Round: January 26th, 2012

**2 types of activities:**

**Roundtable**

- Participants are separated into 3 distinct groups:
  - Leaders
  - Elders
  - Community Members
- Specific questions will be discussed among participants at each table
- A period of 15 to 20 minutes is given to participants in order to answer questions

**Follow Up and Next Steps**
**(Recap Day Discussion)**

- Summary of the discussion
- Period dedicated to general questions, comments, suggestions on the MVH Extension Project

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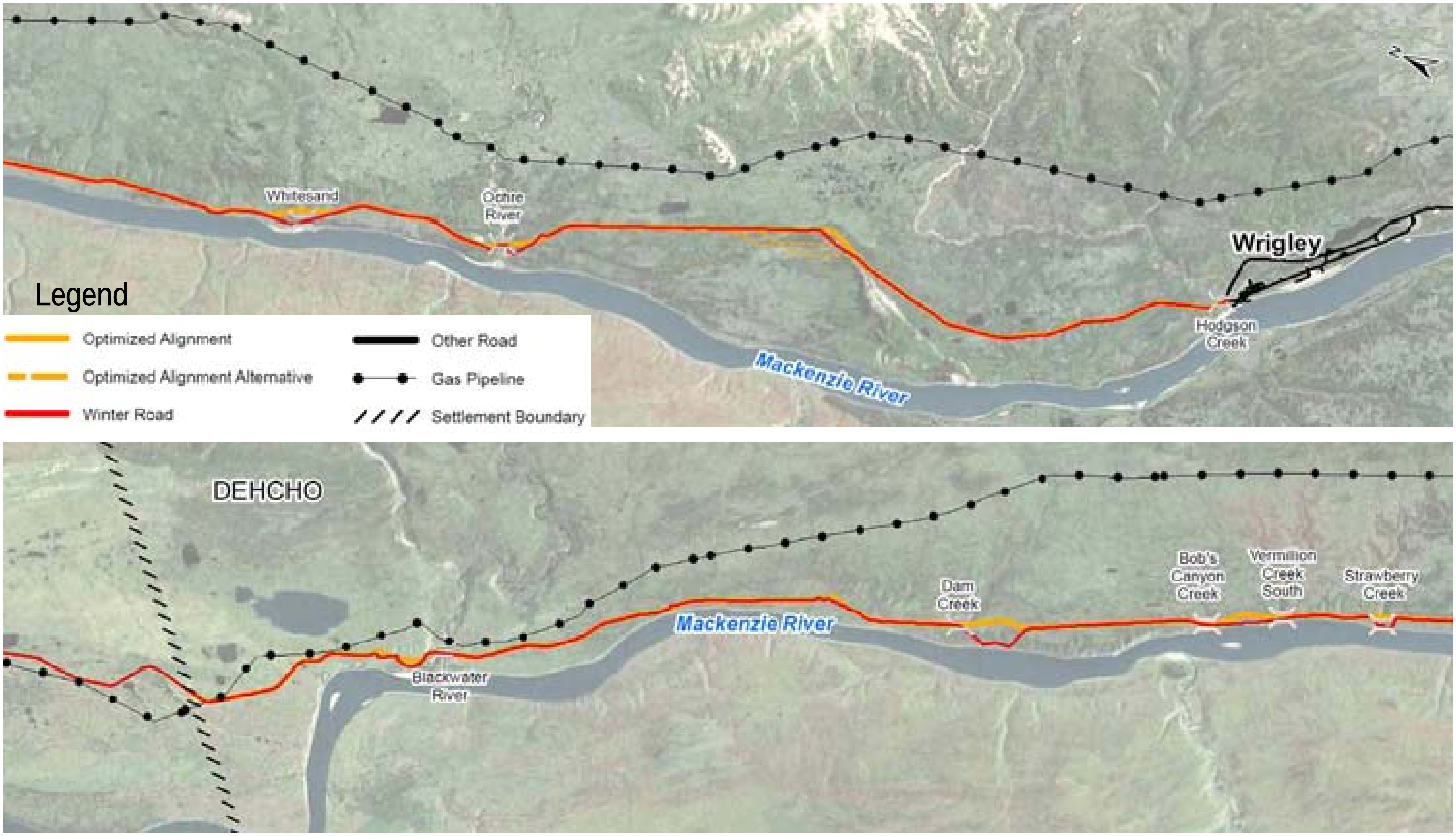
# Community Activity

**Themes to be discussed in Roundtable**

1. Family Benefits and Impacts
2. Community Benefits and Impacts
3. Socio Economic Benefits and Impacts
4. Cultural Benefits and Impacts
5. Community Involvement in the Project
6. Particular Sensitive Element

# Community Activity

## Follow Up and Next Steps



Mahsi Cho for your attention

For additional information, please contact:

Tannis Cli-Moses at PKCL

Tel: (867) 581-3321

Fax: (867) 581-3229

Email: tannis@pehdzehkicontractors.com

# Annex 4 Comments Sheet

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MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

## QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 26 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

25/12/01

Blackwater to be protected.

IF YOU WANT MY NAME ?
IT'S Justin Cillie

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MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 26 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

This HIGHWAY is going to bring All Kind's of Drudg's to the Community. it's going to be a Change for us. it's my pepole, my land, I'll Fight for it?

tell me, are you guy's going to take responsabilty. I Mean the MACKENZIE VALLEY Highway? for what Action's the Highway will Bring us. "TELL ME NOW"

what do I benafet from it? and my Childern's, Childern. Case one Day I will not be Here, We All HAve over time. I Just WANT what's best for my Kid's.

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

- my grandfather hunted on this land, there are alote of hunting ground's that we Have. your Highway run's over thim How do you think I FEEL ?

- How much more land do you want to distory from us, Just to run your STuped Highway throw over land ?

- tell me How is the Highway going to EFFECT the MACKENZIE - River ? with ~~[illegible]~~, Contanmanated Spill's. an Such thing's !

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MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 26 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

If the Highways go through (extension) it make destroy our Traditional land such as Burial ground, [illegible], camp ground, cabins.
as a PKFN members I would like the highway to be at winter ~~ground~~ Road not through our Town. Because we know that the elders won't sleep because of the Traffic.
Benefits – when the Enbridge pipeline went through they promise that the people from here PKFN members will get Benefits and training which they didn't. what make sure that if The Mackenzie Highway go through That we will get Benefits + Training
Right now PKFN members get ready to start Education + Training Themselves
As the Elders we not talking about ourselves now. We speak for the Young Generation.
They should realize That it their future we Talking about, but it's seem that hardly nobody is here to speak about Extension

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MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

## QUESTIONS / COMMENTS / SUGGESTIONS

| Meeting Date and Time : 26 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

What Kind of impacts will there be if this highway is to come through the dehcho region?
I Know their is going to be positive effects from this highway but their will also be negative effects, will this effect our natural wildlife in the near future?
In the past our elders of Pehdzeh Ki first nations fought hard to have this highway halted, what can this highway provide us will this project help boost the economy of this community, our we Garunteed not to be left out?
If the highway is decided to go through the Dehcho region will our natural resources such as water, the land, the wild life and the forest areas, are these resources garunteed not to be contaminated or destroyed by the chemicals and other resources that will be transported for the construction of the highway?

# Annex 5 PKFN 3-day Agenda

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Pehdzeh Ki First Nation
Public Community Meeting – Mackenzie Valley Highway PDR
January 24th to the 26th, 2012
Wrigley, Northwest Territories

AGENDA

January 24th, 2012 – Tuesday

| | |
|---|---|
| 5:30 PM | Supper – Stew and Bannock, Platters |
| 7:00 PM | Public Community Meeting |
| | PKCL Report and Update |
| | MOU with Devonian |
| | Mackenzie Valley Highway PDR |
| | Enbridge Willowlake River Oil Spill |
| | Next Steps: |

January 25th, 2012 – Wednesday

| | |
|---|---|
| 10:00 AM | Mackenzie Valley Highway PDR |
| | Introductions |
| | Overview of Draft Report |
| | Maps and Surveys |
| | Community Discussion |
| 12:00 PM | Lunch |
| 1:00 PM | Socio Economic Impact |
| | Funding |
| 4:00 PM | Recap Day Discussions |
| 5:30 PM | Feast |
| 7:00 PM | Youth Handgames and Drum Dance |

January 26th, 2012 – Thursday

| | |
|---|---|
| 10:00 AM | Mackenzie Valley Highway PDR – Dessau LVM |
| 12:00 PM | Lunch |
| 1:00 PM | Mackenzie Valley Highway - Community Roundtable |
| | Family Benefits and Impacts |
| | Community Benefits and Impacts |
| | Cultural Benefits and Impacts |
| | Socio and Economic Benefits and Impacts |
| | Follow and Next Steps |
| 4:00 PM | Recap Day Discussions |
| 6:00 PM | Feast |
| 7:00 PM | Men / Youth Open Handgames and Drum Dance |

# Annex 6 January 25th, 2012, Participation Activity

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# PDR Community Discussion

## Socio Economic Impact

Commulativie Effects of pursuing the hwy. S/I.

Immediate Impact – orientation / educ. – priorize the next steps.

Prepare – list down the of the project: economic, social, political, environment, im

Human Resource. Dev – training, surveying, engineering, what will it take, what are the req. we can look at the indepth training for the project.

Phase II – needed to implement follow up the comm. discussion

2

Realignment - when we make decisions keep in mind the teachings of the elders/ancestors we did not surrender or release our lands.

Road too close to the river, general public have access to the river. The area of the study is the only area that is closest to the river; 5 km from the river.

Fall - moose go to the rivers/creeks, to close to this areas

The realignment suggests ~~[illegible]~~ options

1) original
2) realignment
3) Community feedback

allow the community to make choice through a vote.

Less access directly into wrigley.

3

No all season road; both Yes & No → cost of food will decrease, freight, fuel prices, easier access to neighboring communities,

- Unsure of the hwy, need comm involvement. access to health care, housing needed now, training, youth success in education, career development

No hwy thru town disrupt community life, use existing back road.

Need a new store, to be recommended by the membership.

Employment during the project what about maintenance? and would there be employment after the project. What is this budget and cost (now)?

4

Will the hwy affect cultural sensitive areas, and how will they respect these areas?

Economical growth

- At one time we had access to community health, but these services removed.
- Take care of the hwy ourselves for long term opportunity and employment.
- Existing map, we need to talk about it. In providence, we were asked to make a wish list for the hwy. Where is this info?
- Training for youth - heo, mechanics, welders,
- have a grade 12 for Wrigley
- Full time RCMP station
- Hwy opportunities avail - build houses, business thru joint ventures, mining, hwy maintenance, go into partnerships

5

with other communities, to work with them to make things work for us. Learn from our mistake, to make it better for youth/younger generation.

- When the navy was stopped in the 1970's, took opportunities away. Now we have a second chance, and to maximize on this opportunity PKCL should and process to make businesses for the members. Help them to ~~took~~ build businesses. Share business development, and share the wealth. Helps the members have business, members owning businesses will give community members ownership and pride.

- Members moved away because a lack of opportunity, only 20 hired from the north, 100 went to the south. Have we have a say, this is our back yard. ~~and~~

- A ~~lot~~ of things involved tourism and training, we would like the

6

- 96 km (pore) used to train our people on heo, camps, at Bhere River build this road in the summer,

- Transportation / access to mine across the river - possibly a ferry

- The young people have ideas of developing a city/town in Wrigley - class project for the future (high rises, infrastructure.

- We need to control the project and study.

- Youth to attain gr 12 - they will carry on the work for the community.

- Environment & Safety is a priority as well for this project.

-

# MVH - PDR

1

## Pros:

- Opportunities
- Training
- Jobs
- Entrepreneurship
- TOURISM (increase)
- Access - not affected by weather
- Increased Access to Services
- Increase in health
- Infrastructure improvements
- Influx in population
- Governance/Administration Capacity

2

- Improve / Expand infrastructure lagoon, sewage, waste management
- MGP input identified community benefits
- business opport -
- equip
- maintenance
- Encourage business dev and enterprises
- Creating wealth - financing businesses and mortgages through the Nation trust. Reinvestment in to the PKFN (10yr plan)
- Benefits to the membership from generating revenue
- Invest in having homes for our people
- Health & Death Benefits for every member life insurance
- Elders home / home care

3

- Investments in/to community needs
- Have as a practice to put money away in a trust to support the community - for youth education/housing

  *start this now for long term benefits to the people

- Access to traditional territory
- Parks and conservation areas
- Protected Areas
- More research is required
- Potential to build residential areas
- Plan for long term infrastructure, communications, etc.
- Establish regular dialogue on hwy development
- Bld capacity with staff to carry out objectives be involved

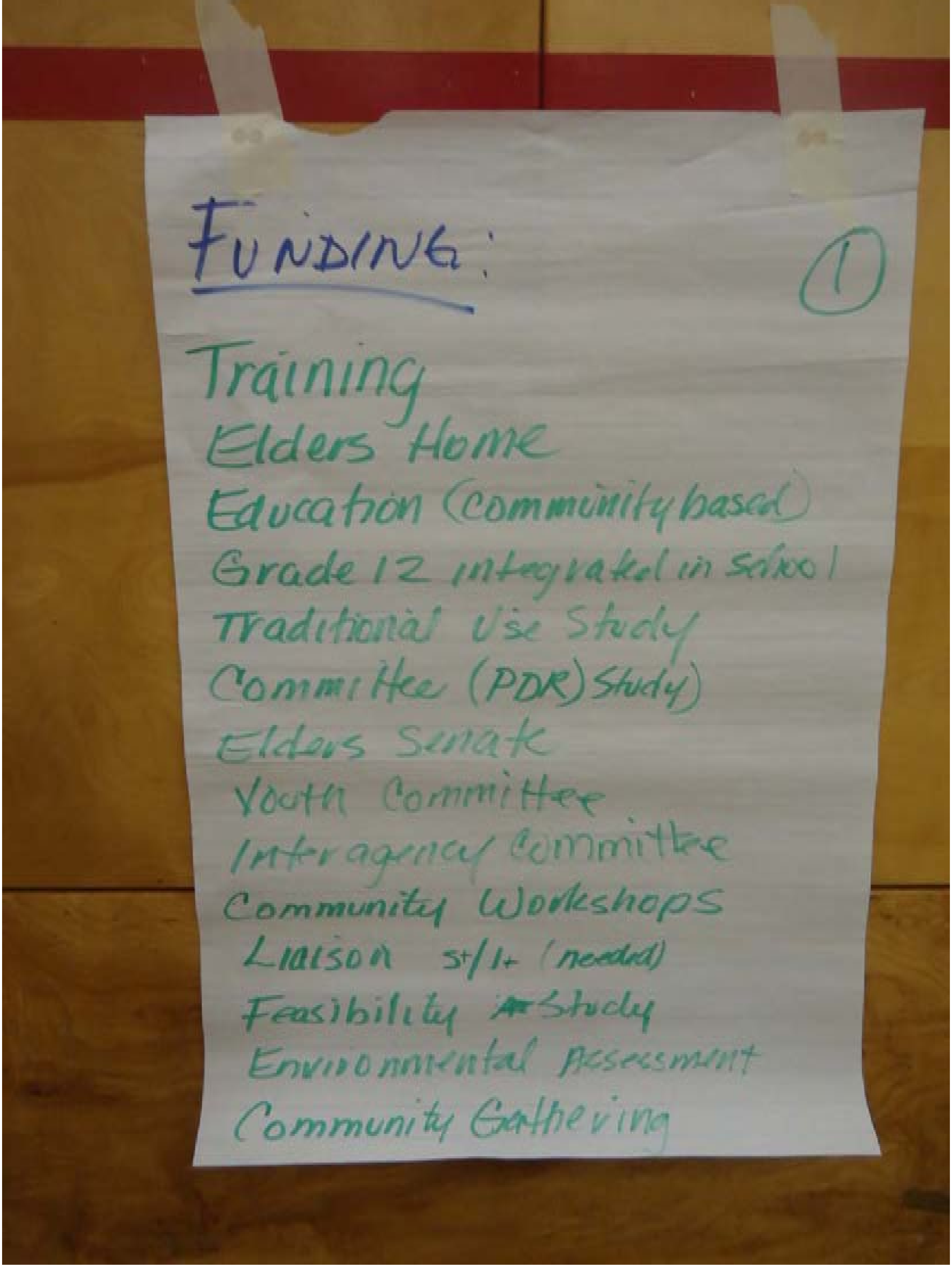
- long term strategic plan for PKFN (4)

CONS:

- Increase in traffic
- Easy access by general public
- Migration to area by ~~[illegible]~~ none PKFN members
- lose opportunities by competitors
- Competitive bidding - out right - sole source opportunity and maintenance
- Current work in Ochre River - they could we given PKFN notice provide list of needs in services, so that the people get the opportunity
- lack of control to access into area

5

- Sharing resources due to access – harvesting. Case examples in existing traditional areas
- Influx of visitors
- Willow River is contaminated, we need to protect the Blackwater area
- Contaminates hauled through the land, more pollution on the rw
- More dust
- Increase in Resource Development in the area
- industry will have easier access to seismic
- Water quality/impacts
- Increase in social issues; crime, violence


FUNDING:
1
Training
Elders Home
Education (community based)
Grade 12 integrated in school
Traditional Use Study
Committee (PDR) Study)
Elders Senate
Youth Committee
Interagency Committee
Community Workshops
Liaison st/lt (needed)
Feasibility Study
Environmental Assessment
Community Gathering

- RKFN / CANADA Relations ②

- * PDR is a component

- Communications @
  - Deh Cho communities

- → TUS Archive

# Annex 7 Public Consultations Photos

DESSAU

## PUBLIC CONSULTATION – JANUARY 25TH, 2012

**PEHDZEH KI COMMUNITY COMPLEX GYM – WRIGLEY – NORTHWEST TERRITORIES**


## PUBLIC CONSULTATION – JANUARY 26TH, 2012

### PEHDZEH KI COMMUNITY COMPLEX GYM – WRIGLEY – NORTHWEST TERRITORIES

# Annex 8 Attendance Sheets

DESSAU

DESSAU

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

## COMMUNITY CONSULTATION

## ATTENDANCE SHEET - CONTACT INFORMATION

| Meeting Date and Time : 25 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 1 | ROBERT NAYALLY | COUNCILLOR | P.K.F.N. | P.O BOX 27 WRIGLEY X0E-1E0 |
| 2 | Angus Ekenale | Councillor | PKFN | P.O. Box ~~45~~ Wrigley X0E-1E0 |
| 3 | ELSIE HARDISTY | COUNCILLOR | PKFN | P.O. BOX-24-WRIGLEY NT. X0E1E0 |
| 4 | Terrence Yendo | Councillor | PKFN | terrenceyendo@hotmail.com |
| 5 | George Moses | Councillor | PKFN | P.O Box 52 Wrigley, NT. X0E1E0 |
| 6 | Lisa Moses | Councillor | PKFN. | P.O.BOX 7, Wrigley NT X0E1E0 |
| 7 | CHIEF Tim Lennie | CHIEF | PKFN | P.O Box 21 Wrigley N.T. |
| 8 | Rose Moses | Staff P | PKFN | rmm.wrigley@hotmail.com |
| 9 | ARMIN ALEXIS | ADVISOR | ITAP/PKCL | armin@itapcanada.com |

Northwest Territories Transportation

DESSAU

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 10 | Sally Nayally | Finance officer | PKFN | finance@pehdzehki.ca |
| 11 | Tannis Moses | Procurement | PKCL | tinnis@pehdzehkicontractors.ca |
| 12 | Margaret Moses | Elder | PKFN | Wrigley, NT |
| 13 | [illegible] | MEMBER | PKFN | WRIGLEY NT |
| 14 | Keith Nayally | member | PKFN | Kanayally@H.M.com |
| 15 | Julie MacKenzie | | | JulesMac@Hotmail.com |
| 16 | Albert Moses | MEMBER | PKFN | Wrigley NWT. |
| 17 | Henry Hardisty | MEMBER | PKFN | WRIGLEY, NWT. |
| 18 | Edward Hardy | member | PKFN | WRIGLEY NT. |
| 19 | GINA POTTS ALEXIS | FACILITATOR | ITAP | gina@itapcanada.com |
| 20 | Gabe Hardisty | Elder | PKFN. | |
| 21 | JIM STEVENS | DIR. MACK VALL HGH. | GNWT DOT | jim_stevens@gov.nt.ca |

DESSAU

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

## COMMUNITY CONSULTATION

## ATTENDANCE SHEET - CONTACT INFORMATION

| Meeting Date and Time : 26 January 2012 – 10h00am | Venue: Pehdzeh Ki Community Complex Gym, NWT |
|---|---|

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 1 | Terrence Yendo | councillor | PKFN | Box 28 |
| 2 | ROBERT NAYALLY | COUNCILLOR | P.K.F.N | PoBox 27 Wrigley X0E1E0 |
| 3 | George Moses | Councillor | PKFN | PoBox 52 Wrigley NT. |
| 4 | Ellie Hardisty | Councillor | PKFN | P.O.Box 24 - Wrigley NT X0E 1E0 |
| 5 | Angus Ekenale | Councille | PKFN | P.O. Box, 24. X0E-1E0 |
| 6 | Lisa Moses | Councillor | PKFN | P.O.Box 7, Wrigley NT. |
| 7 | Gabe Hardisty | Elder. | PKFN | |
| 8 | ARMIN ALEXIS | Advisor | MAM/PKCL | armin@Hapcanada.com |
| 9 | JIM STEVENS | DIR MACK VALLEY HIGH | GNWT DOT | jim_stevens@gov.nt.ca |

DESSAU

Northwest Territories Transportation

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 10 | Justin Chillie | Member | P.K.F.N. | NO E-MAIL [redacted] |
| 11 | CHIEF TIM LENNIE | CHIEF | PKFN | [redacted] 2X Band |
| 12 | MARGARET MOSES | ELDER | PKFN | |
| 13 | Henry Hardisty | P.K.F.N. MEMBERS | PKFN | WRIGLEY, NT. X0E 1E0 |
| 14 | EDWARD GARGAN | MEMBER | PKFN | WRIGLEY N.T |
| 15 | Sarah Lennie | member | " | " |
| 16 | Charlotte Canadien | Member | " | |
| 17 | Nellie Vera Pokiak | School Counsellor | DDEC - Ft Simpson | nellie54pokiak@live.ca |
| 18 | Leona Sellar | Teacher | CJYS - Wrigley | b-lsell@telusplanet.net |
| 19 | Blair Sellar | Principal | CJYS- Wrigley | b-lsell@telusplanet.net |
| 20 | Jamie Lauckner | Volunteer | CJYS Frontiers Fdt. | jlauckner@uwaterloo.ca |
| 21 | Freddie Lennie | Volunteer | PKFN Member | nahtene86@hotmail.com |

Northwest Territories Transportation

PEHDZEH KI CONTRACTORS

DESSAU

MACKENZIE VALLEY HIGHWAY EXTENSION PROJECT – DEHCHO REGION

COMMUNITY CONSULTATION

**Meeting Participants:**

| | Name | Position | Organization | E-Mail Address or Mailing Address |
|---|---|---|---|---|
| 22 | Heiley Moses | Mumbers/Student | PKFN | wrigley NT X0E 1E0 PO Box 52 |
| 23 | Shenaugha Hardisty | Mumbers/Student | PKFN | PO BOX 24 Wrigley N.T X0E 1E0 |
| 24 | Allen moses | mumbers/student | PKFN | wrigley NT X0E1E0 PO BOX 52 |
| 25 | Gloria Hardisty | Member | PKFN | Wrigley, NT Box 8 · X0E1E0 |
| 26 | Chris Yendo | Member | RKFN | ↓ |
| 27 | | | | |
| 28 | | | | |
| 29 | | | | |
| 30 | | | | |
| 31 | | | | |
| 32 | | | | |
| 33 | | | | |

# Annex 9 Band Council Resolution - February 8th, 2012

DESSAU

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

Chronological no. - N° consécutif: 001 - 2012

File reference no. - N° de référence du dossier:

# BAND COUNCIL RESOLUTION
# RÉSOLUTION DE CONSEIL DE BANDE

NOTE: The words "from our Band Funds" "capital" or "revenue", whichever is the case, must appear in all resolutions requesting expenditures from Band Funds.
NOTA: Les mots "des fonds de notre bande" "capital" ou "revenu" selon le cas doivent paraître dans toutes les résolutions portant sur des dépenses à même les fonds des bandes

| | | Cash free balance - Solde disponible |
|---|---|---|
| The council of the / Le conseil de: Pehdzeh Ki First Nation | | Capital account / Compte capital $ |
| Date of duly convened meeting / Date de l'assemblée dûment convoquée: D-J 01 / M 08 / Y-A 2012 | Province | Revenue account / Compte revenu $ |

DO HEREBY RESOLVE:
DÉCIDE, PAR LES PRÉSENTES:

WHEREAS, the Pehdzeh Ki First Nation Chief and Council have the governing responsibility for the Nation and its members; and

WHEREAS, the Pehdzeh Ki First Nation hosted a community consultation session on the DRAFT report of the Mackenzie Valley Highway Project Description Report in Wrigley, NWT on January 25 and 26th 2012; and

WHEREAS, the members of the Pehdzeh Ki First Nation provided recommendations and feedback on the results of the DRAFT report - Phase One MVH PDR study; and

THEREFORE BE IT RESOLVED, that the Pehdzeh Ki First Nation Chief and Council reviewed the said MVH PDR, and accept in principle the draft report as prepared by PKCL and Dessau LVM.

BE IT FURTHER RESOLVED, that the MVH PDR be submitted to the Department of Transportation GNWT, and request GNWT to identify and provide resources for Phase Two of the MVH PDR which will further examine Environment and Traditional Use Study.

Quorum 5

Robert Nayally (Chief - Chef)

Lisa Moses (Councillor - Conseiller)

George Moses (Councillor - Conseiller)

(Councillor - Conseiller)

Olivia Hardisty (Councillor - Conseiller)

(Councillor - Conseiller)

(Councillor - Conseiller)

Terrence Yendo (Councillor - Conseiller)

(Councillor - Conseiller)

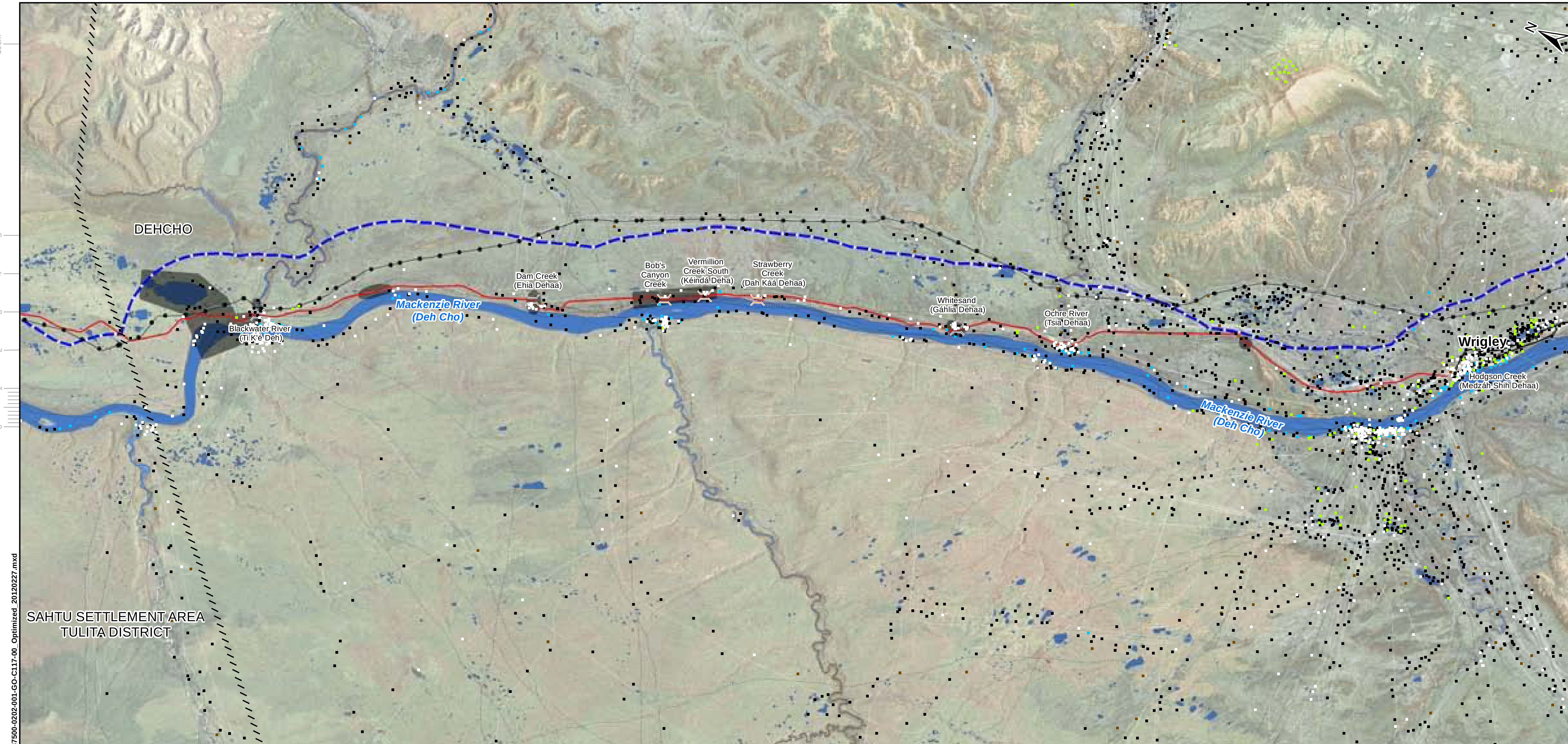
(Councillor - Conseiller)

## FOR DEPARTMENTAL USE ONLY - RÉSERVÉ AU MINISTERE

| Expenditure - Dépenses | Authority (Indian Act Section) Autorité (Article de la Loi sur les Indiens) | Source of funds Source des fonds | Expenditure - Dépenses | Authority (Indian Act Section) Autorité (Article de la Loi sur les Indiens) | Source of funds Source des fonds |
|---|---|---|---|---|---|
| | | ☐ Capital ☐ Revenue Revenu | | | ☐ Capital ☐ Revenue Revenu |

# Appendix 9 PKFN Public Consultations Inputs (January 25th and 26th, 2012)

DESSAU




- Winter Road
- Other Road
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- PKFN trails
- 5 km reference line
- Contour line (20 meters interval)

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

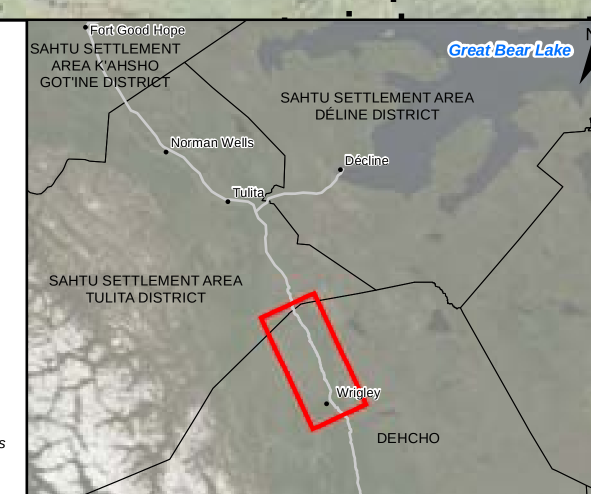
- PKFN Main Traditional Activity Site

**PKFN Traditional Land Use and Occupancy**

**(Data given during Public Consultation (Jan, 2012))**

- Occupancy
- Gathering
- Hunting (Big Game , Small Game and Birds)
- Fishing
- Trapping/Snaring
- Trapping/Snaring line

*Sources :*
*- © Bing Maps, 2006-2009*
*- CanVec, Canada Government.*
*- Northwest Territories, Centre for Geomatics*
*- © Deh Cho First Nations, 2004*
*- PKFN, 2011*
*- Dessau, 2011.*




Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25-26th, 2012)**

| | | | |
|---|---|---|---|
| Prepared : | G. Colaneri | No : | 068-P0037500-202-001-GO-C117-00 |
| Drawn : | G. Lemay | Scale : | 1:275 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

0 10 km

Projection UTM zone 10N, WGS84

DESSAU

FORMAT : 11" x 17"
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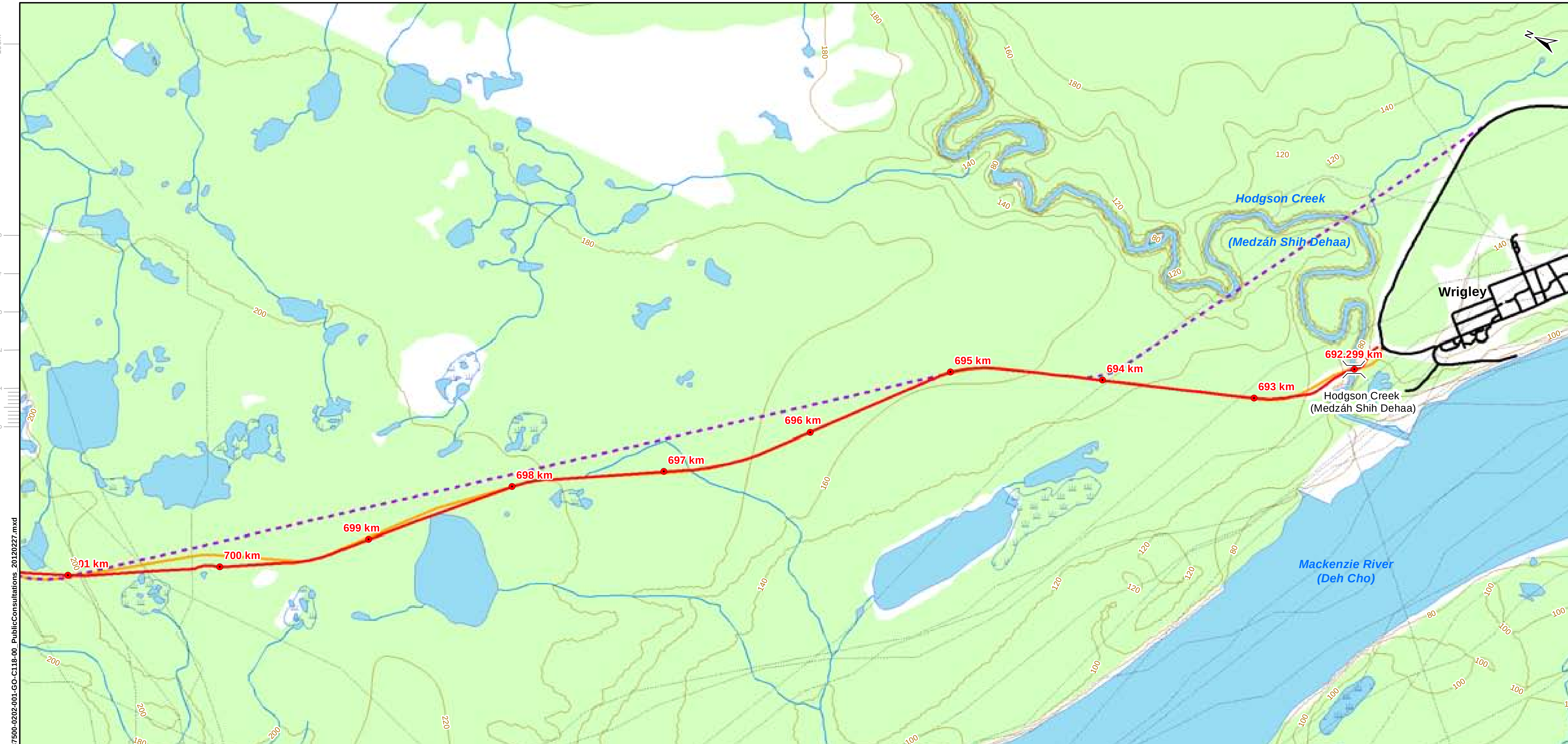


- Winter Road - KM Marker
- Optimized Alignment
- Optimized Alignment Alternative
- Winter Road
- Other Road
- PKFN Realigment Proposals (Jan 25, 2012)
- Gas Pipeline
- Settlement Boundary
- Existing bridge
- Bridge to be built or re-built
- Sahtu Private Lands
- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Island

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
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*- LiDAR EBA.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- © Bing Maps, 2006-2009*
*- Dessau, 2011.*


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**

**Sheet 1**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C118-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

DESSAU

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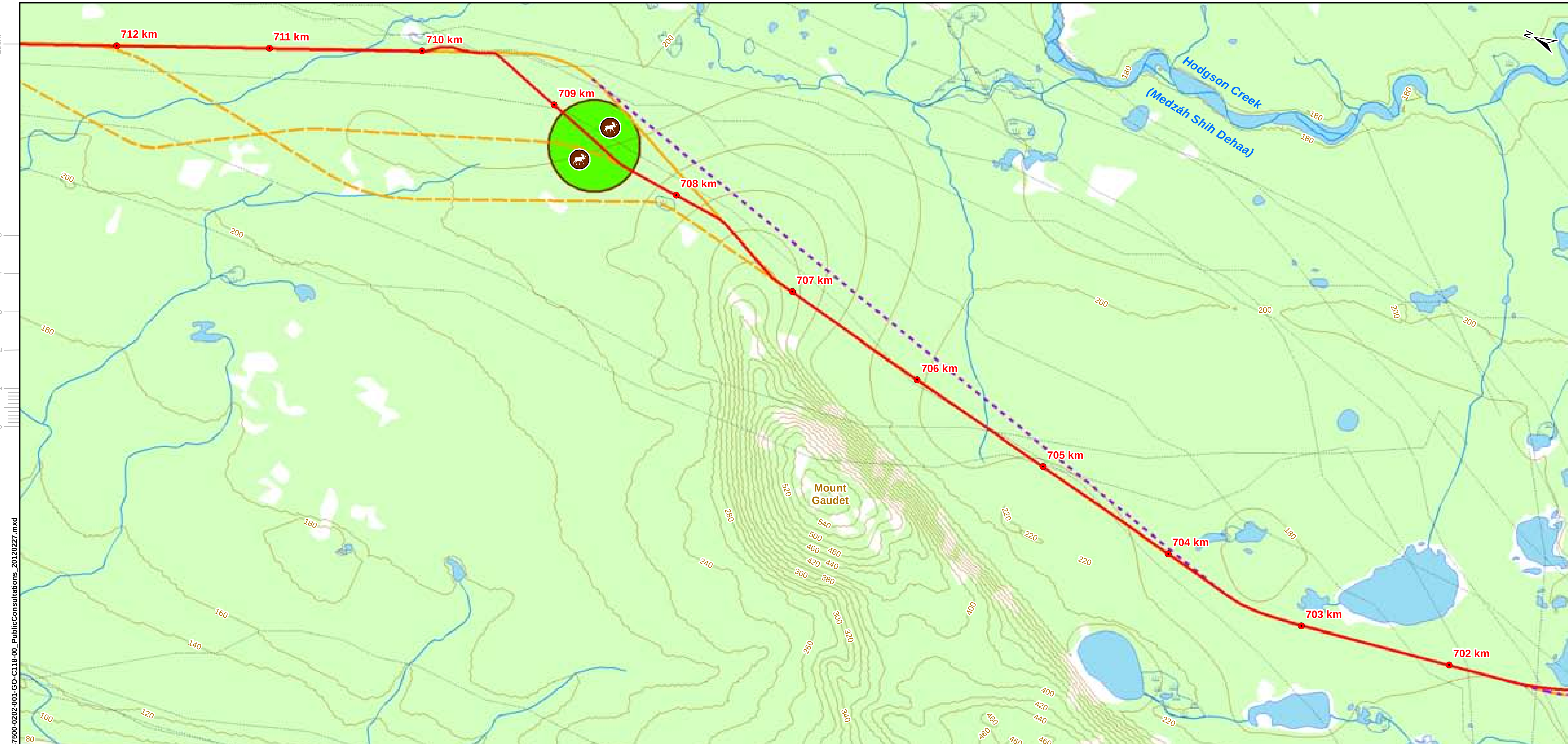


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*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
*- © Bing Maps, 2006-2009*
*- Dessau, 2011.*


Project
Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title
**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 2**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C118-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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Winter Road - KM Marker
Optimized Alignment
Optimized Alignment Alternative
Winter Road
Other Road
PKFN Realigment Proposals (Jan 25, 2012)
Gas Pipeline
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Existing bridge
Bridge to be built or re-built
Sahtu Private Lands

Contour line (in meters)
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PKFN trails
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Wetland
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Island

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

Burial Area
Hunting Cabins and Traplines
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*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
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*- Dessau, 2011.*


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 3**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C118-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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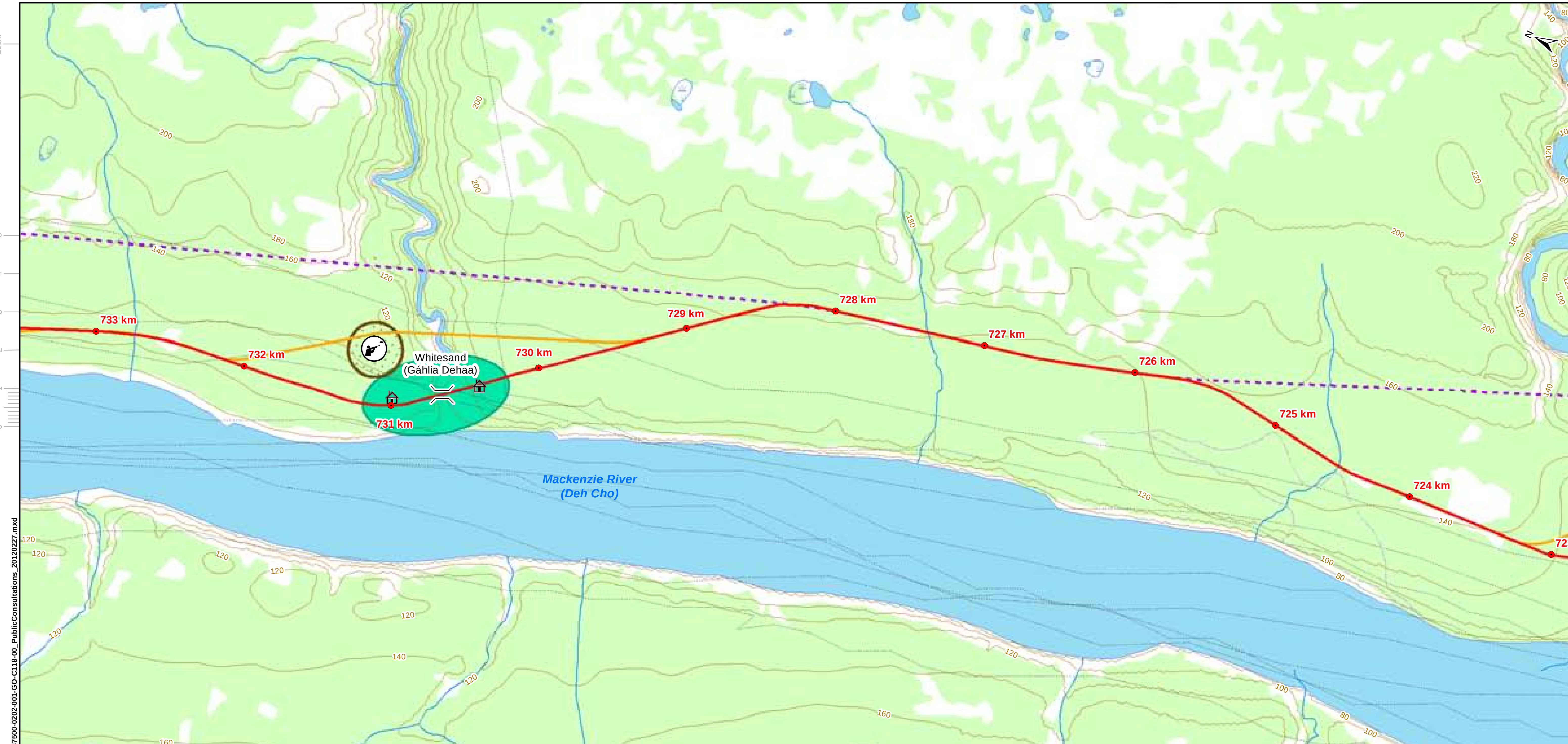


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PKFN Realigment Proposals (Jan 25, 2012)
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Existing bridge
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PKFN trails
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River
Waterbody
Wooded Area
Island

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

Burial Area
Hunting Cabins and Traplines
Moose Pasture Area
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Water Proximity Concern
Traditional Hunting Ground

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*- © Deh Cho First Nations, 2004*
*- © Bing Maps, 2006-2009*
*- Dessau, 2011.*


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**

**Sheet 4**

Prepared : C. Abdel-Malek
Drawn : G. Lemay
Checked : D. Aubin

No : 068-P0037500-202-001-GO-C118-00
Scale : 1:25 000
Date : February 27, 2012

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Projection UTM zone 10N, WGS84

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- Winter Road - KM Marker
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**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

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- Water Proximity Concern
- Traditional Hunting Ground

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*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
*- © Deh Cho First Nations, 2004*
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*- Dessau, 2011.*


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 5**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C118-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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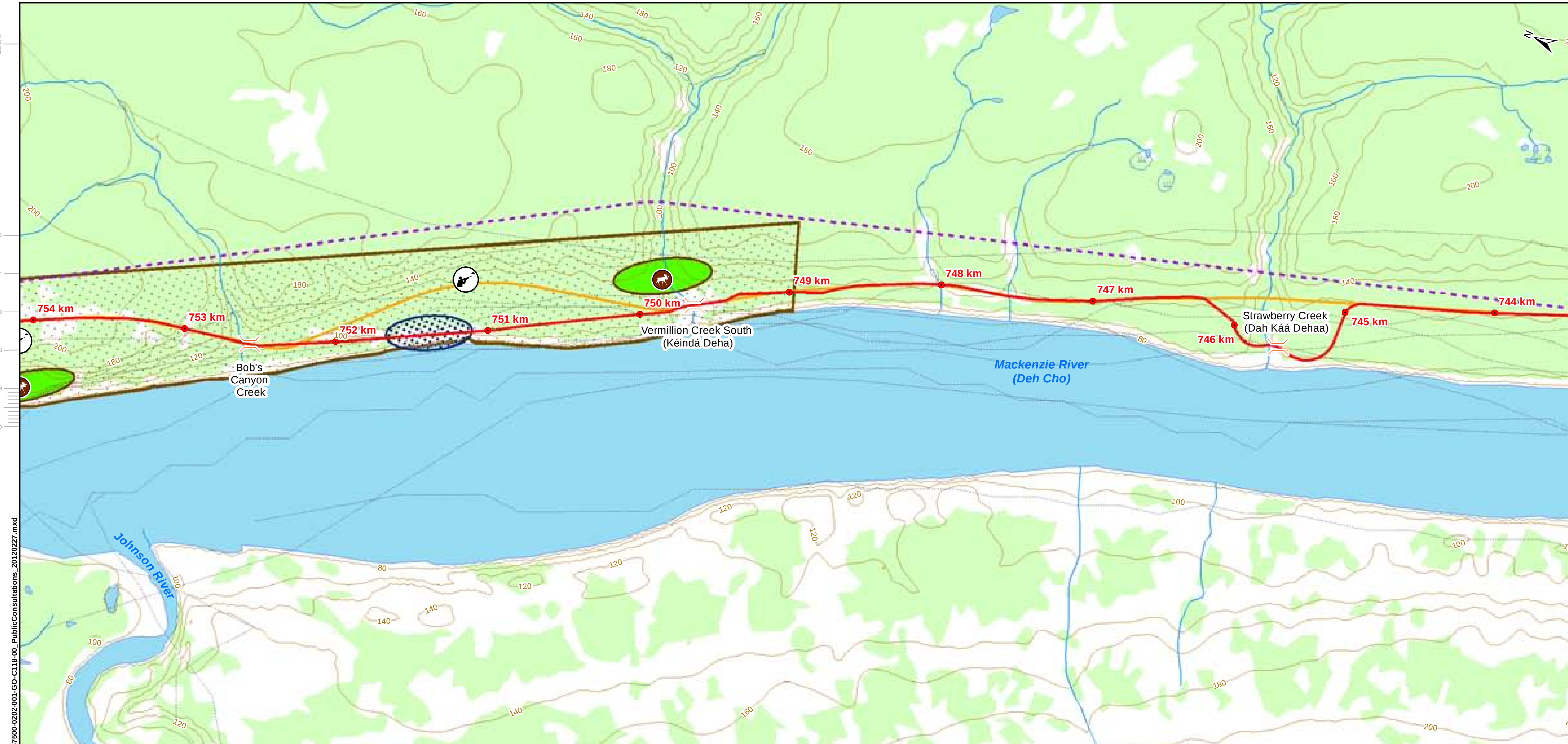


| | |
|---|---|
| Winter Road - KM Marker | Contour line (in meters) |
| Optimized Alignment | Trail |
| Optimized Alignment Alternative | PKFN trails |
| Winter Road | Sand |
| Other Road | Wetland |
| PKFN Realigment Proposals (Jan 25, 2012) | River |
| Gas Pipeline | Waterbody |
| Settlement Boundary | Wooded Area |
| Existing bridge | Island |
| Bridge to be built or re-built | |
| Sahtu Private Lands | |

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

- Burial Area
- Hunting Cabins and Traplines
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Sources :
- *CanVec, Canada Government.*
- *LiDAR EBA.*
- *Northwest Territories, Centre for Geomatics*
- *PKFN, 2011*
- *© Deh Cho First Nations, 2004*
- *© Bing Maps, 2006-2009*
- *Dessau, 2011.*


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 6**

| | | | |
|---|---|---|---|
| Prepared : | C. Abdel-Malek | No : | 068-P0037500-202-001-GO-C118-00 |
| Drawn : | G. Lemay | Scale : | 1:25 000 |
| Checked : | D. Aubin | Date : | February 27, 2012 |

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Projection UTM zone 10N, WGS84

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- Winter Road - KM Marker
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- Optimized Alignment Alternative
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- Contour line (in meters)
- Trail
- PKFN trails
- Sand
- Wetland
- River
- Waterbody
- Wooded Area
- Island

**PKFN Main Traditional Activity Site**

**(Data Collected during Public Consultation (July, 2011))**

- Burial Area
- Hunting Cabins and Traplines
- Moose Pasture Area
- Spiritual and Cultural Sites
- Water Proximity Concern
- Traditional Hunting Ground

*Sources :*
*- CanVec, Canada Government.*
*- LiDAR EBA.*
*- Northwest Territories, Centre for Geomatics*
*- PKFN, 2011*
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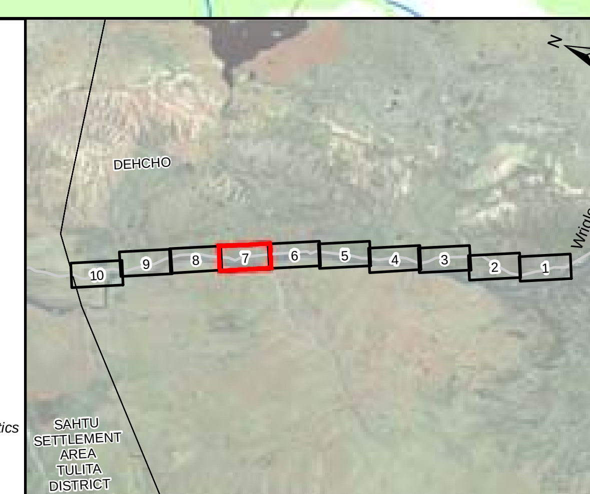


Project

Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

Title

**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 7**

| | | | |
|---|---|---|---|
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| Checked : | D. Aubin | Date : | February 27, 2012 |

0 1 000 m

Projection UTM zone 10N, WGS84

DESSAU

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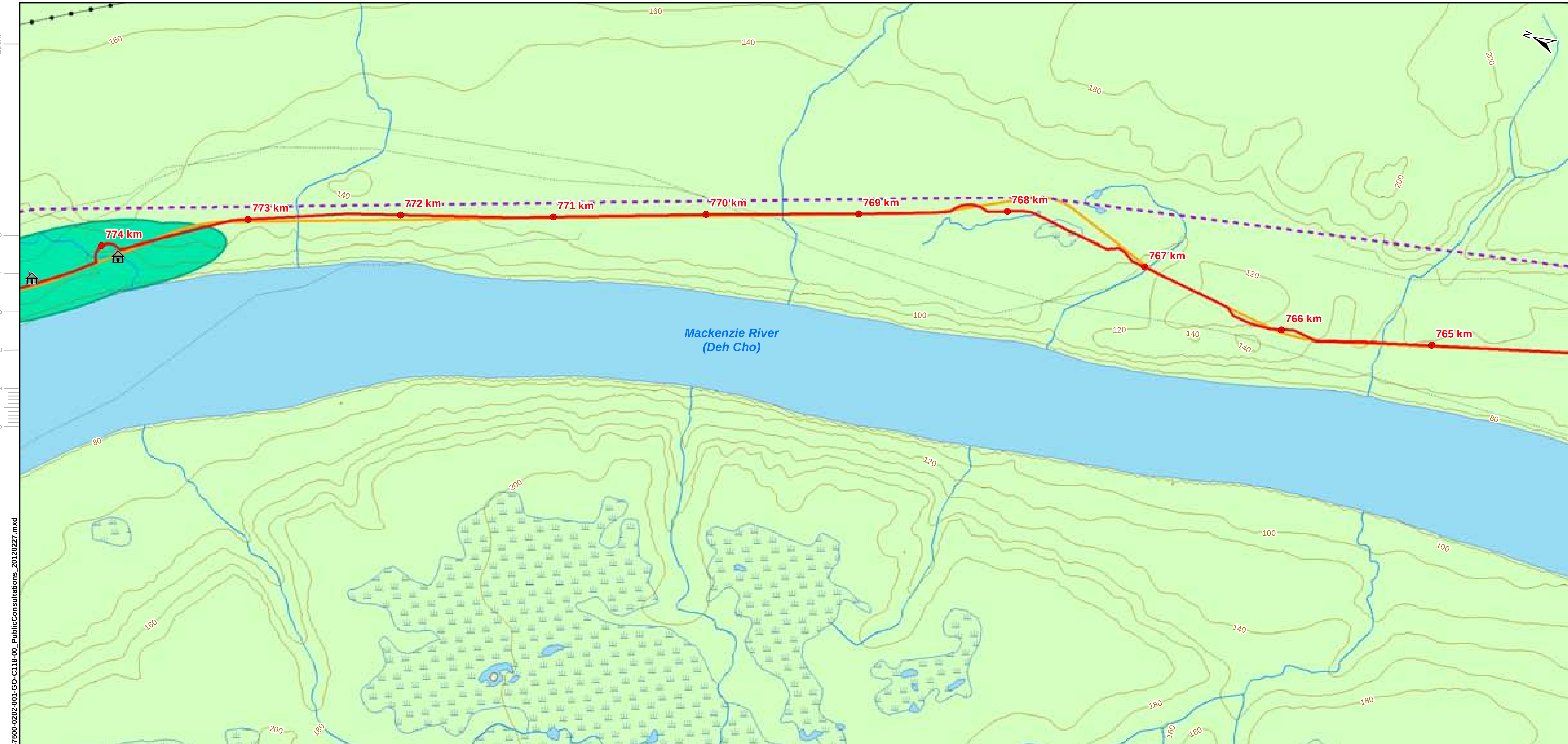


Winter Road - KM Marker
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Mackenzie Valley Highway Extension
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Pehdzeh Ki Ndeh - Dehcho Region

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**PKFN Public Consultation Inputs (January 25th, 2012)**
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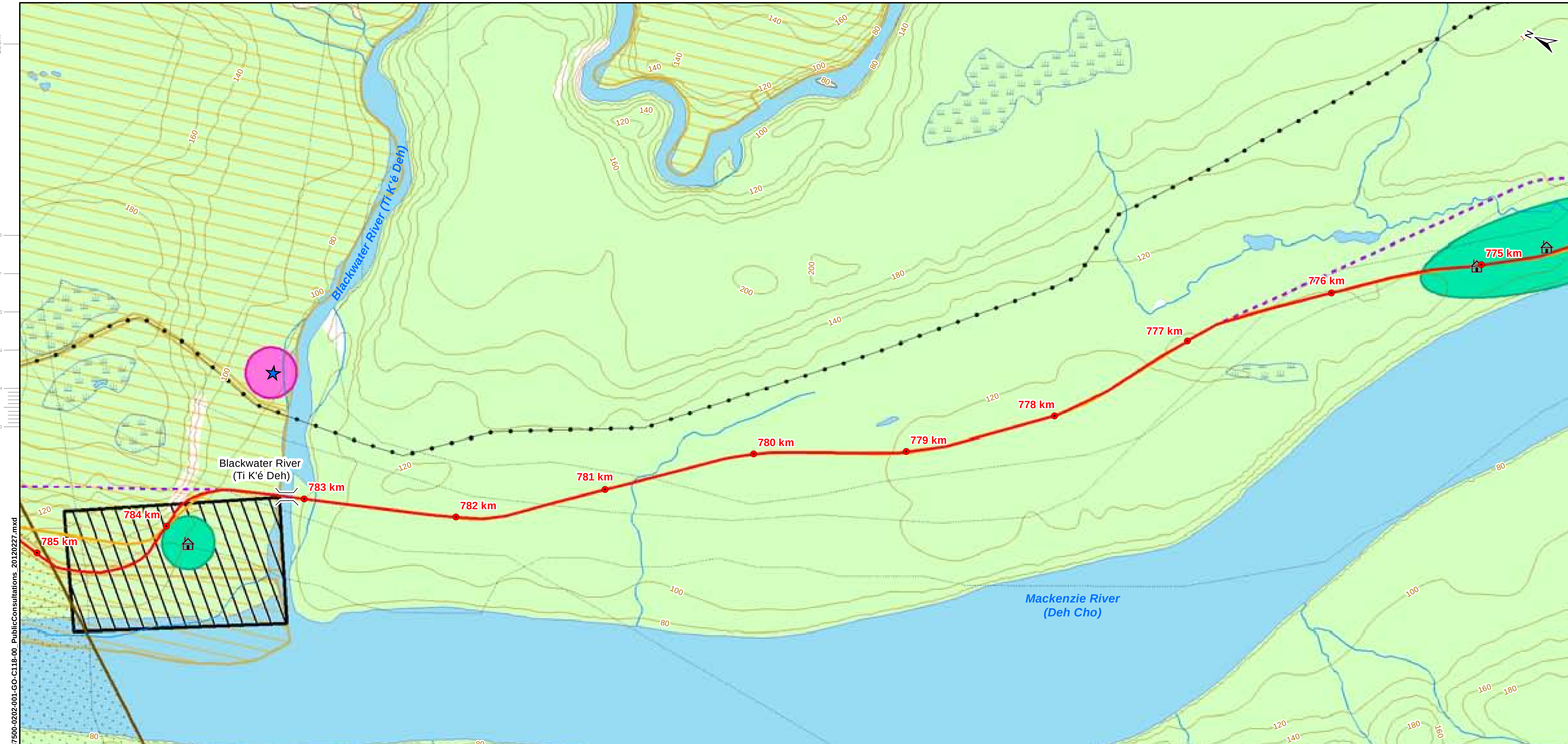


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Mackenzie Valley Highway Extension
Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**PKFN Public Consultation Inputs (January 25th, 2012)**
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Projection UTM zone 10N, WGS84

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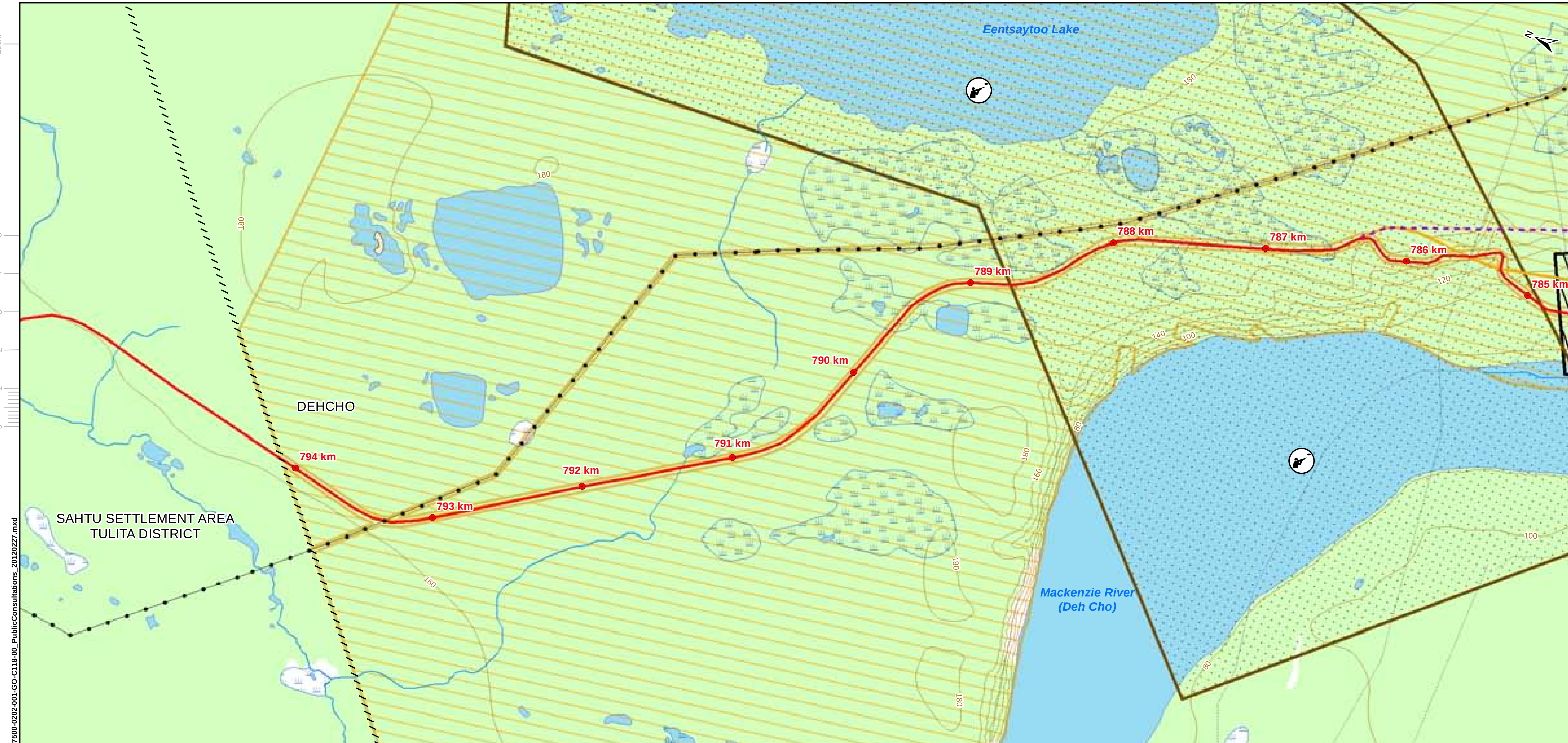


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Project
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Project Description Report
Pehdzeh Ki Ndeh - Dehcho Region

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**PKFN Public Consultation Inputs (January 25th, 2012)**
**Sheet 10**

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## Appendix 10 Analytical Results of Rivers - Water and Sediment

DESSAU

**Table 6-92: Deh Cho Region Rivers – Sediment Quality**

| Parameter | Units | Blackwater River (RPR-377) | Ochre River (RPR-391) | River Between Two Mountains (RPR-419) | Willowlake River (RPR-428) | Trail River (RPR-457) | Harris River (RPR-466) |
|---|---|---|---|---|---|---|---|
| | | July 24, 2002 | July 25, 2002 | July 26, 2002 | July 27, 2002 | July 28, 2002 | July 29, 2002 |
| **Particle Size** | | | | | | | |
| Particle size – % sand | % | 94 | 95 | 83 | 82 | 61 | 67 |
| Particle size – % silt | % | 2 | 3 | 12 | 12 | 24 | 19 |
| Particle size – % clay | % | 4 | 2 | 5 | 6 | 15 | 14 |
| Moisture content | % | 21 | 20 | 26 | 40 | 25 | 21 |
| **Carbon Content** | | | | | | | |
| Total inorganic carbon | % by wt | 2.2 | 2.1 | 1.1 | 1 | 0.2 | 2.6 |
| Total organic carbon | % by wt | 0.6 | 0.5 | 0.7 | 0.3 | 0.8 | <0.1 |
| Total carbon | % by wt | 2.8 | 2.6 | 1.7 | 1.4 | 1 | 2.3 |
| **Total Metals** | | | | | | | |
| Aluminum | µg/g | 3,430 | 3,040 | 5,340 | 3,830 | 17,100 | 6,310 |
| Arsenic | µg/g | 2.4 | 2.9 | 4.6 | 3.8 | **6.8**[1] | 3.7 |
| Barium | µg/g | 118 | 78 | 121 | 125 | 151 | 78 |
| Beryllium | µg/g | 0.2 | <0.2 | 0.2 | <0.2 | 0.7 | 0.3 |
| Boron | µg/g | 5 | 4 | 3 | 3 | 5 | 5 |
| Cadmium | µg/g | <0.1 | <0.1 | <0.1 | <0.1 | 0.2 | <0.1 |
| Calcium | µg/g | 52,000 | 36,800 | 18,600 | 8,200 | 6,300 | 27,400 |
| Chromium | µg/g | 4.9 | 5.9 | 8.7 | 6.2 | 26.5 | 12 |
| Cobalt | µg/g | 2.8 | 3.2 | 5.1 | 2.8 | 12.5 | 6 |
| Copper | µg/g | 4 | 5 | 8 | 5 | **36**[1] | 9 |
| Iron | µg/g | 7,500 | 9,000 | 15,100 | 7,500 | 30,200 | 14,400 |
| Lead | µg/g | 3.9 | 3.7 | 5.4 | 3.1 | 9.5 | 5.5 |
| Magnesium | µg/g | 19,500 | 13,400 | 10,500 | 3,660 | 6,860 | 12,000 |
| Manganese | µg/g | 218 | 179 | 313 | 138 | 559 | 307 |
| Mercury | µg/g | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Molybdenum | µg/g | 0.7 | 0.5 | 0.8 | 0.5 | 0.3 | 0.6 |
| Nickel | µg/g | 5.9 | 6.5 | 11.2 | 7.5 | 35.1 | 16.4 |
| Potassium | µg/g | 590 | 600 | 810 | 790 | 1,990 | 940 |

**Table 6-92: Deh Cho Region Rivers – Sediment Quality (cont'd)**

| Parameter | Units | Blackwater River (RPR-377) | Ochre River (RPR-391) | River Between Two Mountains (RPR-419) | Willowlake River (RPR-428) | Trail River (RPR-457) | Harris River (RPR-466) |
|---|---|---|---|---|---|---|---|
| | | July 24, 2002 | July 25, 2002 | July 26, 2002 | July 27, 2002 | July 28, 2002 | July 29, 2002 |
| **Total Metals (cont'd)** | | | | | | | |
| Selenium | µg/g | <0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| Silver | µg/g | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Sodium | µg/g | 100 | 60 | 100 | 220 | 170 | 90 |
| Strontium | µg/g | 50 | 32 | 22 | 20 | 24 | 30 |
| Thallium | µg/g | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Titanium | µg/g | 108 | 52.3 | 34.2 | 81.1 | 5.5 | 24.6 |
| Uranium | µg/g | 0.6 | 1 | 0.7 | 0.6 | 0.3 | 0.7 |
| Vanadium | µg/g | 9 | 9.5 | 14 | 13 | 27.5 | 13.7 |
| Zinc | µg/g | 31 | 17 | 35 | 26 | 83 | 31 |
| **Organic Compounds** | | | | | | | |
| Total recoverable hydrocarbons | µg/g | <100 | <100 | <100 | <100 | <100 | <100 |
| Total volatile hydrocarbons ($C_5$-$C_{10}$) | µg/g | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | 0.7 |
| Total extractable hydrocarbons ($C_{11}$-$C_{30}$) | µg/g | <5 | 13 | 11 | 120 | <5 | <5 |
| **Target PAHs and Alkylated PAHs** | | | | | | | |
| Naphthalene | µg/g | 0.002[a] | 0.002 | 0.007 | 0.026 | 0.011 | 0.008 |
| $C_1$-substituted naphthalenes | µg/g | 0.005 | 0.003 | **0.021**[j] | **0.059**[j] | **0.021**[j] | 0.004 |
| $C_2$-substituted naphthalenes | µg/g | 0.007 | 0.004 | 0.031 | 0.068 | 0.02 | 0.012 |
| $C_3$-substituted naphthalenes | µg/g | 0.004 | 0.007 | 0.036 | 0.073 | 0.039 | 0.028 |
| $C_4$-substituted naphthalenes | µg/g | 0.004 | 0.011 | 0.051 | 0.074 | 0.064 | <0.001 |
| Acenaphthene | µg/g | <0.0005 | <0.0003 | <0.001 | <0.001 | <0.001 | <0.001 |
| $C_1$-substituted acenaphthene | µg/g | <0.0004 | <0.0002 | 0.001[a] | 0.005 | 0.001[a] | <0.0001 |
| Acenaphthylene | µg/g | <0.0003 | <0.0002 | <0.0004 | <0.001 | <0.0003 | <0.0002 |
| Anthracene | µg/g | <0.0002 | <0.0003 | <0.0005 | 0.03 | <0.001 | <0.0004 |
| Dibenzo(a,h)anthracene | µg/g | <0.001 | <0.0003 | <0.001 | <0.001 | <0.001 | <0.001 |
| Benzo(a)anthracene | µg/g | <0.0003 | 0.001[a] | 0.001[a] | 0.002[a] | 0.0004[a] | 0.001[a] |

Table 6-92: Deh Cho Region Rivers – Sediment Quality (cont'd)

| Parameter | Units | Blackwater River (RPR-377) July 24, 2002 | Ochre River (RPR-391) July 25, 2002 | River Between Two Mountains (RPR-419) July 26, 2002 | Willowlake River (RPR-428) July 27, 2002 | Trail River (RPR-457) July 28, 2002 | Harris River (RPR-466) July 29, 2002 |
|---|---|---|---|---|---|---|---|
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | |
| $C_1$-substituted benzo(a)anthracene/chrysene | µg/g | 0.012 | 0.027 | 0.066 | 0.097 | 0.065 | 0.054 |
| $C_2$-substituted benzo(a)anthracene/chrysene | µg/g | 0.002 | 0.007 | 0.017 | 0.023 | 0.012 | 0.02 |
| Benzo(a)pyrene | µg/g | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.001 |
| $C_1$-substituted benzo(b&k) fluoranthene/benzo(a)pyrene | µg/g | <0.001 | 0.003 | 0.01 | 0.043 | 0.003 | 0.002 |
| $C_2$-substituted benzo(b& k) fluoranthene/benzo(a)pyrene | µg/g | <0.001 | 0.001 | <0.003 | 0.013 | <0.001 | 0.003 |
| Benzofluoranthenes | µg/g | 0.001 | 0.001[a] | 0.004 | 0.007 | 0.003 | 0.001[a] |
| Benzo(g,h,i)perylene | µg/g | 0.001 | 0.001 | 0.005 | 0.011 | 0.001 | 0.001[a] |
| Biphenyl | µg/g | 0.001 | 0.0005[a] | 0.007 | 0.005 | 0.018 | 0.009 |
| $C_1$-substituted biphenyl | µg/g | <0.0004 | <0.0003 | 0.003 | 0.004 | <0.001 | <0.0003 |
| $C_2$-substituted biphenyl | µg/g | <0.0004 | <0.0003 | 0.003 | 0.006 | 0.002 | 0.0005 |
| Chrysene | µg/g | 0.002 | 0.003 | 0.009 | 0.016 | 0.013 | 0.009[a] |
| Dibenzothiophene | µg/g | <0.0003 | <0.0003 | 0.002[a] | 0.002 | 0.011 | 0.004 |
| $C_1$-substituted dibenzothiophene | µg/g | 0.001 | 0.002 | 0.01 | 0.012 | 0.024 | 0.011 |
| $C_2$-substituted dibenzothiophene | µg/g | 0.002 | 0.006 | 0.022 | 0.022 | 0.056 | 0.034 |
| $C_3$-substituted dibenzothiophene | µg/g | 0.002 | 0.008 | 0.024 | 0.025 | 0.048 | 0.038 |
| $C_4$-substituted dibenzothiophene | µg/g | <0.001 | 0.007 | 0.018 | 0.019 | 0.041 | 0.02 |
| Fluoranthene | µg/g | 0.001 | 0.001[a] | 0.003 | 0.004 | 0.002 | 0.003 |
| $C_1$-substituted fluoranthene/pyrene | µg/g | 0.003 | 0.003 | 0.016 | 0.023 | 0.012 | 0.027 |
| $C_2$-substituted fluoranthene/pyrene | µg/g | 0.003 | 0.006 | 0.001 | 0.03 | 0.015 | 0.025 |
| $C_3$-substituted fluoranthene/pyrene | µg/g | 0.002 | 0.006 | 0.016 | 0.017 | 0.012 | 0.021 |
| Fluorene | µg/g | <0.0003 | <0.0002 | 0.001 | 0.002 | 0.002 | <0.0003 |
| $C_1$-substituted fluorene | µg/g | 0.001 | <0.001 | 0.006 | 0.01 | 0.007 | 0.001 |
| $C_2$-substituted fluorene | µg/g | 0.002 | 0.005 | 0.019 | 0.033 | 0.022 | 0.008 |
| $C_3$-substituted fluorene | µg/g | 0.002 | 0.009 | 0.027 | 0.052 | 0.037 | 0.026 |

**Table 6-92: Deh Cho Region Rivers – Sediment Quality (cont'd)**

| Parameter | Units | Blackwater River (RPR-377) July 24, 2002 | Ochre River (RPR-391) July 25, 2002 | River Between Two Mountains (RPR-419) July 26, 2002 | Willowlake River (RPR-428) July 27, 2002 | Trail River (RPR-457) July 28, 2002 | Harris River (RPR-466) July 29, 2002 |
|---|---|---|---|---|---|---|---|
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | |
| Indeno(1,2,3,cd)pyrene | µg/g | <0.0005 | <0.0004 | 0.001 | 0.001[a] | <0.001 | 0.0004[a] |
| Phenanthrene | µg/g | 0.003[a] | 0.002 | 0.02 | 0.03 | 0.02 | 0.01 |
| $C_1$-substituted phenanthrene/anthracene | µg/g | 0.01 | 0.01 | 0.03 | 0.07 | 0.05 | 0.03 |
| $C_2$-substituted phenanthrene/anthracene | µg/g | 0.01 | 0.02 | 0.05 | 0.08 | 0.06 | 0.1 |
| $C_3$-substituted phenanthrene/anthracene | µg/g | 0.01 | 0.02 | 0.05 | 0.06 | 0.05 | 0.12 |
| $C_4$-substituted phenanthrene/anthracene | µg/g | 0.01 | 0.04 | 0.11 | 0.16 | 0.14 | 0.19 |
| 1-Methyl-7-isopropyl-phenanthrene (Retene) | µg/g | 0.001 | 0.001a | 0.01 | 0.06 | 0.04 | 0.01 |
| Pyrene | µg/g | 0.001 | 0.002 | 0.006 | 0.008 | 0.005 | 0.011 |

NOTES:
I = concentration higher than the interim sediment quality guideline (CCME 1999)
a PAH concentrations are reported with the limitation that the GCMS spectra used to develop these values were ill-defined, i.e., these numbers might contain a larger degree of error than those produced from clearly defined spectra
Boldface indicates values are higher than the relevant sediment quality guideline levels

## Table 6-77: Blackwater River (RPR-377) – Water Quality

| Parameter | Units | 2002 | Historical Data (1971–1999) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Summer | Summer | | | | Fall | | | | Winter | | | | Spring | | | |
| | | July 24 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Field Measured** | | | | | | | | | | | | | | | | | | |
| pH | N/A | 8 | 8.2 | 7.3 | 8.4 | 14 | 8.2 | 7.9 | 8.5 | 4 | 7.9 | 7.2 | **8.8**[illegible] | 10 | 8 | 7.8 | 8.4 | 3 |
| Conductance | µS/cm | 342 | 240 | 171 | 370 | 11 | 383 | 246 | 520 | 2 | 1,085 | 242 | 1,540 | 8 | 206 | 190 | 222 | 2 |
| Temperature | °C | 15.2 | 11 | 7 | 22.7 | 17 | 8.3 | 3.5 | 20.5 | 6 | 4.5 | 0 | 22.2 | 12 | 12.7 | 2.5 | 24.7 | 4 |
| Dissolved oxygen | mg/L | 11.2 | 10.7 | 8.4 | 12.4 | 6 | 12 | – | – | 1 | 12 | 11.8 | 13 | 4 | – | – | – | – |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | |
| Colour | TCU | **70**[illegible] | – | – | – | – | – | – | – | – | – | – | – | – | **80**[illegible] | – | – | 1 |
| Conductance | µS/cm | 304 | 230 | 150 | 315 | 9 | 401 | 210 | 468 | 3 | 1,220 | 225 | 1,942 | 12 | 248 | 236 | 270 | 3 |
| Dissolved organic carbon | mg/L | 10 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hardness | mg/L | 115 | 96 | 84 | 123 | 8 | 137 | 109 | 165 | 2 | 457 | 101 | 635 | 8 | 90 | 88 | 95 | 3 |
| pH | N/A | 7.9 | 8 | 7.7 | 8.1 | 9 | 8.2 | 8 | 8.2 | 3 | 8 | 7.5 | 8.4 | 10 | 8.1 | 7.8 | 8.4 | 4 |
| Total alkalinity | mg/L | 88 | 74 | 65 | 86 | 8 | 92 | 82 | 98 | 3 | 137 | 84 | 169 | 9 | 75 | 66 | 77 | 4 |
| Total dissolved solids | mg/L | 157* | – | – | – | – | 337 | – | – | 1 | – | – | – | – | – | – | – | – |
| Total organic carbon | mg/L | 12 | 12 | 7 | 15 | 9 | 12 | 11 | 12 | 3 | 10 | 4 | 35 | 12 | 15 | 11 | 18 | 4 |
| Total suspended solids | mg/L | <3 | 17 | <1 | 92 | 5 | 1 | <1 | 1 | 2 | 12 | – | – | 1 | 47 | 43 | 50 | 2 |
| **Major Ions** | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | 107 | – | – | – | – | 0.2 | – | – | 1 | 190 | – | – | 1 | – | – | – | – |
| Calcium | mg/L | 28 | 29 | 26 | 33 | 8 | 36 | 29 | 46 | 3 | 135 | 27 | 211 | 9 | 26 | 21 | 28 | 4 |
| Carbonate | mg/L | <5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Chloride | mg/L | 22 | 19 | 12 | 25 | 9 | 36 | 22 | 48 | 3 | 195 | 18 | **275**[illegible] | 13 | 17 | 14 | 18 | 4 |
| Magnesium | mg/L | 11 | – | – | – | – | 12 | – | – | 1 | 51 | – | – | 1 | 8 | – | – | 1 |
| Potassium | mg/L | 1 | 1 | 1 | 1 | 9 | 1 | 1 | 1 | 3 | 1 | 1 | 146 | 13 | 1 | 1 | 1 | 4 |
| Sodium | mg/L | 17 | 14 | 9 | 18 | 9 | 26 | 16 | 33 | 3 | 124 | 13 | 178 | 13 | 13 | 11 | 13 | 4 |
| Sulphate | mg/L | 25 | 23 | 14 | 31 | 9 | 56 | 25 | 57 | 3 | 303 | 14 | 451 | 13 | 16 | 14 | 17 | 4 |
| Sulphide | mg/L | <0.003 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | | | |
| Nitrate + nitrite | mg/L | 0.1 | 0.1 | 0.04 | 0.1 | 6 | 0.1 | 0.1 | 0.1 | 2 | 0.2 | 0.1 | 0.3 | 7 | 0.2 | 0.1 | 0.2 | 3 |
| Nitrogen – ammonia | mg/L | <0.05 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Nitrogen – Kjeldahl | mg/L | 0.8 | 0.5 | <0.5 | 1.3 | 9 | <0.5 | – | – | 1 | 0.5 | 0.4 | 0.8 | 10 | 0.6 | <0.5 | 0.6 | 4 |
| Phosphorus – total | mg/L | 0.007 | 0.019 | 0.009 | 0.065 | 4 | <0.003 | – | – | 1 | 0.013 | <0.005 | 0.02 | 4 | 0.021 | 0.008 | 0.031 | 3 |
| Phosphorus – dissolved | mg/L | 0.004 | <0.003 | – | – | 1 | <0.003 | – | – | 1 | <0.003 | – | – | 1 | – | – | – | – |
| **Total Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.07 | – | – | – | – | – | – | – | – | <0.1 | – | – | 1 | – | – | – | – |
| Antimony | mg/L | 0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Barium | mg/L | 0.039 | – | – | – | – | – | – | – | – | <0.1 | – | – | 1 | – | – | – | – |

## Table 6-77: Blackwater River (RPR-377) – Water Quality (cont'd)

| Parameter | Units | 2002 | Historical Data (1971–1999) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Summer | Summer | | | | Fall | | | | Winter | | | | Spring | | | |
| | | July 24 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Total Metals (cont'd)** | | | | | | | | | | | | | | | | | | |
| Beryllium | mg/L | <0.001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boron | mg/L | <0.02 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Cadmium | mg/L | <0.0002[D<C] | <0.001[D<C] | <0.001[D<C] | **0.004**[C] | 9 | <0.001[D<C] | <0.001[D<C] | **0.003**[C] | 3 | <0.001[D<C] | <0.001[D<C] | **0.004**[C] | 11 | <0.001[D<C] | <0.001[D<C] | <0.001[D<C] | |
| Chromium | mg/L | <0.0008 | <0.01[D<C] | <0.01[D<C] | **0.012**[C] | 9 | <0.01[D<C] | <0.01[D<C] | <0.015[D<C] | 3 | <0.01[D<C] | <0.01[D<C] | <0.015[D<C] | 10 | <0.01[D<C] | <0.01[D<C] | **0.01**[C] | 4 |
| Cobalt | mg/L | <0.0002 | 0.001 | <0.001 | 0.015 | 9 | 0.002 | <0.002 | 0.002 | 3 | <0.001 | <0.001 | 0.004 | 11 | 0.0025 | <0.001 | 0.009 | 4 |
| Copper | mg/L | 0.002 | <0.001 | <0.001 | **0.003**[C] | 9 | 0.001 | <0.001 | 0.001 | 3 | <0.001 | <0.001 | **0.004**[C] | 12 | **0.0025**[C] | <0.001 | **0.006**[C] | 4 |
| Iron | mg/L | 0.13 | **0.39**[C,W] | 0.1 | **2.8**[C,W] | 9 | 0.08 | 0.08 | 0.13 | 3 | 0.08 | <0.05 | 0.09 | 12 | **0.97**[C,W] | **0.38**[C,W] | **1.6**[C,W] | 4 |
| Lead | mg/L | 0.0008 | <0.001 | <0.001 | **0.016**[C,W] | 9 | <0.001 | <0.001 | <0.004[D<C] | 3 | <0.001 | <0.001 | **0.008**[C] | 11 | <0.001 | <0.001 | **0.01**[C] | 4 |
| Lithium | mg/L | <0.006 | <0.005 | <0.005 | 0.007 | 9 | <0.005 | <0.005 | 0.57 | 3 | 0.013 | <0.005 | 0.016 | 11 | <0.005 | <0.005 | <0.005 | 4 |
| Manganese | mg/L | 0.003 | <0.01 | <0.01 | **0.07**[W] | 9 | <0.01 | <0.01 | <0.01 | 3 | <0.01 | <0.006 | 0.02 | 12 | 0.04 | 0.01 | **0.09**[W] | 4 |
| Mercury [1] | mg/L | <0.0000006 | 0.00009 | <0.00005 | **0.00013**[C] | 2 | <0.00005 | – | – | 1 | <0.00005 | <0.00005 | <0.00005 | 3 | <0.00005 | – | – | 1 |
| Molybdenum | mg/L | 0.0006 | <0.05 | <0.05 | <0.05 | 9 | <0.05 | <0.05 | <0.1[D<C] | 3 | <0.05 | <0.05 | <0.1[D<C] | 10 | <0.05 | <0.05 | <0.05 | 4 |
| Nickel | mg/L | 0.0013 | 0.006 | <0.001 | 0.014 | 9 | 0.004 | <0.001 | 0.006 | 3 | <0.001 | <0.001 | 0.007 | 11 | 0.0085 | 0.004 | 0.016 | 4 |
| Selenium | mg/L | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Silver [1] | mg/L | 0.000076 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Strontium [2] | mg/L | 0.2 | 0.21 | 0.15 | 0.41 | 9 | 0.26 | <0.01 | 0.77 | 3 | 2.2 | 0.36 | 5.1 | 11 | 0.13 | 0.09 | 0.15 | 4 |
| Thallium | mg/L | <0.0001 | – | – | – | – | – | – | – | – | <0.1[D<C] | – | – | 1 | – | – | – | – |
| Titanium | mg/L | <0.005 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0003 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Vanadium | mg/L | 0.0004 | <0.05 | <0.05 | <0.05 | 9 | <0.05 | <0.05 | <0.05 | 3 | <0.05 | <0.05 | <0.05 | 11 | <0.05 | <0.05 | <0.05 | 4 |
| Zinc | mg/L | 0.012 | 0.007 | 0.001 | **0.12**[C] | 9 | 0.005 | 0.002 | 0.014 | 3 | 0.004 | <0.001 | **0.11**[C] | 12 | 0.008 | 0.006 | <0.01 | 4 |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | <0.01 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Antimony | mg/L | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | <0.0004 | 0.0055 | <0.0005 | 0.01 | 8 | <0.0028 | <0.0005 | <0.005 | 2 | 0.0065 | <0.0005 | 0.022 | 8 | 0.006 | <0.0005 | 0.008 | 4 |
| Barium | mg/L | 0.035 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Beryllium | mg/L | <0.001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boron | mg/L | 0.01 | 0.06 | <0.02 | 0.09 | 6 | 0.08 | 0.08 | 0.08 | 2 | 0.09 | 0.04 | 0.11 | 12 | 0.08 | 0.05 | 0.16 | 4 |
| Cadmium | mg/L | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Chromium | mg/L | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Cobalt | mg/L | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

**Table 6-77: Blackwater River (RPR-377) – Water Quality (cont'd)**

| | | 2002 | Historical Data (1971–1999) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Summer | Summer | | | | Fall | | | | Winter | | | | Spring | | | |
| Parameter | Units | July 24 | Median | Min. | Max. | *n* | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Dissolved Metals (cont'd)** | | | | | | | | | | | | | | | | | | |
| Copper | mg/L | 0.0019 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Iron | mg/L | 0.05 | 0.06 | – | – | 1 | – | – | – | – | 0.07 | – | – | 1 | – | – | – | – |
| Lead | mg/L | 0.0006 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lithium | mg/L | 0.002 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Manganese | mg/L | 0.002 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Mercury | mg/L | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Molybdenum | mg/L | 0.0005 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Nickel | mg/L | 0.0015 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Selenium | mg/L | 0.0005 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Silver | mg/L | <0.0002 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Strontium [2] | mg/L | 0.21 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Thallium | mg/L | <0.00005 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Titanium | mg/L | 0.0008 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0003 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Vanadium | mg/L | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Zinc | mg/L | *0.018* | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

NOTES:
N/A = not applicable
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline
W = concentration higher than the relevant drinking water guideline or beyond the recommended pH range
TCU = true colour unit
D>C = analytical detection limit is higher than the chronic aquatic life guideline (C)
a Calculated TDS value is reported
1 Ultra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for dissolved mercury and silver.
2 The accuracy of reported total and dissolved strontium levels is uncertain because irregularities in quality control sample results might indicate sample contamination
Boldface indicates values are higher than water quality guideline levels
Italicized font indicates that the accuracy of the reported dissolved metal concentration is uncertain because it exceeds the concentration reported for the corresponding total metal by more than 20%, indicating possible contamination

SOURCES: Historical data – Environment Canada (2003) [Station NW10HC0005 (extractable metals from Environment Canada are conservatively included in this table as total metals)]; GeoNorth and Golder 2000; Hatfield et al. 1972a; Interprovincial Pipeline Ltd. 1985; McCart 1974; McCart and McCart 1982; Shotton 1973; Slaney, F.F. and Company Ltd. 1974b

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | Historical Data (2000)[e] | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Particle Size** | | | | | | | | | | | | |
| Particle size – % sand | % | 17 | – | – | 68 | 80 | 74.5 | 36 | 16 | – | 37 | 60 |
| Particle size – % silt | % | 65 | – | – | 18 | 10 | 17 | 38 | 51 | – | 32 | 34 |
| Particle size – % clay | % | 19 | – | – | 14 | 10 | 9 | 27 | 33 | – | 31 | 6 |
| Moisture content | % | 30 | – | – | 35 | 40 | 57.5 | 56 | 80 | – | 63 | 79 |
| **Carbon Content** | | | | | | | | | | | | |
| Total inorganic carbon | % by wt | 1.9 | – | – | 0.2 | 0.08 | 0.1 | 0.1 | 0.1 | – | 0.1 | 0.1 |
| Total organic carbon | % by wt | 1.6 | – | – | 1.5 | 1.7 | 3.6 | 5.8 | 6.3 | – | 7.2 | 29.2 |
| Total carbon | % by wt | 3.4 | – | – | 1.7 | 1.7 | 3.7 | 5.9 | 6.4 | – | 7.3 | 29.3 |
| **Organic Compounds** | | | | | | | | | | | | |
| Total recoverable hydrocarbons | µg/g | 200 | – | – | 300 | 200 | 550 | 1,400 | 2,950 | – | 2,300 | 6,100 |
| Total volatile hydrocarbons ($C_5$–$C_{10}$) | µg/g | <0.5 | – | – | <0.5 | 1.2 | <0.5 | <0.5 | <0.5 | – | 11 | <0.5 |
| Total extractable hydrocarbons ($C_{11}$–$C_{30}$) | µg/g | <5 | – | – | 68 | 5 | <5 | 470 | 25 | – | 98 | 180 |

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake: RPR-046L, West Basin | Jimmy Lake: RPR-048L, South Basin[a] | Jimmy Lake | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Total Metals** | | | | | | | | | | | | |
| Aluminum | µg/g | 12,400 | – | – | 7,920 | 4,680 | 6,135 | 13,900 | 9,825 | 30,300 | 9,070 | 3,950 |
| Arsenic | µg/g | **8.4**[I] | – | – | **10.2**[I] | **8.2**[I] | **8.7**[I] | **12.6**[I] | **20.9**[P] | **76**[P] | **10.1**[I] | **8.8**[I] |
| Barium | µg/g | 401 | – | – | 247 | 298 | 276.5 | 267 | 221.5 | 1,700 | 284 | 180 |
| Beryllium | µg/g | 0.6 | – | – | 0.5 | 0.3 | 0.4 | 0.8 | 1 | 1.4 | 0.6 | 0.3 |
| Boron | µg/g | 9 | – | – | 3 | 4 | 4 | 5 | 4 | 86 | 4 | 6 |
| Cadmium | µg/g | **0.7**[I] | **5.2**[P] | – | 0.3 | 0.1 | 0.3 | **0.7**[I] | **1**[I] | **1.3**[I] | 0.5 | 0.6 |
| Calcium | µg/g | 48,100 | – | – | 2,100 | 1,600 | 4,500 | 3,900 | 4,600 | 4,190 | 7,000 | 7,800 |
| Chromium | µg/g | 34.9 | 7.5 | – | 12.2 | 9.3 | 12.2 | 24 | 24.3 | **52.3**[I] | 17.6 | 8.0 |
| Cobalt | µg/g | 10.2 | 11 | – | 10.4 | 5.9 | 6.1 | 18 | 28.5 | 38.5 | 9.5 | 7.5 |
| Copper | µg/g | 22 | 23 | – | 16 | 7.0 | 11.5 | 31 | **36.4**[I] | **64.8**[I] | 24.8 | 13.9 |
| Iron | µg/g | 23,900 | – | – | 23,200 | 17,400 | 13,600 | 31,500 | 34,800 | 112,000 | 23,100 | 9,600 |
| Lead | µg/g | 10.8 | 2.5 | – | 8.0 | 6.0 | 6.4 | 12.1 | 13.7 | 22.9 | 10.6 | 5.4 |
| Magnesium | µg/g | 19,000 | – | – | 2,260 | 1,110 | 2,655 | 3,620 | 3,580 | 5,440 | 2,990 | 1,590 |
| Manganese | µg/g | 392 | – | – | 388 | 484 | 327.5 | 451 | 320.5 | 19,300 | 511 | 147 |
| Mercury | µg/g | 0.1 | – | – | 0.1 | <0.05 | <0.1 | 0.1 | 0.1 | **0.4**[I] | <0.1 | <0.1 |
| Molybdenum | µg/g | 1.1 | – | – | 2.4 | 0.5 | 0.8 | 2.3 | 4.5 | 32.2 | 1.7 | 1.1 |
| Nickel | µg/g | 36.0 | – | – | 22.8 | 10 | 15.8 | 36.5 | 71.5 | 102 | 30.2 | 30.3 |
| Potassium | µg/g | 2,190 | – | – | 1,050 | 720 | 1,080 | 1,890 | 1,500 | – | 1,220 | 440 |
| Selenium | µg/g | 1 | – | – | 1 | 0.2 | 1 | 2 | 1.9 | <0.2 | 1.7 | 1 |

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Total Metals (cont'd)** | | | | | | | | | | | | |
| Silver | µg/g | 0.1 | – | – | <0.1 | <0.1 | <0.1 | <0.1 | <0.2 | 0.2 | <0.2 | <0.2 |
| Sodium | µg/g | 180 | – | – | 90 | 60 | 160 | 220 | 100 | – | 100 | 100 |
| Strontium | µg/g | 100 | – | – | 22 | 24 | 37 | 32 | 25.5 | 53 | 48 | 26 |
| Thallium | µg/g | 0.3 | – | – | 0.2 | 0.07 | 0.1 | 0.3 | 0.3 | 0.8 | 0.2 | 0.1 |
| Titanium | µg/g | 16.4 | – | – | 4.4 | 10.7 | 9.4 | 4.1 | 7 | – | 9 | 11 |
| Uranium | µg/g | 1.1 | – | – | 1.4 | 0.5 | 0.7 | 2 | 2.2 | 3.3 | 1.9 | 1.3 |
| Vanadium | µg/g | 39.6 | – | – | 24.5 | 18.7 | 26.8 | 42.5 | 25.2 | 119 | 25.2 | 13.1 |
| Zinc | µg/g | 102 | 112 | – | 94 | 56 | 50.5 | 158[j] | 198.5[j] | 314[j] | 103 | 216[j] |
| **Target PAHs and Alkylated PAHs** | | | | | | | | | | | | |
| Naphthalene | µg/g | **0.089**[j] | – | **0.138**[j] | 0.018 | 0.003 | 0.009 | 0.028 | 0.033 | 0.02 | 0.02 | 0.007 |
| $C_1$-substituted naphthalenes | µg/g | **0.287**[p] | – | **0.218**[p] | **0.053**[j] | 0.009 | **0.025**[j] | **0.084**[j] | **0.09**[j] | – | **0.062**[j] | 0.014 |
| $C_2$-substituted naphthalenes | µg/g | 0.394 | – | 0.222 | 0.099 | 0.009 | 0.034 | 0.135 | 0.176 | – | 0.099 | 0.11 |
| $C_3$-substituted naphthalenes | µg/g | 0.392 | – | – | 0.117 | 0.015 | 0.028 | 0.153 | 0.171 | – | 0.088 | 0.028 |
| $C_4$-substituted naphthalenes | µg/g | 0.253 | – | – | 0.079 | 0.011 | 0.014 | 0.094 | 0.13 | – | 0.055 | 0.02 |
| Acenaphthene | µg/g | 0.006[c] | – | **0.007**[j] | 0.003[c] | 0.0005 | 0.001 | 0.005[c] | 0.005 | <0.01[D,H] | 0.002 | 0.003 |

### Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake: RPR-046L, West Basin | Jimmy Lake: RPR-048L, South Basin[a] | Jimmy Lake: Historical Data (2000)[e] | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | | | | |
| $C_1$-substituted acenaphthene | µg/g | 0.001[c] | – | – | 0.001[c] | <0.0002 | 0.0004 | 0.001[c] | 0.001[c] | – | <0.0003 | <0.0002 |
| Acenaphthylene | µg/g | <0.0002 | – | 0.002 | <0.0003 | <0.0002 | 0.0003 | <0.0004 | <0.0004 | <0.01[D,i] | <0.0002 | <0.0003 |
| Anthracene | µg/g | 0.002 | – | 0.008 | 0.002 | 0.0002 | 0.0004 | 0.002 | 0.002 | – | 0.001 | 0.001 |
| Dibenzo(a,h) anthracene | µg/g | 0.006 | – | **0.022**[j] | <0.001 | <0.001 | 0.001 | <0.001 | 0.006[c] | <0.01[D,i] | 0.003[c] | 0.001[c] |
| Benzo(a)anthracene | µg/g | 0.009[c] | – | 0.024 | 0.005[c] | 0.001[c] | 0.002[c] | 0.008[c] | 0.009 | 0.02 | 0.003 | 0.001 |
| $C_1$-substituted benzo(a)anthracene / chrysene | µg/g | 0.339 | – | – | 0.167 | 0.031 | 0.092 | 0.207 | 0.229 | – | 0.183 | 0.129 |
| $C_2$-substituted benzo(a)anthracene / chrysene | µg/g | 0.054 | – | – | 0.029 | 0.004 | 0.005 | 0.037 | 0.05 | – | 0.057 | 0.024 |
| Benzo(a)pyrene | µg/g | 0.012 | – | **0.047**[j] | 0.006 | <0.001 | 0.001 | 0.008 | 0.01 | <0.01 | 0.005 | 0.001 |
| Benzo(e)pyrene | µg/g | – | – | 0.131 | | | | | | | | |
| $C_1$-substituted benzo(b&k) fluoranthene / benzo(a)pyrene | µg/g | 0.117 | – | – | 0.046 | 0.008 | 0.009 | 0.067 | 0.097 | – | 0.051 | 0.021 |

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | | | | |
| $C_2$-substituted benzo(b&k) fluoranthene / benzo(a)pyrene | µg/g | 0.021 | – | – | 0.01 | 0.001 | 0.002 | 0.007 | 0.033 | – | 0.024 | 0.011 |
| Benzofluoranthenes | µg/g | 0.036[f] | – | – | 0.021 | 0.005 | 0.005 | 0.03[f] | 0.031 | 0.01 | 0.017 | 0.006 |
| Benzo(b,j,k) fluoranthene | µg/g | – | – | 0.092 | – | – | – | – | – | – | – | – |
| Benzo(g,h,i)perylene | µg/g | 0.054 | – | 0.182 | 0.019 | 0.005[c] | 0.002[c] | 0.025[c] | 0.031 | 0.02 | 0.021 | 0.005[c] |
| Biphenyl | µg/g | 0.019 | – | – | 0.005 | 0.001 | 0.003 | 0.007 | 0.007 | – | 0.006 | 0.003 |
| $C_1$-substituted biphenyl | µg/g | <0.0003 | – | – | <0.0004 | <0.0002 | 0.001 | <0.0004 | 0.011 | – | 0.006 | 0.002 |
| $C_2$-substituted biphenyl | µg/g | 0.03 | – | – | 0.014 | 0.002 | 0.004 | 0.017 | 0.022 | – | 0.009 | 0.005 |
| Chrysene | µg/g | 0.05 | – | **0.105**[i] | 0.022 | 0.004 | 0.006 | 0.027 | 0.03 | – | 0.02 | 0.005[c] |
| Dibenzothiophene | µg/g | 0.012[c] | – | – | 0.005[c] | 0.001 | 0.001[c] | 0.005[c] | 0.004[c] | – | 0.002[c] | 0.001[c] |
| $C_1$-substituted dibenzothiophene | µg/g | 0.045 | – | – | 0.02 | 0.002 | 0.003 | 0.019 | 0.013 | – | 0.008 | 0.003 |
| $C_2$-substituted dibenzothiophene | µg/g | 0.063 | – | – | 0.028 | 0.004 | 0.004 | 0.03 | 0.02 | – | 0.011 | 0.005 |

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | | | | |
| $C_3$-substituted dibenzothiophene | µg/g | 0.037 | – | – | 0.02 | 0.002 | 0.002 | 0.021 | 0.013 | – | 0.007 | 0.003 |
| $C_4$-substituted dibenzothiophene | µg/g | 0.03 | – | – | 0.014 | 0.002 | 0.001 | 0.021 | 0.011 | – | 0.006 | 0.006 |
| Fluoranthene | µg/g | 0.016 | – | 0.036 | 0.013 | 0.002 | 0.002 | 0.016 | 0.016 | 0.01 | 0.006 | 0.003 |
| $C_1$-substituted fluoranthene / pyrene | µg/g | 0.1 | – | – | 0.053 | 0.009 | 0.01 | 0.071 | 0.079 | – | 0.031 | 0.012 |
| $C_2$-substituted fluoranthene / pyrene | µg/g | 0.104 | – | – | 0.054 | 0.011 | 0.014 | 0.068 | 0.08 | – | 0.039 | 0.013 |
| $C_3$-substituted fluoranthene / pyrene | µg/g | 0.069 | – | – | 0.034 | 0.007 | 0.007 | 0.054 | 0.028 | – | 0.017 | 0.007 |
| Fluorine | µg/g | 0.016 | – | **0.041**[f] | 0.006 | 0.001[c] | 0.001 | 0.009 | 0.008 | <0.01 | 0.005 | 0.006 |
| $C_1$-substituted fluorine | µg/g | 0.036 | – | – | 0.013 | 0.002 | 0.003 | 0.029 | 0.078 | – | 0.027 | 0.018 |
| $C_2$-substituted fluorine | µg/g | 0.092 | – | – | 0.039 | 0.006 | 0.007 | 0.061 | 0.161 | – | 0.055 | 0.034 |

**Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | | Summer | Summer | Summer | Summer | Summer | | Summer | Summer |
| | | July 30 | August 1 | Summer | July 27 | July 29 | July 30 | July 31 | July 23 | Fall | July 20 | July 26 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | | | | |
| $C_3$-substituted fluorine | µg/g | 0.11 | – | – | 0.049 | 0.011 | 0.015 | 0.076 | 0.186 | – | 0.069 | 0.038 |
| Indeno(1,2,3,cd) pyrene | µg/g | 0.01 | – | 0.022 | 0.007 | 0.001[c] | 0.001[c] | 0.008[c] | 0.009 | <0.01 | 0.005 | 0.002[c] |
| Phenanthrene | µg/g | **0.1**[i] | – | **0.25**[i] | 0.03 | 0.01 | 0.01 | 0.04 | 0.04 | 0.02 | 0.03 | 0.01 |
| $C_1$-substituted phenanthrene / anthracene | µg/g | 0.26 | – | – | 0.08 | 0.01 | 0.03 | 0.1 | 0.12 | – | 0.07 | 0.02 |
| $C_2$-substituted phenanthrene / anthracene | µg/g | 0.21 | – | – | 0.08 | 0.01 | 0.02 | 0.1 | 0.1 | – | 0.06 | 0.02 |
| $C_3$-substituted phenanthrene / anthracene | µg/g | 0.13 | – | – | 0.06 | 0.01 | 0.01 | 0.06 | 0.06 | – | 0.04 | 0.01 |
| $C_4$-substituted phenanthrene / anthracene | µg/g | 0.25 | – | – | 0.13 | 0.1 | 0.05 | 0.18 | 0.13 | – | 0.1 | 0.06 |
| 1-Methyl-7-isopropyl-phenanthrene (Retene) | µg/g | 0.09 | – | – | 0.04 | 0.09 | 0.03 | 0.09 | 0.03 | – | 0.05 | 0.03 |

Table 6-49: Taglu and Storm Hills Laterals – Sediment Quality (cont'd)

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | Unnamed Stream (RPR-048) | Inflow to Yaya Lake (RPR-007)[a] | Yaya Lake (RPR-007L)[a] | Jimmy Lake | | | Unnamed Lake (RPR-006) | Unnamed Lake (RPR-035)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | RPR-046L, West Basin | RPR-048L, South Basin[a] | | | |
| | | 2002 | Historical Data (1972)[d] | Historical Data (1987)[f] | 2002 | 2002 | 2002 | 2002 | 2003 | Historical Data (2000)[e] | 2003 | 2003 |
| | | Summer | Summer | Summer | Summer | Summer | Summer | Summer | Summer | Fall | Summer | Summer |
| | | July 30 | August 1 | | July 27 | July 29 | July 30 | July 31 | July 23 | | July 20 | July 26 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | | | | |
| Pyrene | µg/g | 0.036 | – | **0.064**[I] | 0.018 | 0.003 | 0.004 | 0.024 | 0.022 | 0.02 | 0.011 | 0.003 |

NOTES:
– = not available, i.e., no data for that parameter
I = concentration higher than the interim sediment quality guideline value (CCME 1999)
P = concentration higher than the probable effect level (CCME 1999)
D>I = analytical detection limit is higher than the interim sediment quality guideline value (I)
a Concentration calculated as average of split samples
b PAH values are median of split sample
c PAH concentrations are reported with the limitation that the GCMS spectra used to develop these values were ill-defined, i.e., these numbers might contain a larger degree of error than those produced from clearly defined spectra
Boldface indicates values higher than the relevant sediment quality guideline levels

SOURCES:
d Wagemann et al. (1977)
e Golder Associates (2000b)
f PAH data of suspended particulates from Yunker and MacDonald (1995). Concentrations shown are mean values of 10 TSS samples from three principal channels

**Table 6-41: East Channel, Mackenzie River and Holmes Creek – Water Quality (Excluding Metals and PAHs)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | | | | Holmes Creek (Site 23)[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | July 30, 2002[a] | Historical Data (1972–1987)[3] | | | | | July 28, 2002 | Historical Data (1973–1975)[4] | | | |
| | | | Summer | | Winter | | | | Summer | | Winter | |
| | | | Range or Value | n | Median | Range | n | | Range or Value | n | Value | n |
| **Field Measured** | | | | | | | | | | | | |
| pH | N/A | 7.8 | 8.0-8.0 | 2 | 8.2 | 8.0-**8.8**[W] | 5 | 7.8 | 7.1 | 1 | 7.4 | 1 |
| Conductance | µS/cm | 240 | – | – | 277 | 190-301 | 5 | 57 | >8000 | 1 | <50 | 1 |
| Temperature | °C | 14.1 | 15 | 1 | -1 | – | 1 | 9.9 | 9.5-9.5 | 2 | 13 | 1 |
| Dissolved oxygen | mg/L | 9.3 | 9.0-10.0 | 2 | **5.2**[C] | – | 1 | 10.6 | 11.0 | 1 | 9.4 | 1 |
| **Conventional Parameters** | | | | | | | | | | | | |
| Colour | TCU | **28**[W] | – | – | – | – | – | **50**[W] | – | – | – | – |
| Conductance | µS/cm | 272 | – | – | – | – | – | 55 | – | – | – | – |
| Dissolved organic carbon | mg/L | 5 | – | – | – | – | – | 10 | – | – | – | – |
| Hardness | mg/L | 124 | 112-120 | 3 | 127 | 125-131 | 4 | 23 | – | – | – | – |
| pH | N/A | 7.8 | 8.2 | 1 | – | – | – | 7.1 | – | – | – | – |
| Total alkalinity | mg/L | 90 | 100-137 | 3 | 124 | 123-124 | 4 | 20 | – | – | – | – |
| Total dissolved solids | mg/L | 149[C] | – | – | – | – | – | 29[C] | – | – | – | – |
| Total organic carbon | mg/L | 6 | 18 | 1 | 9 | 4-11 | 4 | 11 | – | – | – | – |
| Total suspended solids | mg/L | 200 | 51-205 | 2 | 6 | 4-7 | 3 | <3 | – | – | – | – |
| **Major Ions** | | | | | | | | | | | | |
| Bicarbonate | mg/L | 109 | – | – | – | – | – | 24 | – | – | – | – |
| Calcium | mg/L | 34 | – | – | 34 | 34-34 | 4 | 6 | – | – | – | – |
| Carbonate | mg/L | <5 | – | – | – | – | – | <5 | – | – | – | – |
| Chloride | mg/L | 5 | 11 | 1 | 12 | 11-13 | 4 | 3 | – | – | – | – |
| Magnesium | mg/L | 9 | – | – | 10 | 10-12 | 4 | 2 | – | – | – | – |

**Table 6-41: East Channel, Mackenzie River and Holmes Creek – Water Quality (Excluding Metals and PAHs) (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | | | | | Holmes Creek (Site 23)[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | July 30, 2002[a] | Historical Data (1972–1987)[3] | | | | | July 28, 2002 | Historical Data (1973–1975)[4] | | | |
| | | | Summer | | Winter | | | | Summer | | Winter | |
| | | | Range or Value | n | Median | Range | n | | Range or Value | n | Value | n |
| **Major Ions (cont'd)** | | | | | | | | | | | | |
| Potassium | mg/L | 1 | – | – | – | – | – | 1 | – | – | – | – |
| Sodium | mg/L | 6 | – | – | – | – | – | 2 | – | – | – | – |
| Sulphate | mg/L | 40 | 26 | 1 | 49 | 35-64 | 4 | 3 | – | – | – | – |
| Sulphide | mg/L | 0.004 | – | – | – | – | – | 0.005 | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | |
| Nitrate + nitrite | mg/L | <0.1 | – | – | – | – | – | <0.1 | – | – | – | – |
| Nitrate | mg/L | – | 0.118-0.124 | 2 | – | – | – | – | – | – | – | – |
| Nitrogen – ammonia | mg/L | <0.05 | – | – | – | – | – | <0.05 | – | – | – | – |
| Nitrogen – Kjeldahl | mg/L | 1.4 | – | – | – | – | – | 0.8 | – | – | – | – |
| Phosphorus – total | mg/L | 0.118 | – | – | – | – | – | 0.02 | – | – | – | – |
| Phosphorus – dissolved | mg/L | 0.005 | – | – | – | – | – | 0.01 | – | – | – | – |

NOTES:
N/A = not applicable
– = not available, i.e., no data for that parameter
C = concentration higher than the relevant chronic aquatic life guideline value or outside the recommended dissolved oxygen range
W = concentration higher than the relevant drinking water guideline value or beyond the recommended pH range
n = number of samples
TCU = true colour unit
a Reported value is the average of two split samples
b Site is not crossed by the revised pipeline route
c Calculated total dissolved solids value is reported, as the laboratory-measured value might be somewhat overestimated
Boldface indicates values higher than water quality guideline levels

SOURCES:
Historical data –
3 MacDonald et al. 1988; Mann and Snyder 1975; Slaney, F.F. and Company Ltd. 1974a
4 McCart 1974; McCart et al. 1976

**Table 6-42: East Channel, Mackenzie River and Holmes Creek – Water Quality (Metals and PAHs)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | Holmes Creek (Site 23)[a] |
|---|---|---|---|---|
| | | July 30, 2002[b] | Historical Data (1972–1987)[c] Summer (n = 1) | July 28, 2002 |
| **Total Metals** | | | | |
| Aluminum | mg/L | **5.56**[C,W] | – | 0.1 |
| Antimony | mg/L | 0.001 | – | 0.0014 |
| Arsenic | mg/L | 0.0021 | – | 0.001 |
| Barium | mg/L | 0.156 | – | 0.041 |
| Beryllium | mg/L | <0.001 | – | <0.001 |
| Boron | mg/L | <0.02 | – | <0.02 |
| Cadmium | mg/L | <0.0002[D<C] | – | <0.0002[D<C] |
| Chromium | mg/L | **0.0075**[C] | – | <0.0008 |
| Cobalt | mg/L | 0.0028 | – | 0.0007 |
| Copper | mg/L | **0.007**[C] | – | 0.002 |
| Iron | mg/L | **5.66**[C,W] | – | **0.48**[C,W] |
| Lead | mg/L | **0.0053**[C] | – | 0.0003 |
| Lithium | mg/L | 0.008 | – | <0.006 |
| Manganese | mg/L | **0.091**[W] | – | 0.016 |
| Mercury[1] | mg/L | 0.0000074 | – | <0.0000006 |
| Molybdenum | mg/L | 0.0016 | – | 0.0004 |
| Nickel | mg/L | 0.0089 | – | 0.0022 |
| Selenium | mg/L | <0.0004 | – | 0.0004 |
| Silver[1] | mg/L | 0.00005 | – | 0.000014 |
| Strontium[2] | mg/L | 0.22 | – | 0.02 |
| Thallium | mg/L | 0.0001 | – | <0.0001 |
| Titanium | mg/L | 0.0495 | – | <0.005 |
| Uranium | mg/L | 0.001 | – | <0.0001 |
| Vanadium | mg/L | 0.0198 | – | 0.0004 |
| Zinc | mg/L | **0.06**[C] | – | 0.004 |
| **Dissolved Metals** | | | | |
| Aluminum | mg/L | 0.07 | – | 0.01 |
| Antimony | mg/L | 0.0005 | – | 0.0004 |
| Arsenic | mg/L | 0.0006 | – | 0.0009 |
| Barium | mg/L | 0.057 | – | 0.044 |
| Beryllium | mg/L | <0.001 | – | <0.001 |
| Boron | mg/L | 0.01 | – | 0.01 |
| Cadmium | mg/L | <0.0001 | – | <0.0001 |
| Chromium | mg/L | 0.0005 | – | *0.0063* |
| Cobalt | mg/L | 0.0001 | – | <0.0001 |
| Copper | mg/L | 0.0021 | – | 0.0023 |
| Iron | mg/L | 0.06 | – | 0.32 |

**Table 6-42: East Channel, Mackenzie River and Holmes Creek – Water Quality (Metals and PAHs) (cont'd)**

| Parameter | Units | Mackenzie River, East Channel (RPR-013) | | Holmes Creek (Site 23)[a] |
|---|---|---|---|---|
| | | July 30, 2002[b] | Historical Data (1972–1987)[c] Summer (n = 1) | July 28, 2002 |
| **Dissolved Metals (cont'd)** | | | | |
| Lead | mg/L | 0.0003 | – | – |
| Lithium | mg/L | 0.005 | – | 0.002 |
| Manganese | mg/L | 0.002 | – | 0.009 |
| Mercury | mg/L | <0.0001 | – | <0.0001 |
| Molybdenum | mg/L | 0.0013 | – | 0.0004 |
| Nickel | mg/L | 0.0007 | – | 0.0016 |
| Selenium | mg/L | 0.0005 | – | <0.0004 |
| Silver | mg/L | <0.0002 | – | <0.0002 |
| Strontium[2] | mg/L | 0.19 | – | *0.07* |
| Thallium | mg/L | <0.00005 | – | <0.00005 |
| Titanium | mg/L | 0.0022 | – | <0.0003 |
| Uranium | mg/L | 0.0008 | – | <0.0001 |
| Vanadium | mg/L | 0.0006 | – | *0.0026* |
| Zinc | mg/L | <0.002 | – | 0.002 |
| **Target PAHs and Alkylated PAHs** | | | | |
| Naphthalene | µg/L | – | 0.2 | – |
| Acenaphthene | µg/L | – | 0.03 | – |
| Fluorine | µg/L | – | 0.032 | – |

NOTES:
– = not available, i.e., no data for that parameter
C = concentration higher than the relevant chronic aquatic life guideline value or outside the recommended dissolved oxygen range
D>C = analytical detection limit is higher than the relevant chronic aquatic life guideline value (C)
W = concentration higher than the relevant drinking water guideline value or beyond the recommended pH range
n = number of samples
a Site is not crossed by the revised pipeline route
b Reported value is the average of two split samples
1 Ultra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for the dissolved mercury and silver analysis
2 The accuracy of reported total and dissolved strontium levels is uncertain because of irregularities in QC sample results, which might indicate sample contamination
Boldface indicates values higher than water quality guideline levels
Italicized font indicates that the accuracy of the reported dissolved metal concentration is uncertain because it exceeds the concentration reported for the corresponding total metal by more than 20%, which indicates possible contamination

SOURCES:
Historical data –
c Carey et al. 1990

## Table 6-82: Mackenzie River Downstream of the Liard River (RPR-465.5 and RPR-465.6) – Water Quality

| Parameter | Units | Mackenzie River - West Side (RPR-465.5) | Mackenzie River - East Side (RPR-465.6) | Mackenzie River, Downstream of the Liard River | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | 2002 | Historical Data (1960–1974) | | | | | | | | | | | | | | | |
| | | Fall | Fall | Fall | | | | Winter | | | | Spring | | | | Summer | | | |
| | | September 13 | September 13 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Field Measured** | | | | | | | | | | | | | | | | | | | |
| pH | N/A | 8.8 | 8.8 | 8 | 7.9 | 8.1 | 2 | 7.9 | 7.8 | 8.3 | 6 | 8 | 7.7 | 8.3 | 4 | 8 | 7.6 | 8.1 | 7 |
| Conductance | µS/cm | 268 | 234 | 197 | – | – | 1 | 198 | 190 | 240 | 6 | 194 | 105 | 205 | 4 | 205 | 188 | 220 | 4 |
| Temperature | °C | 11.3 | 12.8 | 11 | 9.5 | 21.8 | 5 | 4.4 | 0 | 23.4 | 11 | 18.9 | 1 | 23.2 | 5 | 16 | 5.6 | 24 | 29 |
| Dissolved oxygen | mg/L | 7.7 | 7.6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | |
| Colour | TCU | **25**[V] | **20**[V] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Conductance | µS/cm | 278 | 242 | 223 | 150 | 278 | 5 | 239 | 142 | 413 | 15 | 176 | 137 | 285 | 4 | 235 | 170 | 441 | 31 |
| Dissolved organic carbon | mg/L | 4 | 7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hardness | mg/L | 143 | 107 | 97 | 95 | 136 | 3 | 108 | 98 | 197 | 8 | 94 | 91 | 102 | 4 | 100 | 83 | 190 | 26 |
| pH | N/A | 8.1 | 8.1 | 8 | 7.6 | 8.2 | 5 | 8 | 7.3 | 8.5 | 14 | 7.8 | 7.6 | 8.1 | 5 | 8 | 7.3 | **8.6**[V] | 31 |
| Total alkalinity | mg/L | 102 | 83 | 77 | 76 | 103 | 4 | 85 | 76 | 168 | 11 | 71 | 70 | 76 | 4 | 79 | 64 | 173 | 30 |
| Total dissolved solids | mg/L | 157[*] | 132[*] | – | – | – | – | – | – | – | – | – | – | – | – | 145 | – | – | 1 |
| Total organic carbon | mg/L | 6 | 7 | 7 | 5 | 10 | 4 | 6 | <1 | 11 | 12 | 8 | 6 | 19 | 4 | 8 | 5 | 30 | 25 |
| Total suspended solids | mg/L | 48 | 12 | – | – | – | – | 3 | <1 | 169 | 9 | 292 | 24 | 560 | 2 | 13 | 3 | 107 | 11 |
| **Major Ions** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | 125 | 101 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Calcium | mg/L | 40 | 31 | 29 | 27 | 39 | 4 | 32 | 27 | 54 | 11 | 30 | 29 | 33 | 4 | 30 | 14 | 58 | 29 |
| Carbonate | mg/L | <5 | <5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Chloride | mg/L | 1 | 6 | 8 | 1 | 8 | 5 | 8 | 3 | 10 | 15 | 8 | 7 | 10 | 4 | 7 | 1 | 55 | 31 |
| Magnesium | mg/L | 11 | 8 | 7 | – | – | 1 | 7 | 6 | 7 | 3 | – | – | – | – | 6 | 6 | 7 | 4 |
| Potassium | mg/L | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 2 | 15 | 1 | 1 | 2 | 4 | 1 | 1 | 1 | 17 |
| Sodium | mg/L | 3 | 8 | 7 | 7 | 8 | 4 | 8 | 4 | 9 | 15 | 7 | 7 | 9 | 4 | 7 | 2 | 10 | 17 |
| Sulphate | mg/L | 40 | 29 | 25 | 23 | 33 | 5 | 24 | 20 | 41 | 15 | 24 | 22 | 33 | 4 | 24 | 14 | 43 | 31 |
| Sulphide | mg/L | 0.003 | 0.004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

## Table 6-82: Mackenzie River Downstream of the Liard River (RPR-465.5 and RPR-465.6) – Water Quality (cont'd)

| Parameter | Units | Mackenzie River - West Side (RPR-465.5) | Mackenzie River - East Side (RPR-465.6) | Mackenzie River, Downstream of the Liard River | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | 2002 | Historical Data (1960–1974) | | | | | | | | | | | | | | | |
| | | Fall | Fall | Fall | | | | Winter | | | | Spring | | | | Summer | | | |
| | | September 13 | September 13 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Nutrients** | | | | | | | | | | | | | | | | | | | |
| Nitrate + nitrite | mg/L | <0.1 | <0.1 | 0.4 | 0.03 | 0.5 | 3 | 0.2 | 0.1 | 0.6 | 7 | 0.1 | 0.03 | 0.2 | 4 | 0.03 | <0.001 | 0.4 | 24 |
| Nitrogen – ammonia | mg/L | <0.05 | <0.05 | – | – | – | – | 0.3 | 0.1 | 0.3 | 3 | – | – | – | – | 0.1 | <0.1 | 0.3 | 4 |
| Nitrogen – Kjeldahl | mg/L | 0.4 | 0.4 | 0.6 | – | – | 1 | 0.5 | 0.4 | 1.6 | 8 | 0.5 | <0.5 | 0.9 | 4 | <0.5 | <0.5 | 0.5 | 9 |
| Phosphorus – total | mg/L | 0.052 | 0.013 | 0.019 | <0.003 | 1.1 | 3 | 0.015 | 0.009 | 0.028 | 6 | 0.012 | 0.009 | 0.037 | 3 | 0.04 | 0.008 | 2 | 22 |
| Phosphorus – dissolved | mg/L | 0.002 | 0.002 | 0.011 | <0.003 | 0.019 | 2 | <0.003 | – | – | 1 | – | – | – | – | <0.003 | – | – | 1 |
| **Total Metals** | | | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | **3.64**[C,W] | **0.54**[C,W] | – | – | – | – | **0.16**[C,W] | – | – | 1 | – | – | – | – | – | – | – | – |
| Antimony | mg/L | 0.0007 | 0.0006 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | 0.0018 | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Barium | mg/L | 0.103 | 0.046 | – | – | – | – | <0.1 | – | – | 1 | – | – | – | – | – | – | – | – |
| Beryllium | mg/L | <0.001 | <0.001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boron | mg/L | <0.02 | <0.02 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Cadmium | mg/L | <0.0002[D<C] | <0.0002[D<C] | <0.001[D<C] | <0.001[D<C] | **0.003**[C] | 3 | <0.001[D<C] | <0.001[D<C] | **0.004**[C] | 10 | <0.001[D<C] | <0.001[D<C] | **0.002**[C] | 4 | <0.001[D<C] | <0.001[D<C] | **0.006**[C,W] | 9 |
| Chromium | mg/L | **0.0149**[C] | <0.0008 | <0.01[D<C] | <0.01[D<C] | <0.015[D<C] | 3 | <0.01[D<C] | <0.01[D<C] | <0.015[D<C] | 10 | <0.01[D<C] | <0.01[D<C] | <0.01[D<C] | 4 | <0.01[D<C] | <0.01[D<C] | <0.01[D<C] | 9 |
| Cobalt | mg/L | 0.0012 | <0.0002 | 0.002 | <0.001 | 0.002 | 3 | 0.0015 | <0.001 | 0.005 | 10 | 0.0015 | <0.001 | 0.009 | 4 | 0.002 | <0.001 | 0.004 | 9 |
| Copper | mg/L | **0.015**[C] | 0.002 | **0.003**[C] | 0.002 | **0.005**[C] | 3 | 0.002 | <0.001 | <0.01[D<C] | 13 | **0.0025**[C] | 0.002 | **0.004**[C] | 4 | **0.004**[C] | **0.002** | <0.01[D<C] | 14 |
| Iron | mg/L | **2.53**[C,W] | **0.39**[C,W] | 0.14 | 0.11 | **0.88**[C,W] | 3 | 0.13 | <0.05 | **0.38**[C,W] | 13 | **0.54**[C,W] | **0.45**[C,W] | **0.79**[C,W] | 4 | **0.39**[C,W] | 0.1 | **0.7**[C,W] | 12 |
| Lead | mg/L | 0.0017 | 0.0005 | **0.0275**[C,W] | 0.005[C] | <0.05[D<C,W] | 2 | <0.001 | <0.001 | **0.014**[C,W] | 10 | **0.003**[C] | <0.001 | **0.005**[C] | 4 | <0.0015 | <0.001 | **0.03**[C,W] | 10 |
| Lithium | mg/L | 0.009 | <0.006 | 0.005 | <0.005 | 0.006 | 3 | 0.005 | <0.005 | 0.007 | 10 | 0.005 | <0.005 | 0.005 | 4 | 0.005 | <0.005 | 0.008 | 9 |
| Manganese | mg/L | 0.034 | 0.008 | <0.01 | <0.01 | <0.01 | 3 | <0.01 | 0.007 | 0.01 | 12 | 0.02 | 0.02 | 0.03 | 4 | <0.01 | <0.01 | **0.08**[W] | 12 |
| Mercury [1] | mg/L | 0.0000055 | 0.0000017 | <0.00005 | – | – | 1 | <0.00005 | <0.00005 | 0.00008 | 4 | <0.00005 | – | – | 1 | 0.000065 | <0.00005 | 0.00008 | 2 |
| Molybdenum | mg/L | 0.0016 | 0.0008 | <0.05 | <0.05 | <0.1[D<C] | 3 | <0.05 | <0.05 | **0.56**[C] | 10 | <0.05 | <0.05 | <0.05 | 4 | <0.05 | <0.05 | <0.05 | 9 |
| Nickel | mg/L | 0.0047 | 0.0014 | 0.006 | 0.006 | 0.008 | 3 | 0.004 | <0.001 | 0.008 | 10 | 0.006 | 0.006 | 0.006 | 4 | 0.007 | <0.001 | 0.021 | 9 |
| Selenium | mg/L | **0.0026**[C] | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Silver [1] | mg/L | 0.000054 | 0.000016 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Strontium [2] | mg/L | 0.17 | 0.14 | 0.12 | 0.09 | 0.13 | 3 | 0.15 | 0.1 | 0.22 | 10 | 0.12 | 0.1 | 0.13 | 4 | 0.14 | 0.09 | 0.18 | 9 |

**Table 6-82: Mackenzie River Downstream of the Liard River (RPR-465.5 and RPR-465.6) – Water Quality (cont'd)**

| Parameter | Units | Mackenzie River - West Side (RPR-465.5) | Mackenzie River - East Side (RPR-465.6) | Mackenzie River, Downstream of the Liard River | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | 2002 | Historical Data (1960–1974) | | | | | | | | | | | | | | | |
| | | Fall | Fall | Fall | | | | Winter | | | | Spring | | | | Summer | | | |
| | | September 13 | September 13 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Total Metals (cont'd)** | | | | | | | | | | | | | | | | | | | |
| Thallium | mg/L | <0.0001 | <0.0001 | – | – | – | – | <0.1[D,C] | – | – | 1 | – | – | – | – | – | – | – | – |
| Titanium | mg/L | 0.049 | 0.009 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0013 | 0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Vanadium | mg/L | 0.0161 | 0.0011 | <0.05 | <0.05 | <0.05 | 3 | <0.05 | <0.05 | <0.05 | 10 | <0.05 | <0.05 | 0.06 | 4 | <0.05 | <0.05 | <0.05 | 9 |
| Zinc | mg/L | 0.02 | 0.014 | 0.007 | 0.002 | **0.035**[E] | 3 | 0.002 | 0.001 | <0.01 | 13 | 0.009 | 0.003 | 0.01 | 4 | 0.01 | <0.001 | 0.03 | 13 |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.03 | <0.01 | – | – | – | – | 0.01 | <0.01 | 0.04 | 3 | – | – | – | – | 0.02 | <0.01 | 0.09 | 4 |
| Antimony | mg/L | 0.0007 | 0.0007 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | <0.0004 | <0.0004 | 0.0028 | 0.0006 | <0.005 | 2 | 0.005 | 0.0006 | 0.01 | 7 | <0.005 | <0.0005 | <0.005 | 4 | <0.005 | <0.0005 | 0.007 | 8 |
| Barium | mg/L | 0.049 | 0.042 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Beryllium | mg/L | <0.001 | <0.001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boron | mg/L | <0.002 | 0.003 | 0.04 | <0.01 | 0.04 | 3 | 0.04 | 0.01 | 0.06 | 11 | 0.05 | 0.05 | 0.07 | 4 | 0.03 | <0.01 | 0.05 | 6 |
| Cadmium | mg/L | <0.0001 | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | <0.001 | – | – | 1 |
| Cobalt | mg/L | 0.0001 | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Copper | mg/L | 0.0012 | 0.0022 | 0.002 | – | – | 1 | 0.01 | – | – | 1 | 0.007 | – | – | 1 | 0.002 | <0.001 | <0.01 | 17 |
| Iron | mg/L | 0.02 | 0.01 | 0.02 | – | – | 1 | <0.01 | <0.01 | 0.01 | 4 | 0.06 | – | – | 1 | 0.02 | <0.001 | 0.38 | 23 |
| Lead | mg/L | 0.0002 | 0.0002 | 0.018 | – | – | 1 | <0.001 | – | – | 1 | <0.01 | – | – | 1 | <0.001 | <0.001 | 0.009 | 17 |
| Lithium | mg/L | 0.004 | 0.004 | – | – | – | – | – | – | – | – | – | – | – | – | 0.005 | – | – | 1 |
| Manganese | mg/L | 0.001 | <0.001 | <0.01 | – | – | 1 | <0.01 | <0.01 | <0.01 | 4 | <0.01 | – | – | 1 | <0.01 | <0.01 | 0.01 | 22 |
| Mercury | mg/L | <0.0001 | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Molybdenum | mg/L | 0.0012 | 0.0007 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Nickel | mg/L | 0.0013 | 0.0011 | 0.008 | – | – | 1 | – | – | – | – | – | – | – | – | <0.002 | – | – | 1 |
| Selenium | mg/L | <0.0004 | <0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Silver | mg/L | <0.0002 | <0.0002 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Strontium [1] | mg/L | 0.15 | 0.14 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Thallium | mg/L | <0.00005 | <0.00005 | – | – | – | – | – | – | – | – | – | – | – | – | <0.005 | – | – | 1 |

## Table 6-82: Mackenzie River Downstream of the Liard River (RPR-465.5 and RPR-465.6) – Water Quality (cont'd)

| Parameter | Units | Mackenzie River - West Side (RPR-465.5) | Mackenzie River - East Side (RPR-465.6) | Mackenzie River, Downstream of the Liard River | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | 2002 | Historical Data (1960–1974) | | | | | | | | | | | | | | | |
| | | Fall | Fall | Fall | | | | Winter | | | | Spring | | | | Summer | | | |
| | | September 13 | September 13 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Dissolved Metals (cont'd)** | | | | | | | | | | | | | | | | | | | |
| Titanium | mg/L | <0.0003 | <0.0003 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0011 | 0.0004 | – | – | – | – | – | – | – | – | – | – | – | – | 0.0004 | – | – | 1 |
| Vanadium | mg/L | <0.0001 | <0.0001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Zinc | mg/L | 0.007 | 0.007 | 0.005 | – | – | 1 | 0.017 | – | – | 1 | <0.001 | – | – | 1 | 0.002 | <0.001 | <0.01 | 17 |
| **Organic Compounds** | | | | | | | | | | | | | | | | | | | |
| Phenol | mg/L | <0.001 | <0.001 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

NOTES:
N/A = not applicable
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline
W = concentration higher than the relevant drinking water guideline or beyond the recommended pH range
TCU = true colour unit
D>C = analytical detection limit is higher than the chronic aquatic life guideline (C)
D>W = analytical detection limit is higher than the relevant drinking water guideline (W)
a Calculated TDS value is reported
1 Ultra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for dissolved mercury and silver.
2 The accuracy of reported total and dissolved strontium levels is uncertain because irregularities in quality control sample results might indicate sample contamination
Boldface indicates values are higher than water quality guideline levels

SOURCES: Historical data – Environment Canada (2003) [Station NW10FB0005 (extractable metals from Environment Canada are conservatively included in this table as total metals)]

**Table 6-78: Ochre River (RPR-391) and River Between Two Mountains (RPR-419) – Water Quality (Excluding Metals)**

| | | Ochre River (RPR-391) | | | | | | | | | | River Between Two Mountains (RPR-419) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1971–1999) | | | | | | | | | 2002 | Historical Data (1971–1981) | | | | | |
| | | Summer | Summer | | | Fall | | | Winter | | | Summer | Summer | | Fall | | Winter | |
| Parameter | Units | July 25 | Median | Range | n | Median | Range | n | Median | Range | n | July 26 | Range or Value | n | Range or Value | n | Range or Value | n |
| **Field Measured** | | | | | | | | | | | | | | | | | | |
| pH | N/A | 7.3 | 8.2 | 7.8-**8.8**$^{W}$ | 10 | 8.5 | 7.8-8.5 | 3 | 7.8 | 7.6-7.8 | 3 | 8 | 8.3-8.4 | 2 | – | – | 6.7-7.9 | 2 |
| Conductance | µS/cm | 345 | 260 | 105-380 | 9 | 330 | – | 1 | 595 | 380-810 | 2 | 184 | 120-140 | 2 | – | – | 325-700 | 2 |
| Temperature | °C | 22.6 | 16 | 8.5-20.5 | 15 | 6 | 3-9 | 5 | 2.8 | 1.5-4 | 2 | 21.6 | 15.5-21 | 6 | 4-12 | 4 | 0-0.5 | 2 |
| Dissolved oxygen | mg/L | 9.2 | 10.8 | 9-11.8 | 11 | 11.6 | 9-11.6 | 3 | 10.4 | **6**$^{C}$-16 | 3 | 9.0 | 9.4-10.2 | 2 | 12-12 | 2 | 9.4-12.4 | 2 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | |
| Colour | TCU | **60**$^{W}$ | – | – | – | – | – | – | – | – | – | **50**$^{W}$ | – | – | – | – | – | – |
| Conductance | µS/cm | 343 | 550 | – | 1 | – | – | – | – | – | – | 186 | 187 | 1 | – | – | – | – |
| Dissolved organic carbon | mg/L | 9 | – | – | – | – | – | – | – | – | – | 10 | – | – | – | – | – | – |
| Hardness | mg/L | 154 | 68 | 68-195 | 3 | – | – | – | – | – | – | 91 | 78 | 1 | – | – | – | – |
| pH | N/A | 8.2 | 8.5 | – | 1 | – | – | – | – | – | – | 7.9 | 8 | 1 | – | – | – | – |
| Total alkalinity | mg/L | 127 | 94 | 68-156 | 6 | – | – | – | – | – | – | 75 | 66 | 1 | – | – | – | – |
| Total dissolved solids | mg/L | 240 | – | – | – | – | – | – | – | – | – | 111$^{a}$ | – | – | 167 | 1 | – | – |
| Total organic carbon | mg/L | 11 | – | – | – | – | – | – | – | – | – | 12 | – | – | – | – | – | – |
| Total suspended solids | mg/L | <3 | – | – | – | – | – | – | 8 | – | 1 | 12 | – | – | 1 | 1 | 2 | 1 |
| **Major Ions** | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | 154 | 190 | – | 1 | 0.3 | – | 1 | 222 | – | 1 | 91 | 81 | 1 | 0.3 | 1 | 115 | 1 |
| Calcium | mg/L | 39 | 52 | – | 1 | – | – | – | 55 | – | 1 | 23 | 22 | 1 | – | – | 38 | 1 |
| Carbonate | mg/L | <5 | – | – | – | – | – | – | – | – | – | <5 | – | – | – | – | – | – |
| Chloride | mg/L | 15 | 42 | – | 1 | – | – | – | 3 | – | 1 | 2 | 3 | 1 | – | – | – | – |

**Table 6-78: Ochre River (RPR-391) and River Between Two Mountains (RPR-419) – Water Quality (Excluding Metals) (cont'd)**

| | | Ochre River (RPR-391) | | | | | | | | | | River Between Two Mountains (RPR-419) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1971–1999) | | | | | | | | | 2002 | Historical Data (1971–1981) | | | | | |
| | | Summer | Summer | | | Fall | | | Winter | | | Summer | Summer | | Fall | | Winter | |
| Parameter | Units | July 25 | Median | Range | n | Median | Range | n | Median | Range | n | July 26 | Range or Value | n | Range or Value | n | Range or Value | n |
| **Major Ions (cont'd)** | | | | | | | | | | | | | | | | | | |
| Magnesium | mg/L | 14 | 16 | – | 1 | – | – | – | 17 | – | 1 | 8 | 6 | 1 | – | – | 14 | 1 |
| Potassium | mg/L | 1 | 1 | – | 1 | – | – | – | 1 | – | 1 | 4 | 1 | 1 | – | – | 12 | 1 |
| Sodium | mg/L | 15 | 30 | – | 1 | – | – | – | 6 | – | 1 | 4 | 4 | 1 | – | – | 12 | 1 |
| Sulphate | mg/L | 34 | 49 | – | 1 | – | – | – | 33 | – | 1 | 25 | 12 | 1 | – | – | 47 | 1 |
| Sulphide | mg/L | <0.003 | – | – | – | – | – | – | – | – | – | 0.004 | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | | | |
| Nitrate + nitrite | mg/L | <0.1 | – | – | – | – | – | – | – | – | – | <0.1 | – | – | – | – | – | – |
| Nitrate | mg/L | – | – | – | – | – | – | – | 0.21 | – | 1 | – | – | – | – | – | **25**[W] | 1 |
| Nitrogen – ammonia | mg/L | <0.05 | – | – | – | – | – | – | – | – | – | <0.05 | – | – | – | – | – | – |
| Nitrogen – Kjeldahl | mg/L | 0.8 | – | – | – | – | – | – | – | – | – | 0.8 | – | – | – | – | – | – |
| Phosphorus – total | mg/L | 0.005 | – | – | – | – | – | – | – | – | – | 0.012 | – | – | – | – | – | – |
| Phosphorus – dissolved | mg/L | 0.004 | – | – | – | – | – | – | – | – | – | 0.005 | – | – | – | – | – | – |

NOTES:
N/A = not applicable
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline or beyond the recommended dissolved oxygen range
W = concentration higher than the relevant drinking water guideline or beyond the recommended pH range
TCU = true colour unit
a Calculated TDS value is reported
Boldface indicates values are higher than water quality guideline levels

SOURCES: Historical data – Dryden et al. 1973; GeoNorth and Golder 2000; Hatfield et al. 1972b; Interprovincial Pipeline Ltd. 1985; McCart 1974; McCart and McCart 1982; Reid et al. 1974; Shotton 1973; Slaney, F.F. and Company Ltd. 1974b

**Table 6-79: Ochre River (RPR-391) and River Between Two Mountains (RPR-419) – Water Quality (Metals)**

| Parameter | Units | Ochre River (RPR-391) | | | River Between Two Mountains (RPR-419) |
|---|---|---|---|---|---|
| | | 2002 | Historical Data (1971–1999) | | 2002 |
| | | Summer | Winter | | Summer |
| | | July 25 | Median | n | July 26 |
| **Total Metals** | | | | | |
| Aluminum | mg/L | **0.2**[C,W] | – | – | **0.73**[C,W] |
| Antimony | mg/L | 0.0005 | – | – | 0.0008 |
| Arsenic | mg/L | <0.0004 | – | – | 0.0005 |
| Barium | mg/L | 0.055 | – | – | 0.039 |
| Beryllium | mg/L | <0.001 | – | – | <0.001 |
| Boron | mg/L | <0.02 | – | – | <0.02 |
| Cadmium | mg/L | <0.0002[D>C] | – | – | <0.0002[D>C] |
| Chromium | mg/L | <0.0008 | – | – | <0.0008 |
| Cobalt | mg/L | <0.0002 | – | – | 0.0003 |
| Copper | mg/L | 0.002 | – | – | 0.002 |
| Iron | mg/L | 0.2 | 0.28 | 1 | **0.54**[C,W] |
| Lead | mg/L | 0.0002 | – | – | 0.0006 |
| Lithium | mg/L | 0.007 | – | – | <0.006 |
| Manganese | mg/L | 0.004 | 0.01 | 1 | 0.015 |
| Mercury [1] | mg/L | 0.0000007 | – | – | 0.0000008 |
| Molybdenum | mg/L | 0.0006 | – | – | 0.0004 |
| Nickel | mg/L | 0.001 | – | – | 0.0012 |
| Selenium | mg/L | <0.0004 | – | – | <0.0004 |
| Silver [1] | mg/L | 0.000019 | – | – | 0.000019 |
| Strontium [2] | mg/L | 0.38 | – | – | 0.14 |
| Thallium | mg/L | <0.0001 | – | – | <0.0001 |
| Titanium | mg/L | 0.006 | – | – | 0.01 |
| Uranium | mg/L | 0.0004 | – | – | 0.0002 |
| Vanadium | mg/L | 0.0007 | – | – | 0.0018 |
| Zinc | mg/L | 0.006 | – | – | **0.046**[C] |
| **Dissolved Metals** | | | | | |
| Aluminum | mg/L | 0.01 | – | – | <0.01 |
| Antimony | mg/L | 0.0004 | – | – | <0.0004 |
| Arsenic | mg/L | <0.0004 | – | – | <0.0004 |
| Barium | mg/L | 0.055 | – | – | 0.033 |
| Beryllium | mg/L | <0.001 | – | – | <0.001 |
| Boron | mg/L | 0.02 | – | – | 0.01 |
| Cadmium | mg/L | <0.0001 | – | – | <0.0001 |
| Chromium | mg/L | <0.0004 | – | – | <0.0004 |
| Cobalt | mg/L | <0.0001 | – | – | <0.0001 |
| Copper | mg/L | 0.0018 | – | – | 0.0009 |
| Iron | mg/L | 0.04 | – | – | 0.03 |
| Lead | mg/L | 0.0002 | – | – | 0.0002 |
| Lithium | mg/L | 0.007 | – | – | 0.002 |

**Table 6-79: Ochre River (RPR-391) and River Between Two Mountains (RPR-419) – Water Quality (Metals) (cont'd)**

| | | Ochre River (RPR-391) | | | River Between Two Mountains (RPR-419) |
|---|---|---|---|---|---|
| | | 2002 | Historical Data (1971–1999) | | 2002 |
| | | Summer | Winter | | Summer |
| Parameter | Units | July 25 | Median | n | July 26 |
| **Dissolved Metals (cont'd)** | | | | | |
| Manganese | mg/L | 0.003 | – | – | 0.003 |
| Mercury | mg/L | <0.0001 | – | – | <0.0001 |
| Molybdenum | mg/L | 0.0005 | – | – | 0.0003 |
| Nickel | mg/L | 0.0009 | – | – | 0.0006 |
| Selenium | mg/L | <0.0004 | – | – | <0.0004 |
| Silver | mg/L | <0.0002 | – | – | <0.0002 |
| Strontium [2] | mg/L | 0.35 | – | – | 0.13 |
| Thallium | mg/L | <0.00005 | – | – | <0.00005 |
| Titanium | mg/L | 0.0005 | – | – | 0.0005 |
| Uranium | mg/L | 0.0004 | – | – | 0.0001 |
| Vanadium | mg/L | <0.0001 | – | – | <0.0001 |
| Zinc | mg/L | 0.004 | – | – | 0.004 |

NOTES:
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline
W = concentration higher than the relevant drinking water guideline
D>C = analytical detection limit is higher than the chronic aquatic life guideline (C)
1 Ultra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for dissolved mercury and silver.
2 The accuracy of reported total and dissolved strontium levels is uncertain because irregularities in quality control sample results might indicate sample contamination
Boldface indicates values are higher than water quality guideline levels

SOURCES: Historical data – Dryden et al. 1973; GeoNorth and Golder 2000; Hatfield et al. 1972b; Interprovincial Pipeline Ltd. 1985; McCart 1974; McCart and McCart 1982; Reid et al. 1974; Shotton 1973; Slaney, F.F. and Company Ltd. 1974b

**Table 6-93: Deh Cho Region Rivers, Creeks and Lakes – Sediment Quality**

| Parameter | Units | Mackenzie River, Upstream of the Liard River and Fort Simpson (RPR-470)[a] | Trout River (RPR-479) | Kakisa River (Site 644) | White Sand Creek (Site 488) | Hodgson Creek (RPR-399)[b] | Manners Creek (RPR-472) | Unnamed Lake (RPR-474)[b] | Jean-Marie Creek (RPR-475) |
|---|---|---|---|---|---|---|---|---|---|
| | | September 13, 2002 | July 30, 2002 | July 29, 2002 | August 1, 2002 | July 27, 2002 | September 10, 2002 | October 21, 2003 | September 10, 2002 |
| **Particle Size** | | | | | | | | | |
| Particle size – % sand | % | 53 | 94 | 81 | 91 | 82 | 43 | – | 82 |
| Particle size – % silt | % | 26 | 4 | 11 | 3 | 12 | 38 | – | 12 |
| Particle size – % clay | % | 20.5 | 2 | 9 | 6 | 6 | 19 | – | 5 |
| Moisture content | % | 16.5 | 22 | 35 | 15 | 40 | 41 | 95 | 31 |
| **Carbon Content** | | | | | | | | | |
| Total inorganic carbon | % by wt | 2.1 | 0.8 | 0.9 | 4.9 | 1 | 1.4 | 0.1 | 1.1 |
| Total organic carbon | % by wt | <0.1 | 0.6 | 3.3 | 1.6 | 0.3 | 2.9 | 38.4 | 0.9 |
| Total carbon | % by wt | 2 | 1.5 | 4.2 | 6.6 | 1.4 | 4.3 | 38.4 | 2 |
| **Organic Compounds** | | | | | | | | | |
| Total recoverable hydrocarbons | µg/g | 100 | <100 | 200 | <100 | <100 | 300 | 2,750 | <100 |
| Total volatile hydrocarbons ($C_5$–$C_{10}$) | µg/g | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | 0.8 | <0.5 | <0.5 |
| Total extractable hydrocarbons ($C_{11}$–$C_{30}$) | µg/g | 6 | <5 | <5 | <5 | 120 | 59 | 42 | <5 |
| **Total Metals** | | | | | | | | | |
| Aluminum | µg/g | 8,495 | 4,050 | 3,500 | 2,250 | 3,830 | 4,850 | 1,165 | 2,840 |
| Arsenic | µg/g | 4.5 | 2.7 | 2 | 1.9 | 3.8 | **6**[i] | 1.8 | 2 |
| Barium | µg/g | 120.5 | 70 | 64 | 64 | 125 | 363 | 123.5 | 50 |
| Beryllium | µg/g | 0.4 | <0.2 | 0.2 | <0.2 | <0.2 | 0.3 | <0.2 | <0.2 |
| Boron | µg/g | 4.5 | 5 | 4 | 4 | 3 | <2 | 16 | <2 |
| Cadmium | µg/g | <0.1 | 0.2 | 0.2 | <0.1 | <0.1 | 0.4 | 0.2 | <0.1 |
| Calcium | µg/g | 36,600 | 20,800 | 12,300 | 117,000 | 8,200 | 37,300 | 18,000 | 30,600 |

**Table 6-93: Deh Cho Region Rivers, Creeks and Lakes – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, Upstream of the Liard River and Fort Simpson (RPR-470)[a] | Trout River (RPR-479) | Kakisa River (Site 644) | White Sand Creek (Site 488) | Hodgson Creek (RPR-399)[b] | Manners Creek (RPR-472) | Unnamed Lake (RPR-474)[b] | Jean-Marie Creek (RPR-475) |
|---|---|---|---|---|---|---|---|---|---|
| | | September 13, 2002 | July 30, 2002 | July 29, 2002 | August 1, 2002 | July 27, 2002 | September 10, 2002 | October 21, 2003 | September 10, 2002 |
| **Total Metals (cont'd)** | | | | | | | | | |
| Chromium | µg/g | 17.5 | 9.3 | 7 | 4.2 | 6.2 | 10.6 | 1.6 | 5.6 |
| Cobalt | µg/g | 8.4 | 3.3 | 3.4 | 2.5 | 2.8 | 7 | 0.9 | 3.1 |
| Copper | µg/g | 18.5 | 7 | 6 | 4 | 5 | 15 | 3.2 | 6 |
| Iron | µg/g | 19,900 | 8,400 | 8,500 | 6,000 | 7,500 | 17,300 | 9,650 | 7,100 |
| Lead | µg/g | 6.8 | 5.1 | 3.1 | 2.7 | 3.1 | 10 | 4.2 | 3.6 |
| Magnesium | µg/g | 11,210 | 7,440 | 5,540 | 29,400 | 3,660 | 12,000 | 2,380 | 10,200 |
| Manganese | µg/g | 425.5 | 129 | 165 | 216 | 138 | 619 | 200 | 209 |
| Mercury | µg/g | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | 0.1 | <0.1 |
| Molybdenum | µg/g | 0.5 | 1 | 0.4 | 0.5 | 0.5 | 0.7 | 0.9 | 0.2 |
| Nickel | µg/g | 23.6 | 7.8 | 6.9 | 4.5 | 7.5 | 18.9 | 2.1 | 7.4 |
| Potassium | µg/g | 1,230 | 760 | 520 | 440 | 790 | 560 | 200 | 290 |
| Selenium | µg/g | <0.2 | 0.4 | 0.4 | <0.2 | 0.2 | 1 | 0.4 | 0.3 |
| Silver | µg/g | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | <0.2 | <0.1 |
| Sodium | µg/g | 95 | 90 | 60 | 80 | 220 | 60 | 200 | 40 |
| Strontium | µg/g | 54.5 | 25 | 18 | 79 | 20 | 77 | 65 | 32 |
| Thallium | µg/g | 0.1 | 0.1 | 0.1 | <0.1 | 0.1 | 0.1 | <0.1 | <0.1 |
| Titanium | µg/g | 13.3 | 114 | 34.5 | 66.8 | 81.1 | 16.2 | 18.5 | 18.6 |
| Uranium | µg/g | 0.6 | 0.9 | 1.1 | 0.8 | 0.6 | 0.7 | 0.3 | 0.4 |
| Vanadium | µg/g | 18.9 | 15.6 | 12.1 | 7 | 13 | 16.4 | 1.6 | 8.4 |
| Zinc | µg/g | 51.5 | 32 | 32 | 18 | 26 | 63 | 35.5 | 24 |
| **Target PAHs and Alkylated PAHs** | | | | | | | | | |
| Naphthalene | µg/g | 0.01 | 0.002 | 0.002 | 0.003 | 0.001[e] | 0.017 | 0.015 | 0.004 |
| $C_1$ substituted naphthalenes | µg/g | 0.011 | 0.005 | 0.005 | 0.006 | 0.001 | **0.047**[f] | 0.018 | 0.004 |
| $C_2$ substituted naphthalenes | µg/g | 0.044 | 0.021 | 0.013 | 0.008 | 0.009 | 0.059 | 0.275 | 0.01 |

**Table 6-93: Deh Cho Region Rivers, Creeks and Lakes – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, Upstream of the Liard River and Fort Simpson (RPR-470)[a] | Trout River (RPR-479) | Kakisa River (Site 644) | White Sand Creek (Site 488) | Hodgson Creek (RPR-399)[b] | Manners Creek (RPR-472) | Unnamed Lake (RPR-474)[b] | Jean-Marie Creek (RPR-475) |
|---|---|---|---|---|---|---|---|---|---|
| | | September 13, 2002 | July 30, 2002 | July 29, 2002 | August 1, 2002 | July 27, 2002 | September 10, 2002 | October 21, 2003 | September 10, 2002 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | |
| $C_3$ substituted naphthalenes | µg/g | 0.126 | 0.058 | 0.026 | 0.02 | 0.011 | 0.065 | 0.047 | 0.02 |
| $C_4$ substituted naphthalenes | µg/g | 0.176 | 0.077 | 0.033 | <0.001 | 0.014 | 0.047 | 0.049 | 0.03 |
| Acenaphthene | µg/g | 0.001 | 0.001[c] | <0.001 | <0.0003 | <0.001 | 0.001[c] | 0.004 | <0.0003 |
| $C_1$ substituted acenaphthene | µg/g | 0.0003 | <0.0002 | <0.0003 | <0.0004 | <0.001 | <0.0003 | <0.001 | <0.0002 |
| Acenaphthylene | µg/g | 0.0002 | <0.0002 | <0.001 | <0.0002 | <0.001 | <0.0004 | <0.001 | <0.0001 |
| Anthracene | µg/g | 0.001 | <0.0003 | <0.0004 | <0.0003 | <0.001 | <0.0004 | 0.001 | <0.0002 |
| Dibenzo(a,h)anthracene | µg/g | 0.001 | <0.0004 | <0.001 | <0.0003 | <0.002 | 0.001[c] | <0.001 | <0.0002 |
| Benzo(a)anthracene | µg/g | 0.001[c] | 0.001[c] | 0.001[c] | 0.0003[c] | <0.001 | 0.002 | <0.001 | 0.0004 |
| $C_1$ substituted benzo(a)anthracene/chrysene | µg/g | 0.082 | 0.06 | 0.042 | 0.032 | 0.012 | 0.065 | 0.171 | 0.025 |
| $C_2$ substituted benzo(a)anthracene/chrysene | µg/g | 0.022 | 0.015 | 0.009 | 0.01 | 0.003 | 0.012 | 0.019 | 0.007 |
| Benzo(a)pyrene | µg/g | 0.001 | <0.001 | <0.001 | <0.001 | <0.004 | <0.001 | <0.001 | <0.001 |
| $C_1$ substituted benzo(b&k) fluoranthene/benzo(a)pyrene | µg/g | 0.009 | 0.007 | 0.009 | 0.001 | 0.002 | 0.021 | 0.01 | 0.003 |
| $C_2$ substituted benzo(b& k) fluoranthene/benzo(a)pyrene | µg/g | 0.003 | <0.001 | 0.005 | 0.002 | <0.004 | 0.005 | 0.007 | 0.002 |
| Benzofluoranthenes | µg/g | 0.002 | 0.003 | 0.003[c] | 0.001[c] | 0.002[c] | 0.007 | 0.002[c] | 0.001 |
| Benzo(g,h,i)perylene | µg/g | 0.002 | 0.004 | 0.002[c] | 0.001 | 0.001[c] | 0.012[c] | <0.001 | 0.001[c] |
| Biphenyl | µg/g | 0.021 | 0.0005[c] | 0.0003 | <0.0003 | 0.001 | 0.003 | 0.008 | 0.004 |
| $C_1$ substituted biphenyl | µg/g | 0.0003 | <0.0003 | <0.0002 | <0.0002 | <0.001 | <0.0004 | 0.003 | <0.0003 |
| $C_2$ substituted biphenyl | µg/g | 0.004 | 0.002 | 0.001 | <0.0005 | <0.001 | 0.005 | 0.014 | 0.001 |
| Chrysene | µg/g | 0.012 | 0.01 | 0.008 | 0.004 | 0.002 | 0.009 | 0.002[c] | 0.004 |
| Dibenzothiophene | µg/g | 0.008[c] | 0.002 | 0.002 | <0.0004 | <0.001 | 0.002[c] | 0.004[c] | 0.001[c] |
| $C_1$ substituted dibenzothiophene | µg/g | 0.026 | 0.029 | 0.018 | 0.006 | 0.003 | 0.006 | 0.007 | 0.005 |

**Table 6-93: Deh Cho Region Rivers, Creeks and Lakes – Sediment Quality (cont'd)**

| Parameter | Units | Mackenzie River, Upstream of the Liard River and Fort Simpson (RPR-470)[a] | Trout River (RPR-479) | Kakisa River (Site 644) | White Sand Creek (Site 488) | Hodgson Creek (RPR-399)[b] | Manners Creek (RPR-472) | Unnamed Lake (RPR-474)[b] | Jean-Marie Creek (RPR-475) |
|---|---|---|---|---|---|---|---|---|---|
| | | September 13, 2002 | July 30, 2002 | July 29, 2002 | August 1, 2002 | July 27, 2002 | September 10, 2002 | October 21, 2003 | September 10, 2002 |
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | |
| $C_2$ substituted dibenzothiophene | µg/g | 0.052 | 0.075 | 0.062 | 0.016 | 0.005 | 0.009 | 0.005 | 0.011 |
| $C_3$ substituted dibenzothiophene | µg/g | 0.034 | 0.06 | 0.058 | 0.015 | 0.006 | 0.005 | 0.003 | 0.007 |
| $C_4$ substituted dibenzothiophene | µg/g | 0.031 | 0.057 | 0.083 | 0.013 | 0.003 | 0.009 | 0.015 | 0.009 |
| Fluoranthene | µg/g | 0.003 | 0.002 | 0.002 | 0.001 | 0.001 | 0.004 | 0.005 | 0.001 |
| $C_1$ substituted fluoranthene/pyrene | µg/g | 0.014 | 0.017 | 0.045 | 0.005 | 0.002 | 0.019 | 0.014 | 0.004 |
| $C_2$ substituted fluoranthene/pyrene | µg/g | 0.029 | 0.026 | 0.025 | 0.012 | 0.003 | 0.026 | 0.012 | 0.008 |
| $C_3$ substituted fluoranthene/pyrene | µg/g | 0.027 | 0.025 | 0.015 | 0.013 | 0.003 | 0.014 | 0.018 | 0.007 |
| Fluorene | µg/g | 0.001[c] | 0.001[c] | <0.001 | <0.0002 | <0.001 | 0.002[c] | 0.01 | 0.0003 |
| $C_1$ substituted fluorene | µg/g | 0.005 | 0.003 | 0.001 | <0.0005 | <0.002 | 0.007 | 0.039 | 0.001 |
| $C_2$ substituted fluorene | µg/g | 0.036 | 0.015 | 0.01 | 0.004 | 0.003 | 0.019 | 0.068 | 0.006 |
| $C_3$ substituted fluorene | µg/g | 0.052 | 0.036 | 0.018 | 0.012 | 0.006 | 0.021 | 0.071 | 0.014 |
| Indeno(1,2,3,cd)pyrene | µg/g | 0.0005 | 0.0005[c] | <0.001 | <0.0003 | <0.001 | 0.002[c] | 0.002[c] | <0.0003 |
| Phenanthrene | µg/g | 0.02 | 0.01 | 0.004 | 0.003 | 0.002[c] | 0.02 | 0.02 | 0.01 |
| $C_1$ substituted phenanthrene/anthracene | µg/g | 0.06 | 0.03 | 0.03 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 |
| $C_2$ substituted phenanthrene/anthracene | µg/g | 0.09 | 0.06 | 0.08 | 0.04 | 0.02 | 0.03 | 0.04 | 0.02 |
| $C_3$ substituted phenanthrene/anthracene | µg/g | 0.08 | 0.06 | 0.09 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 |
| $C_4$ substituted phenanthrene/anthracene | µg/g | 0.17 | 0.17 | 1.27 | 0.05 | 0.03 | 0.16 | 0.12 | 0.05 |

Table 6-93: Deh Cho Region Rivers, Creeks and Lakes – Sediment Quality (cont'd)

| Parameter | Units | Mackenzie River, Upstream of the Liard River and Fort Simpson (RPR-470)[a] September 13, 2002 | Trout River (RPR-479) July 30, 2002 | Kakisa River (Site 644) July 29, 2002 | White Sand Creek (Site 488) August 1, 2002 | Hodgson Creek (RPR-399)[b] July 27, 2002 | Manners Creek (RPR-472) September 10, 2002 | Unnamed Lake (RPR-474)[b] October 21, 2003 | Jean-Marie Creek (RPR-475) September 10, 2002 |
|---|---|---|---|---|---|---|---|---|---|
| **Target PAHs and Alkylated PAHs (cont'd)** | | | | | | | | | |
| 1-Methyl-7-isopropyl-phenanthrene (Retene) | µg/g | 0.01[c] | 0.01[c] | 1.2 | 0.003 | 0.001[c] | 0.13 | 0.07 | 0.01 |
| Pyrene | µg/g | 0.006 | 0.007 | 0.011 | 0.002 | 0.001 | 0.007 | 0.004 | 0.002 |

NOTES:
– = not available
I = concentration higher than the interim sediment quality guideline (CCME 1999)
a Reported values are the average of two split sample results
b All reported values, except PAH concentrations, are an average of two split sample results
c PAH concentrations are reported with the limitation that the GCMS spectra used to develop these values were ill-defined, i.e., these numbers might contain a larger degree of error than those produced from clearly defined spectra

**Table 6-87: White Sand Creek (RPR-388) and Hodgson Creek (RPR-399) – Water Quality (Excluding Metals)**

| Parameter | Units | White Sand Creek (RPR-388) | | | | | | | | | | | | | Hodgson Creek (RPR-399) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972–1999) | | | | | | | | | | | | 2002 | Historical Data (1972–1986) | | | | | | | | | |
| | | Summer | Summer | | | | Fall | | | | Winter | | | | Summer | Summer | | | | Fall | | Winter | | | |
| | | August 1 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | July 27 | Median | Min. | Max. | n | Median | n | Median | Min. | Max. | n |
| **Field Measured** | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | N/A | 8.0 | 8.3 | 6.6 | 8.5 | 3 | 9[W] | – | – | 1 | 7.4 | 7.2 | 7.5 | 2 | 8.2 | 8.3 | 6.6 | 8.5 | 10 | – | – | 8.3 | 7.3 | 8.5 | 23 |
| Conductance | µS/cm | 272[a] | 332 | 175 | 480 | 3 | 283 | 228 | 338 | 2 | 300 | – | – | 1 | 324 | 340 | 162 | 565 | 10 | – | – | 540 | 350 | 575 | 22 |
| Temperature | °C | 7 | 21.3 | – | – | 1 | 4.6 | 4.2 | 5 | 2 | 3 | 2 | 4 | 2 | 13.7 | 15 | 10.5 | 15 | 3 | 3.8 | 1 | 1 | 0 | 5 | 31 |
| Dissolved oxygen | mg/L | 12.9 | 10.3 | – | – | 1 | 12.5 | 12.5 | 12.5 | 2 | 8.2 | 3.4[C] | 13 | 2 | 9.4 | 10.3 | 9.8 | 11.2 | 4 | 12.4 | 1 | 13 | 5.2[C] | 16 | 23 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colour | TCU | 70[W] | – | – | – | – | – | – | – | – | – | – | – | – | 20[W] | – | – | – | – | – | – | – | – | – | – |
| Conductance | µS/cm | 356 | – | – | – | – | – | – | – | – | – | – | – | – | 371 | 446 | – | – | 1 | – | – | – | – | – | – |
| Dissolved organic carbon | mg/L | 11 | – | – | – | – | – | – | – | – | – | – | – | – | 4 | 4 | 4 | 7 | 6 | – | – | 1 | 1 | 8 | 17 |
| Hardness | mg/L | 166 | 177 | – | – | 1 | – | – | – | – | – | – | – | – | 200 | 209 | – | – | 1 | – | – | – | – | – | – |
| pH | N/A | 8.1 | – | – | – | – | – | – | – | – | – | – | – | – | 8.2 | 8.5 | – | – | 1 | – | – | – | – | – | – |
| Total alkalinity | mg/L | 140 | 173 | – | – | 1 | 222 | – | – | 1 | – | – | – | – | 152 | 1,410 | 167 | 3,240 | 3 | – | – | 3,790 | 3,170 | 4,390 | 12 |
| Total dissolved solids | mg/L | 155[a] | 211 | – | – | 1 | 251 | – | – | 1 | – | – | – | – | 250 | – | – | – | – | 301 | 1 | – | – | – | – |
| Total organic carbon | mg/L | 11 | – | – | – | – | – | – | – | – | – | – | – | – | 4 | – | – | – | – | – | – | – | – | – | – |
| Total suspended solids | mg/L | 14 | 15 | – | – | 1 | 5 | – | – | 1 | – | – | – | – | <3 | 6 | <1 | 369 | 16 | 2 | 1 | 1 | 0.5 | 5 | 37 |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | 171 | – | – | – | – | 0.4 | – | – | 1 | – | – | – | – | 185 | 204 | – | – | 1 | 0.4 | 1 | 259 | 231 | 264 | 3 |
| Calcium | mg/L | 45 | 48 | – | – | 1 | – | – | – | – | – | – | – | – | 50 | 47 | 21 | 59 | 7 | – | – | 64 | 52 | 70 | 20 |
| Carbonate | mg/L | <5 | – | – | – | – | – | – | – | – | – | – | – | – | <5 | – | – | – | – | – | – | – | – | – | – |
| Chloride | mg/L | <1 | 2 | – | – | 1 | 2 | – | – | 1 | – | – | – | – | <1 | 1 | 0.4 | 2 | 7 | – | – | 5 | 1 | 11 | 20 |
| Magnesium | mg/L | 13 | 14 | – | – | 1 | – | – | – | – | – | – | – | – | 18 | 15 | 6 | 17 | 7 | – | – | 28 | 20 | 38 | 20 |
| Potassium | mg/L | 0.4 | 1 | – | – | 1 | 1 | – | – | 1 | – | – | – | – | 1 | 1 | 1 | 1 | 7 | – | – | 1 | 1 | 14 | 20 |
| Sodium | mg/L | 1 | 2 | – | – | 1 | 2 | – | – | 1 | – | – | – | – | 3 | 2 | 1 | 43 | 7 | – | – | 11 | 4 | 17 | 20 |
| Sulphate | mg/L | 10 | 15 | – | – | 1 | 15 | – | – | 1 | – | – | – | – | 52 | 34 | 17 | 50 | 7 | – | – | 77 | 50 | 106 | 20 |
| Sulphide | mg/L | <0.003 | – | – | – | – | – | – | – | – | – | – | – | – | 0.003 | – | – | – | – | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nitrate + nitrite | mg/L | <0.1 | 0.02 | – | – | 1 | 0.02 | – | – | 1 | – | – | – | – | 0.1 | – | – | – | – | – | – | – | – | – | – |
| Nitrate | mg/L | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0.215 | 0.15 | 0.28 | 2 |
| Nitrogen – ammonia | mg/L | <0.05 | 0.024 | – | – | 1 | 0.024 | – | – | 1 | – | – | – | – | <0.05 | – | – | – | – | – | – | – | – | – | – |
| Nitrogen – Kjeldahl | mg/L | 0.7 | – | – | – | – | – | – | – | – | – | – | – | – | 0.5 | – | – | – | – | – | – | – | – | – | – |

## Table 6-87: White Sand Creek (RPR-388) and Hodgson Creek (RPR-399) – Water Quality (Excluding Metals) (cont'd)

| Parameter | Units | White Sand Creek (RPR-388) | | | | | | | | | | | | | Hodgson Creek (RPR-399) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972–1999) | | | | | | | | | | | | 2002 | Historical Data (1972–1986) | | | | | | | | | |
| | | Summer | Summer | | | | Fall | | | | Winter | | | | Summer | Summer | | | | Fall | | Winter | | | |
| | | August 1 | Median | Min. | Max. | n | Median | Min. | Max. | n | Median | Min. | Max. | n | July 27 | Median | Min. | Max. | n | Median | n | Median | Min. | Max. | n |
| **Field Measured** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phosphorus – total | mg/L | 0.013 | 0.013 | – | – | 1 | 0.013 | – | – | 1 | – | – | – | – | 0.004 | – | – | – | – | – | – | – | – | – | – |
| Phosphorus – dissolved | mg/L | 0.003 | – | – | – | – | – | – | – | – | – | – | – | – | 0.002 | 0.008 | 0.007 | 0.016 | 6 | – | – | 0.006 | 0.002 | 0.04 | 17 |

NOTES:
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline or beyond the recommended dissolved oxygen range
W = concentration higher than the relevant drinking water guideline or beyond the recommended pH range
TCU = true colour unit
a Field Conductance value is questionable as indicated by more than a 20% difference between field and laboratory-measured values
b Calculated TDS value is reported
Boldface indicates values are higher than water quality guideline levels

SOURCES: Historical data – Shotton 1973; McCart 1974; Reid et al. 1974; McCart and McCart 1982; Interprovincial Pipeline Ltd. 1985; McKinnon and Hnytka 1988; Slaney, F.F. and Company Ltd. 1974b; GeoNorth and Golder 2000

**Table 6-88: White Sand Creek (RPR-388) and Hodgson Creek (RPR-399) – Water Quality (Metals)**

| Parameter | Units | White Sand Creek (RPR-388) | | | Hodgson Creek (RPR-399) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972–1999) | | 2002 | Historical Data (1972–1986) | | | | | | | |
| | | Summer | Summer | | Summer | Summer | | | | Winter | | | |
| | | August 1 | Median | n | July 27 | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Total Metals** | | | | | | | | | | | | | |
| Aluminum | mg/L | **0.77**[C,W] | **0.638**[C,W] | 1 | **0.3**[C,W] | – | – | – | – | – | – | – | – |
| Antimony | mg/L | 0.0008 | 0.0007 | 1 | 0.0008 | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | 0.0005 | <0.0002 | 1 | <0.0004 | – | – | – | – | – | – | – | – |
| Barium | mg/L | 0.072 | 0.085 | 1 | 0.072 | – | – | – | – | – | – | – | – |
| Beryllium | mg/L | <0.001 | <0.002 | 1 | <0.001 | – | – | – | – | – | – | – | – |
| Boron | mg/L | <0.02 | – | – | <0.02 | – | – | – | – | – | – | – | – |
| Cadmium | mg/L | <0.0002[D>C] | <0.0003[D>C] | 1 | <0.0002[D>C] | – | – | – | – | – | – | – | – |
| Chromium | mg/L | **0.0021**[C] | <0.003[D>C] | 1 | <0.0008 | – | – | – | – | – | – | – | – |
| Cobalt | mg/L | 0.0005 | <0.001 | 1 | 0.0002 | – | – | – | – | – | – | – | – |
| Copper | mg/L | 0.002 | <0.002 | 1 | 0.001 | – | – | – | – | – | – | – | – |
| Iron | mg/L | **0.59**[C,W] | 0.0005 | 1 | 0.16 | 0.17 | 0.07 | **2.62**[C,W] | 6 | 0.02 | 0.001 | <0.1 | 17 |
| Lead | mg/L | 0.0004 | <0.001 | 1 | 0.0004 | – | – | – | – | – | – | – | – |
| Lithium | mg/L | <0.006 | 0.004 | 1 | <0.006 | – | – | – | – | – | – | – | – |
| Manganese | mg/L | 0.007 | 0.007 | 1 | 0.001 | – | – | – | – | <0.01 | <0.01 | 0 | 2 |
| Mercury [1] | mg/L | 0.0000017 | <0.00001 | 1 | 0.0000007 | – | – | – | – | – | – | – | – |
| Molybdenum | mg/L | 0.0012 | <0.001 | 1 | 0.0012 | – | – | – | – | – | – | – | – |
| Nickel | mg/L | 0.0012 | 0.003 | 1 | 0.0004 | – | – | – | – | – | – | – | – |
| Selenium | mg/L | <0.0004 | <0.01[D>C] | 1 | <0.0004 | – | – | – | – | – | – | – | – |
| Silver [1] | mg/L | 0.000014 | <0.0003[D>C] | 1 | 0.00002 | – | – | – | – | – | – | – | – |
| Strontium [2] | mg/L | 0.31 | 0.28 | 1 | 1.1 | – | – | – | – | – | – | – | – |
| Thallium | mg/L | <0.0001 | <0.0004 | 1 | <0.0001 | – | – | – | – | – | – | – | – |
| Titanium | mg/L | 0.017 | 0.008 | 1 | 0.007 | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0005 | 0.0005 | 1 | 0.0014 | – | – | – | – | – | – | – | – |
| Vanadium | mg/L | 0.0023 | 0.003 | 1 | 0.0005 | – | – | – | – | – | – | – | – |

**Table 6-88: White Sand Creek (RPR-388 and Site 488) and Hodgson Creek (RPR-399) – Water Quality (Metals) (cont'd)**

| Parameter | Units | White Sand Creek (RPR-388) | | | Hodgson Creek (RPR-399) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972–1999) | | 2002 | Historical Data (1972–1986) | | | | | | | |
| | | Summer | Summer | | Summer | Summer | | | | Winter | | | |
| | | August 1 | Median | n | July 27 | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Total Metals (cont'd)** | | | | | | | | | | | | | |
| Zinc | mg/L | 0.008 | <0.01 | 1 | 0.02 | – | – | – | – | – | – | – | – |
| **Dissolved Metals** | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.02 | – | – | <0.01 | – | – | – | – | – | – | – | – |
| Antimony | mg/L | 0.0005 | – | – | <0.0004 | – | – | – | – | – | – | – | – |
| Arsenic | mg/L | <0.0004 | – | – | <0.0004 | – | – | – | – | – | – | – | – |
| Barium | mg/L | 0.061 | – | – | 0.073 | – | – | – | – | – | – | – | – |
| Beryllium | mg/L | <0.001 | – | – | <0.001 | – | – | – | – | – | – | – | – |
| Boron | mg/L | <0.002 | – | – | 0.01 | – | – | – | – | – | – | – | – |
| Cadmium | mg/L | <0.0001 | – | – | <0.0001 | – | – | – | – | – | – | – | – |
| Chromium | mg/L | <0.0004 | – | – | <0.0004 | – | – | – | – | – | – | – | – |
| Cobalt | mg/L | <0.0001 | – | – | <0.0001 | – | – | – | – | – | – | – | – |
| Copper | mg/L | 0.0014 | 0.002 | 1 | 0.0011 | – | – | – | – | – | – | – | – |
| Iron | mg/L | 0.03 | – | – | 0.01 | 0.00004 | <0.00004 | 0.0001 | 6 | <0.00004 | <0.00004 | 0.00008 | 16 |
| Lead | mg/L | 0.0004 | 0.004 | 1 | 0.0002 | – | – | – | – | – | – | – | – |
| Lithium | mg/L | <0.0001 | – | – | 0.004 | – | – | – | – | – | – | – | – |
| Manganese | mg/L | 0.002 | 0.007 | 1 | <0.001 | – | – | – | – | – | – | – | – |
| Mercury | mg/L | 0.0001 | – | – | <0.0001 | – | – | – | – | – | – | – | – |
| Molybdenum | mg/L | 0.0003 | – | – | 0.0011 | – | – | – | – | – | – | – | – |
| Nickel | mg/L | 0.001 | – | – | 0.0005 | – | – | – | – | – | – | – | – |
| Selenium | mg/L | <0.0004 | – | – | <0.0004 | – | – | – | – | – | – | – | – |
| Silicon | mg/L | – | – | – | – | 1.72 | 1.69 | 8.4 | 6 | 2.74 | 2.04 | 2.79 | 17 |
| Silver | mg/L | <0.0002 | – | – | <0.0002 | – | – | – | – | – | – | – | – |

**Table 6-88: White Sand Creek (RPR-388 and Site 488) and Hodgson Creek (RPR-399) – Water Quality (Metals) (cont'd)**

| Parameter | Units | White Sand Creek (RPR-388) | | | Hodgson Creek (RPR-399) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | Historical Data (1972–1999) | | 2002 | Historical Data (1972–1986) | | | | | | | |
| | | Summer | Summer | | Summer | Summer | | | | Winter | | | |
| | | August 1 | Median | n | July 27 | Median | Min. | Max. | n | Median | Min. | Max. | n |
| **Dissolved Metals (cont'd)** | | | | | | | | | | | | | |
| Zinc | mg/L | 0.008 | <0.01 | 1 | 0.02 | – | – | – | – | – | – | – | – |
| Strontium [2] | mg/L | 0.29 | – | – | 1 | – | – | – | – | – | – | – | – |
| Thallium | mg/L | <0.00005 | – | – | 0.00005 | – | – | – | – | – | – | – | – |
| Titanium | mg/L | <0.0003 | – | – | 0.0004 | – | – | – | – | – | – | – | – |
| Uranium | mg/L | 0.0004 | – | – | 0.0015 | – | – | – | – | – | – | – | – |
| Vanadium | mg/L | <0.0001 | – | – | <0.0001 | – | – | – | – | – | – | – | – |
| Zinc | mg/L | <0.002 | – | – | 0.017 | – | – | – | – | – | – | – | – |

NOTES:
– = not available
n = number of samples
C = concentration higher than the relevant chronic aquatic life guideline
W = concentration higher than the relevant drinking water guideline
D>C = analytical detection limit is higher than the chronic aquatic life guideline (C)
1 Ultra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for dissolved mercury and silver.
2 The accuracy of reported total and dissolved strontium levels is uncertain, because of irregularities in quality control sample results that might indicate sample contamination
Boldface indicates values are higher than water quality guideline levels

SOURCES: Historical data – Shotton 1973; McCart 1974; Reid et al. 1974; McCart and McCart 1982; Interprovincial Pipeline Ltd. 1985; McKinnon and Hnytka 1988; Slaney, F.F. and Company Ltd. 1974b; GeoNorth and Golder 2000